AN AUTECOLOGICAL EXPLORATION OF *BUTEA MONOSPERMA* WITH SPECIAL REFERENCE TO NURSERY GROWTH AND REGENERATION BEHAVIOUR

A Thesis

Submitted towards the Requirements for the Award of Degree of

DOCTOR OF PHILOSOPHY

IN

BOTANY

Under the Department of Botany

Submitted By

MANOJ KUSHWAHA

(Enrollment No. 220101064)

Under the Supervision of

Dr. SACHIN SINGH

Assistant Professor

Department of Botany

Faculty of Science



2026

P.K. University

NH-27, Vill, Thanra (P.O. Dinara)

Shivpuri, M.P. India-473665

P.K.UNIVERSITY
SHIVPURI (M.P.)

University Established Under section 2F of UGC ACT 1956 Vide M.P. Government Act No17 of 2015

CERTIFICATE OF THE SUPERVISOR

This is to certify that the work entitled **"AN AUTECOLOGICAL EXPLORATION ON *BUTEA MONOSPERMA* WITH SPECIAL REFERENCE TO NURSERY GROWTH AND REGENERATION BEHAVIOR**" is a piece of research Work done by **Mr. MANOJ KUSHWAHA, (Enrollment No. 220101064)** Under My Guidance and Supervision for the Degree of Doctor of Philosophy in Botany Department of Botany P.K. University Shivpuri (M.P.) India.

I certify That the candidate has put an attendance of more than 240 day with me.

To the best of my knowledge and belief the thesis:

I –Embodies the work of the candidate himself

II –Has duly been completed.

III – Fullfil the requirement of the ordinance relating to the Ph.D. degree of the University.

Date:..../...../…… **Signature of the Supervisor**

DECLARATION BY THE CANDIDATE

I declare that the thesis entitled **"AN AUTECOLOGICAL EXPLORATION ON *BUTEA MONOSPERMA* WITH SPECIAL REFERENCE TO NURSERY GROWTH AND REGENERATION BEHAVIOR**" is my own work conducted under the supervision of **Dr. SACHIN SINGH,** Department of Botany P.K. University, Shivpuri (M.P.) India.

Approved by Research Degree Committee. I have put more than 240 days of attendance with supervisor at the center.

I further declare that to the best of my knowledge the thesis does not contain my part of any work has been submitted for the award of any degree either in this University or in any other University Without proper citation.

Date:-…/…../…… **Signature of the candidate**

Place: P.K. University

P.K.UNIVERSITY
SHIVPURI (M.P.)

University Established Under section 2F of UGC ACT 1956 Vide M.P. Government Act No17 of 2015

COPYRIGHT TRANSFER CERTIFICATE

Title of the Thesis: **"AN AUTECOLOGICAL EXPLORATION ON *BUTEA MONOSPERMA* WITH SPECIAL REFERENCE TO NURSERY GROWTH AND REGENERATION BEHAVIOR"**

Candidate's Name: **Mr. MANOJ KUSHWAHA, (Enrollment No. 220101064)**

COPY RIGHT TRANSFER

The undersigned hereby assigns to the P.K. University, Shivpuri (M.P.) all copyrights that exist inand for the above thesis submitted for the award of the Ph.D. Degree.

Date:…./…../…….. **Name of the scholar**

Note: However, the author may reproduce/publish or authorize others to reproduce, material extracted verbatim from the thesis or derivative of the thesis for author's personal use provided that the source and the University's copyright notice are indicated.

FORWARDING LETTER OF HEAD OF INSTITUTION

The Ph.D. thesis entitled **"AN AUTECOLOGICAL EXPLORATION ON *BUTEA MONOSPERMA* WITH SPECIAL REFERENCE TO NURSERY GROWTH AND REGENERATION BEHAVIOR"** Submitted by **Mr. MANOJ KUSHWAHA, (Enrollment No. 220101064)** is forwarded to the University in seven copies. The candidate has paid the necessary fees and there are No-dues outstanding against him.

Name:-…… **Seal……**

Date:…/…../……..

Place:- P.K. University

(Signature of Head of Institution where the Candidate was registered for Ph.D. degree)

Signature of the Supervisor

Date: ……..

Place:- P.K. University

DrillBit

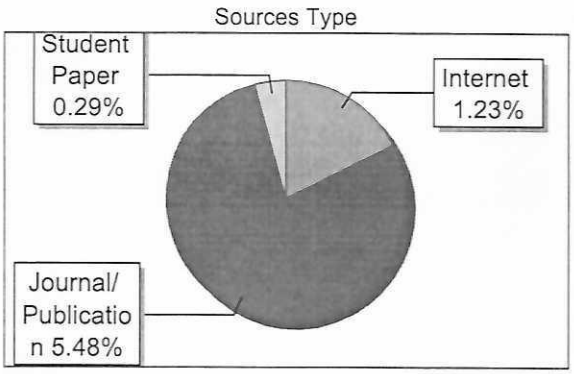
The Report is Generated by DrillBit Plagiarism Detection Software

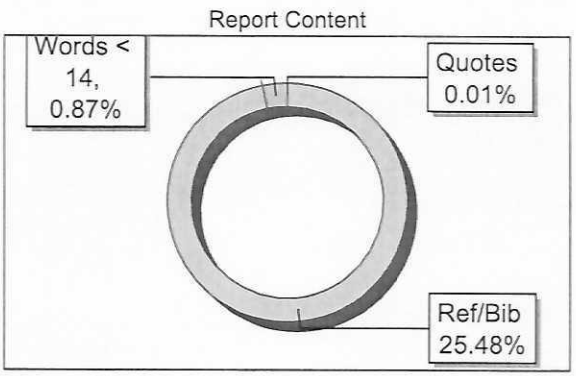
Submission Information

Author Name	Manoj Kushwaha
Title	An Autecological Exploration of Butea monosperma with special reference to nursery growth and regeneration behaviour
Paper/Submission ID	5363369
Submitted by	library.pku@gmail.com
Submission Date	2026-03-18 09:44:41
Total Pages, Total Words	166, 48033
Document type	Thesis Chapter

Result Information

Similarity **7 %**





Exclude Information

Quotes	Not Excluded
References/Bibliography	Not Excluded
Source: Excluded < 14 Words	Not Excluded
Excluded Source	**0 %**
Excluded Phrases	Not Excluded

Database Selection

Language	English
Student Papers	Yes
Journals & publishers	Yes
Internet or Web	Yes
Institution Repository	Yes

A Unique QR Code use to View/Download/Share Pdf File

LIBRARIAN
P.K. University
Shivpuri (M.P.)

P.K.University
Shivpuri (M.P.)

Result - September-2023

Course:	Ph.D. in Botany	Semester:	First Semester
Enrollment No:	220101064	Institute Name:	Faculty of Science
Student Name:	MANOJ KUSHWAHA	Roll No:	221878317
Father's Name:	MANGAL SINGH	Session:	2022-23

S.No.	Subject Code	Subject Name	Credit	Grade	Grade Point	Credit Point
1	PHD101	RESEARCH METHODOLOGY	4	B+	8	32
2	PHD102	BOTANY	6	B+	8	48
3	PHD103	RESEARCH AND PUBLICATION ETHICS	2	A	9	18
		Total	12			98

SGPA:	98 / 12	8.17
CGPA:		8.17
Result:		Pass

* Grade in Repeat Examination



P.K.UNIVERSITY
SHIVPURI (M.P.)

University Established Under section 2f of UGC ACT 1956 Vide MP Government Act No 17 of 2015

Ref. no.:- PhD/PKU/2026/04/59 Date: 21/04/26

Pre – Ph.D Submission Presentation Certificate

This is to certify that **Manoj Kushwaha, Enrollment No: 220101064,** research scholar in Botany under the supervision of Dr. **Sachin Singh**, Faculty of Science has given his open Pre-Ph.D submission presentation on the approved topic "**An Autecological Exploration of Butea Monosperma with Special Reference to Nursery Growth and Regeneartion Behaviour**" on Date 11/03/2026 at Time 10:00 AM in the P.K. University, Shivpuri (MP).

Dean Academic
P.K. University
Shivpuri (M.P.)

ADDRESS: VILL: THANRA, TEHSIL: KARERA, NH-27, DIST: SHIVPURI, M.P. 473665,
MOB: 7241115088, Email:registrar.pkuniversity@gmail.com

ACKNOWLEDGEMENT

The Acknowledgement of a research endeavor is an opportunity to express appreciation for the joint effort of those who have been sources of motivation and support, and who have contributed invaluable knowledge towards achieving success in the pursuit of knowledge. With utmost humility and pride, I reflect on the inspiring individuals who have propelled my work forward, and I am filled with immense pleasure, gratitude and thanks for their unwavering dedication.

First, for most, I would like to thank almighty god for the perseverance, courage, and strength bestowed on me to undertake this project.

I would like to extend my deepest appreciation and gratitude to my esteemed Supervisor, **Dr. Sachin Singh,** Assistant Professor P.K. University Shivpuri (M.P.) without whom this work would not have come to fruition. His exceptional guidance, unwavering support kind cooperation, and provision of a conductive work environment have been invaluable beyond measure. I remain indebted to her for instilling in me a relentless pursuit of excellence, a strong sense of honesty, and respect for ethical principles that govern our profession.

Furthermore, I extend my sincere thanks to the **Shri Jagdeesh Prasad Sharma** Chancellor, P.K University Shivpuri (M.P) for providing the necessary infrastructure and facilities that were essential during my research work. My profound sense of gratitude, faith, and awe also goes to **Prof. (Dr.) Yogesh Chandra Dubey** Vice Chancellor, P.K University Shivpuri (M.P)for his generous and valuable support throughout my research.I express my gratitude to **Prof. (Dr.) Mukesh Chansoriya** ProVice -Chancellor, P.K. University Shivpuri (M.P.) for his generous and valuable support throughout my research.

I take this pleasant opportunity to express my deep sense of gratitude and reverence to his holiness **Dr. Jitendra Kumar Mishra** Director; P.K. University Shivpuri (M.P) for his constant encouragement and for providing me with the required facilities that enabled me to complete my project work.

I also extend my deepest appreciation to **Prof. Jitendra Kumar Malik,** Registrar of P.K. University Shivpuri (M.P.) has inspired me with his encouraging guidance and support right from the beginning of this work despite his busy schedule. I am short of words to thank him for his affectionate behavior and patience throughout the duration of the research work.

I express my gratitude to **Dr. Aiman Fatima,** Dean of Academics of P.K. University Shivpuri (M.P) I owe a great deal of application and gratitude to the entire faculty members and all non-teaching staff of the department without their support it would have been difficult to shape my research work.

I would also like to extend my gratitude to and deep appreciation to respected **Dr. Ashish Vishwakarma,** Dean Research of P.K. University, M.P.

I would also like to thank **Dr Praveen ,** P.K. University, (M.P) **And Manish Kumar,** for her valuable support and guidance.

I also express my gratitude to **Miss Nisha Yadav,** Librarian of P.K University along with Mr. Anand Kumar, Assistant Librarian, and other staff of P.K University. I am also thankful to **Mr. Pankaj Singh, Mr. Alok Khare**, and **Mr. Purushottam Yadav**, I.T. Cell of P.K. University.

I have no words to express my gratitude to my family members and my better half for their love, support and constant encouragement during the entire course of my research work.

Date:…./……/……. **Manoj Kushwaha**

Place: P.K. University

I N D E X

Chapter No.	Topic	Page No.
1	Introduction	1-24
2	Review of Literature	25-50
3	Materials and Methods	51-69
4	Results and Discussion	70-128
5	Conclusion and Recommendations and Future Scope of Research	129-136
-	Bibliography	137-180
-	Annexure	-

LIST OF TABLES

Table No.	Title	Page No.
1.1	India- Reserved/Protected/Unclassed Forest area(in Km^2)	2
1.2	India- Forest Types	2
3.1	Average Monthly Climatic Conditions on Jhansi During the study area (2023-2024)	59
3.2	Abbrebiationsused in the experiments performed at nursery to represent growth parameters of seedlings in relation to different treatments	67
4.1	Vegetation characteristics Of Banguan forest	72
4.2	Vegetation characteristics of Orchha forest	73
4.3	Leafing behavior of forest tree species	77
4.4	Leaf-fall behavior of forest tree species	77
4.5	Flowering behavior of forest tree species	78
4.6	Fruit -fall behavior of forest tree species	78
4.7	Effect of Seed treatment on seed germination of *Butea monosperma*	81

4.8	Showing germination percentage in Laboratory condition	83
4.9	Topographical pattern of Tetrazolium staining received by various seeds of *Butea monosperma*	84
4.10	Comparison between Laboratory germination percentage and viability of seed determined by Tetrazolium test	85
4.11	Data of emergence, duration of germination period and percentage germination of *Butea monosperma* seeds as affected by different depths od sowing (Each value based on an average value of 4 replicates.)	87
4.12	Effect of leaf leachate on germination of seed of *Butea monosperma*	88
4.13	Water absorption (Percent of initial weight) and germination percentage of seeds	89
4.14 (A)	Growth performance of seedl.ings of *Butea monosperma* at the age of Six months in relation to different potting media	92
4.14 (B)	Growth performance of seedl.ings of *Butea monosperma* at the age of Six months in relation to different potting media	93
4.14 (C)	Growth performance of seedl.ings of *Butea monosperma* at the age of Six months in relation to different potting media	93
4.14 (D)	Growth performance of seedl.ings of *Butea monosperma* at the age of Six months in relation to different potting media	94
4.14 (E)	Growth performance of seedl.ings of *Butea monosperma* at the age of Six months in relation to different potting media	94

4.14 (F)	Growth performance of seedl.ings of *Butea monosperma* at the age of Six months in relation to different potting media	95
4.14 (G)	Growth performance of seedl.ings of *Butea monosperma* at the age of Six months in relation to different potting media	95
4.15	Represent the value of Quality Index and Sturdiness Quotient of seedlings in different potting media	96
4.16 (A)	Effect of different light condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements)	103
4.16 (B)	Effect of different light condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements)	103
4.16 (C)	Effect of different light condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements.)	104
4.17	Indicates the value of Quality(QI) Index and Sturdiness Quotient (SQ) of seedlings in different potting media	104
4.18 (A)	Effect of different irrigation condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements)	109
4.18 (B)	Effect of different irrigation condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements)	110
4.18 (C)	Effect of different irrigation condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements)	111
4.19	Indicates the value of Quality(QI) Index and Sturdiness Quotient (SQ) of seedling of *Butea monosperma*grown in different water regime	111

4.20 (A)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	116
4.20 (8)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	116
4.20 (C)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	117
4.20 (D)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	118
4.20 (E)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	119
4.20 (F)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	119
4.20 (G)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	120
4.20 (H)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	120
4.20 (I)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	121
4.20 (J)	Effect of different concentrations of various growth hormone on seedling of *Butea monosperma*)	121
4.21	Showing the value of Quality index and Sturdiness Quotient in different hormonal treatments	122
4.22	Growth of regenerated shoots (one year old) in different lopping treatment (value based on 5 plants each) (value are Mean ±S.E.)	125

LIST OF FIGURES

Figure No.	Title	Page No.
1.1	An Autecological Exploration of *Butea monosperma*with special references to nursery growth and regeneration behavior.	16
1.2	A close view of tree of *Butea monosperma* at flowering stage.	17
1.3 (A to B)	A close view of plant twing of *Butea monosperma* at flowering stage.	19
1.4	Inflorescence of *Butea monosperma.*	20
1.5	Bulk of Pods of *Butea monosperma.*	20
1.6	A flower of *Butea monosperma.*	21
1.7	Leaves of *Butea monosperma.*	21
1.8	Morphology of Seed of *Butea monosperma.*	21
1.9	Bark of *Butea monosperma.*	23
1.10	A fully leafed plant of *Butea monosperma.*	23
3.1	Map of the selected sites (Site-1 Banguan and site-2 Orchha)	53
3.2	Map of Jhansi forest	55
4.1	Germiantion of seeds of *Butea monosperma* in Laboratory condition.	82

4.2	Viability test in seeds of *Butea monosperma.*	82
4.3	The growth performance of six months old seedling of *Butea monosperma* in sand + Black (S_8).	97
4.4	The growth performance of six months old seedling of *Butea monosperma* in sand + Padua (S_6).	98
4.5	The growth performance of *Butea monosperma* in Sand + Red+ Black (S_{11}).	99
4.6	The growth performance of one year old seedling of *Butea monosperma* in canopy light.	100
4.7	The growth performance of one year old seedling of *Butea monosperma* in semi-shady condition.	101
4.8	Effect of daily irrigation regime of one year old seedling of *Butea monosperma.*	102
4.9	Effect of alternately regime of one year old seedling of *Butea monosperma*	113
4.10	Effect of 25ppm/IAA concentration on six months old seedling of *Butea monosperma.*	114
4.11	The seedling performance of *Butea monosperma* in hormonal concentration at 50ppm/GA_3.	117
4.12	Effect of 150ppm/IAA concentration on six months old seedling of *Butea monosperma.*	118
4.13	The seedling performance of *Butea monosperma* in hormonal concentration at 100ppm/IBA.	124

LIST OF GRAPHS

Graph No.	Title	Page no.
4.1	Topographical pattern of Tetrazolium staining received by various seeds of *Butea monosperma* (Seed Lot No-21,27 and 29).	85
4.2	Effect of leachates on germination.	88
4.3	Duration of Imbibition.	90
4.4	Effect of Soil Composition on Shoot Length.	96
4.5	Effect of Soil composition on root length.	97
4.6	Effect of Soil composition on the biomass production of Shoot.	98
4.7	Effect of Soil composition on the biomass production of Shoot.	99
4.8	Effect of different light condition on Shoot length.	105
4.9	Effect of different light condition on root length.	105
4.10	Effect of different light condition on Plant length.	106
4.11	Effect of different light condition on the biomass production of shoot.	106
4.12	Effect of different light condition on the biomass production of root.	107

4.13	Effect of different irrigation on Shoot length.	112
4.14	Effect of different irrigation on Root length.	112
4.15	Effect of hormonal treatment on the Shoot length.	122
4.16	Effect of hormonal treatment on the Root length.	123
4.17	Effect of hormonal treatment on the Biomass production of Shoot.	123
4.18	Effect of hormonal treatment on the Biomass production of Root.	124

LIST OF ABBREVIATIONS

Abbreviations	Full form
IVI	Importance Value Index
RF	Relative Frequency
RD	Relative Density
RA	Relative Abundance
CC	Community co-efficient
W	Sum of the lower frequency percentage of the common species in forest A and B.
A	Frequency values of all species in Forest A (Banguan).
B	Frequency values of all species in Forest B (Orchha).
SL	Shoot length.
RL	Root length.
PL	Plant length.
S/R	Shoot/Root

SDW	Shoot Dry Weight.
RDW	Root Dry Weight.
PDW	Plant Dry Weight.
%M.C.	Percentage Moisture Content.
PSA	Photosynthetic Area.
QI	Quality Index.
TW	Total dry weight of seedling .
H	Seedling height.
SW	Seedling shoot dry weight.
RW	Root dry weight.
SQ	Sturdiness Quotient.
L_1	Light Condition(Full Sun Light).
L_2	Light Condition(Semi-Shady).
L_3	Light Condition(Shady).
I_1	Irrigation(Daily).

I_2	Irrigation(Alternately).
I_3	Irrigation(Twice/Weekly).
S_1	Soil Composition(Pure Padua).
S_2	Soil Composition(Pure Red).
S_3	Soil Composition(Pure Sand).
S_4	Soil Composition(Pure Black).
S_5	Soil Composition(Black+Padua).
S_6	Soil Composition(Red+Padua).
S_7	Soil Composition(Sand+Padua).
S_8	Soil Composition(Sand+Black).
S_9	Soil Composition(Red+Black).
S_{10}	Soil Composition(Sand+Black).
S_{11}	Soil Composition(Sand+Red+Black).
S_{12}	Soil Composition(Red+Black+Padua).
S_{13}	Soil Composition(Red+Padua+Sand).

S_{14}	Soil Composition(Sand+Red+Black).
S_{15}	Soil Composition(Red+Sand+Black+Padua).
H_1	Hormone(25ppm/IAA).
H_2	Hormone(50ppm/IAA).
H_3	Hormone(100ppm/IAA).
H_4	Hormone(150ppm/IAA).
H_5	Hormone(200ppm/IAA).
H_6	Hormone(250ppm/IAA).
H_7	Hormone(25ppm/IBA).
H_8	Hormone(50ppm/IBA).
H_9	Hormone(100ppm/IBA).
H_{10}	Hormone(150ppm/IBA).
H_{11}	Hormone(200ppm/IBA).
H_{12}	Hormone(250ppm/IBA).
H_{13}	Hormone(25ppm/GA_3).

H_{14}	Hormone(50ppm/GA_3).
H_{15}	Hormone(100ppm/GA_3).
H_{16}	Hormone(150ppm/GA_3).
H_{17}	Hormone(200ppm/GA_3).
H_{18}	Hormone(250ppm/GA_3).
H_{19}	Hormone(Control).
IAA	Indole acetic acetic.
GA_3	Gibberellic acid.
IBA	Indole butyric acid.
PPM	Parts Per Million.

Chapter- 1

INTRODUCTION

1.1 INTRODUCTION:-

The forests are not only important for their economic utility but they also influence the social and economic life of mankind, modify their views and provide new thoughts to the poets and artists. They provide an appealing environmental to city and town sick modern man. The forests are no less charming to hunters and fisherman who get ample game. Hence the differe$nt people have different ways of deriving pleasure from the forests. Some would enjoy the scenic beauty; other would like to lose them in an inaccessible wilderness.

Forests and trees play vital role in maintaining a stable environment conductive to sustained development of agriculture. Forest is the grandest biological association of the nature predominated by trees and other plants species. The forest is the splendid source of soil, wood, timber and many other products of universal utility.

Man has since times immemorial been interested in its surrounding. Today, he is master of the whole world, with the ability to modify the nature on any large scale and to control it remotely. The scientific and technological advancement have solved many more problems but have created several new problems for mankind.

From the very earliest time an important factor relating to man's influenced on the environment was fire however, during the Neolithic period it was progress towards agriculture and industrialization. This led to sharp changes in natural condition including Flora, Fauna, soil, climate and hydrological regime. The excessive grazing by domestic animals has resulted in the destruction of plant cover, producing an increased temperature and a decline in the relative humidity with decreased amount of precipitation.

About half of the world's forests are located within tropics in three main regions namely Africa, America and Pacific Asia. The total estimated area of tropical forest is over 2000 millon hectares, out of which about 850 million hectares can be regarded as tropical rain forest. In India, total 765210 km^2 area cover forest which is classify in reserved, Protected and Unclassed Forest area. It is commonly believed that

the tropical Dry deciduous forests play an important role in global ecology and are of vital importance in maintaining environmental quality far beyond the confines of the tropics.

Table 1.1- India – Reserved/Protected/Unclassed Forest area (in Km^2)

Reserved Forests	Protected Forests	Unclassed Forests	Total recorded Forest Area
416516	223309	125385	765210

In India total recorded area of the Tropical Dry deciduous forest is 186620 Sq. km^2 which is 28.6% of the area. The livestock depends on forest for grazing and fodder. The enormous human and livestock populations of the country pose a challenging demand on its land resources, especially on biomass i.e. fuel, fodder, timber etc. obtained from forest.

Source: State of Forest Report, 1995 by Forest Survey of India

Table1.2 - India - Forest types 1995

Sl. No.	Forest Type	Area in Sq. Km.	Percentage
1.	Tropical Wet Evergreen Forest	51249	8.0
2.	Tropical Semi-Evergreen Forest	26794	4.1
3.	Tropical Moist Deciduous Forest	236794	37.0
4.	Littoral and Swamp Forest	4046	0.6
5.	Tropical Dry Deciduous Forest	186620	28.6
6.	Tropical Thorn Forest	16491	2.6
7.	Tropical Dry-Evergreen Forest	1404	0.2
8.	Sub-Tropical Broad Leaved Hill Forest	2781	0.4
9.	Sub-Tropical Pine Forest	42377	6.6
10.	Sub-Tropical Dry Evergreen Forest	12538	2.5
11.	Mountain Wet Temperate Forest	23365	3.5
12.	Himalayan Moist Temperate Forests	22012	3.4
13.	Himalayan Dry Temperate Forest	313	-
14.	Sub-Alpine and Alpine	18628	2.8

Environmentalists, foresters, development planners and policy makers are continuously emphasizing looking into the present status of forests in the country the need for an increased rate of trees planting. It is obvious that increase in the forest area is possible only by adding man made forest i.e., plantation; for which a complete understanding of seed requirement, seed germination behavior and seed storage along with the knowledge of collection and extraction of seeds is essential.

Due to the depletion of forest cover and degradation of large tracts of land, National wasteland development Board was constituted in May, 1985 with the primary aim to tackle the wasteland through afforestation. During the 7th plan very important development took place such as enactment of national forest policy1988, amendment in the forest conservation act 1980 and upgrading the wasteland development programmed through a technology Mission. Crisis in India's forestry largely means a crisis of firewood consumption, because firewood accounts for over 80% of wood use in the country. There are serious crises of firewood and grazing. Forest destruction in India is related to need, poverty greed and affluence (Khoshoo, 1996).

National Mission on wasteland development was set up in October 1989. Indian council of forestry research and education is establishing research institutes in different eco-climatic zones to give new orientation to forestry research and education.

Afforestation needs to plant only those trees which can restore productivity of degraded lands, according to Bhargava (1990), these plants should have natural adaptation to hostile environment. They should be able to propagate both by sexual and vegetative reproduction. In sexual reproduction the seed embryo carries genes of both parent trees, accordingly its genetic character, thus the understanding of all the reproduction process is necessary for forest tree regeneration.

Afforestation on a large scale requires large quantities of seeds of the good quality. Seed quality has a critical effect on the economics of planting trees and their quality. This is true whether the planting and on their quality. This is true whether the plantation is a large sale commercial plantation, a village level social forestry plantation, a small diffused farm woodlot or even an isolated trees. Seed quality comprises both 1- The physiological viability and vigor of the seeds and their genetic quality 2- Their ability to produce healthy off springs which are normally well suited to

the sites where they are planted, but also have a positive influence on the good or services which they are intended to provide (Prasad and Kandya, 1991).

Indian stands classified on the world map of forest resources as belonged to a deficit zone mainly an account of rapidly increasing population and non-intensive forestry practiced so far with the progressive increase in human population pressure on forest in gradually going up.

A recent study by the United Nation Commission for Asia and the pacific has described the destruction of tropical forest in South Asia and India as '' one of the greatest tragedies of our time.'' According to this report 109 million hectares of tropical forest is destroyed around the globe every year. The study says, the degradation of forest in Asia is classic example of third world problem which cannot be ignored by an industrial nation, it further says and stresses that the diappearanance of irreparable forest also means the loss of earth's Green lungs within calculated consequence for the ecological balance of our planet.

A continuous deforestation has resulted in an increased temperature, low and erratic rainfall, poor moisture retentions and poor soil fertility. These conditions become so alarming that the whole pattern of climate of climate is being changed very rapidly.

This have resulted areas in the serious grip of drought on one hand and some in flood and erosion on the other hand. These have launched short coming of climate a number of programs to repair the environment such as afforestation and reforestation of these nude area of low fertility. It is felt there is an urgent need to select some economically and socially important tree species that may survive under arid and semi-arid condition.

The need an immediate attention for rehabitation and regeneration but this situation persists since last many years for want of financial resources and here the forest based industries may come forward and here with financial resources for the rehabilitation of these forests and utilizing the product as raw material on the sustainable basis. The situation with regard to energy is highly unsatisfactory. More than 50% of the energy needs of India are met by biomass. It is estimate that the demand of fuel wood alone is around 167 million tones per years. The production in 28.4 tones

with a deficit of 138.6 million tones per year. Large distribution of forest for woody biomass has resulted in substances of renewal resources and an in repairable environmental damaged. This has directly affected our ecological water and food security.

The existing tree covers is not sufficient to meet the requirement of major and minor forest products and for environment conservation. Though National forest policy 33 percent area should be under forest but only 19.47% of that geographical area of the country has actual vegetation cover (Based on data by FSI, 1999). National wasteland Development (NWDB) was set up in 1985 under the ministry of environment and forestry with the mandate of formulating, within the overall national policy, a perspective plan and programme for the management and development of wasteland; identify the wasteland; promoting encouraging and financing development of wastelands through active involvement of NGOs voluntary agencies and the public at large, including the landless people (Tiwari, 1992). Now this Board was attached with ministry of Rural Development.

A new generation of conservator and ecologist who are concentrating their effect to check further damage to these ecosystem and restore the faded forest areas at national and international level some of international organization like international union for conservation of nature and natural resources (IUCN), UNESCO and a national programme on the afforestation of wasteland has been initiated during the 7^{th} five plan to increase the natural resources and to improve the environment through proper conservation and management. The realization of the concept of social forestry has also added a new responsibility of the public sector. The welfare of the tribe and other classes of the people below the poverty live is yet another equally important aspect of the forestry. In my view, the topic of forestry research is very important for India. In forestry, as in other sector of Indian rural development, research and education play a major role in the development of the country.

The present work is performed by keeping the views in mind on very valuable tree species *Butea monosperma*, which is commonly known as flame of the forest or Bastard teak, is a medium sized deciduous tree of the pea family that is native to humid lowland forested areas of India and Sri Lanka. Flame-of-the-forest common name is in reference to the orange and red flower colors which purportedly mimic the colors of

fire. Other common of *Butea monosperma* is Dkah and Palash. Revered as sacred by Hindus, it is prized for producing an abundance of vivid blooms, and it is also cultivated as an ornamental. *Butea monosperma* tree are found throughout India and South peninsula.*Butea monosperma* is a meduium sized deciduous tree, grows about 10-15 m in height, up to 43 cm. dbh; trunk usually crooked and tortuous with rough grayish-brown, fibrous bark showing a reddish exudates; branch lets densely pubescent. Palash means sacred leaves and this tree has an important place in Hinduism. Palash leaves, wood and flowers are used in religious rituals in Hinduism. According to Hindu belief, the palash tree originated from a fallen feather of an eagle immersed in Somras. The worship of Goddess Saraswati is considered incomplete without the presence of Palash flowers. These beautiful flower resonate knowledge and creativity hence of wisdom.

Other local name of *Butea monosperma* is in Bengali (palas, kinaki, peras, polashi); Burmese (pouk-pen); French (arbre a laque); Gujarati (khakra, phullas, kakria); Hindi (chichratesu, polak, tellamoduga, dhak, palas,desukajhad, chalcha); Indonesia (plasa); khmer (chaa); Nepal (Dhak, palans); Sanskrit (brahmopadapa, lakshataru); Tamilnadu (kattumurukhua) and Urdu (palash, papra).

Plant *Butea monosperma* have enormous medicinal uses. Flower of the Bastard Teak have been used in ancient India in beauty care and to maintain complexion and suppleness of skin. Seeds have been employed in the treatment of worm infestations. They are known to have astringent, diuretic and tonic properties. Palash stem bark might be used in traditional medicine system to treat dyspepsia, diarrhea, ulcers, sore throat and snakebite. Palash wood pulp may be used to treat liver problems, gonorrhea, wound infections and night blindness. Palash is mainly used to get rid of worms from the stomach due to its antihelmintic activity. Different part of the extract of *Butea monosperma* shows various biological and pharmacological activities such as antimicrobial, antifertility, anticonvulsive, antihelmintic, antidiarrhoeal, antimicrobial, antigiardiasis and hepatoprotective, antitumor, antidiabetic, anti-inflammatory, free radical scavenging activity (Chandra and Sabir, 1977).

A substantial amount of work has been carried out on various aspects in ecology. Some notable contributions are made by Bhatnager (1961), Mishra (1961), Prasad (19976), Yadav and Khare (1980), Baines (1980), Jain (1981), Verma and Das (1981), Yadav (1983), Tripathi (1984), Prasad and Mishra (1985), Totey and Bhowmik

(1986), Lall (1988), Saxena (1989), Bhalla, Suman (1992), Chaubey, (1992), Mishra (1992), Thakur and Thakur (1992), Halanda and Ting (1993), Hooda *et. al.* (1993), Chaturvedi (1993), Makhuri (1993), Rathert and Werasopan (1993), Schulzandadams (1995), Balariya, Archana (1996), Tang (1996), Chan *et. al.* (1997), Chaturvedi (1998), Pathak (1998), Roshelo*et. al.* (1998), Kumar (2001), Verma (2002) and Chakraborty *et. al.* (2007) but the work on this equally important tree species of this area was still lacking. Hence an attempt being made here to investigate the autecological and silvicultural aspect of this important forest tree species as follows:

1- Geographical distribution of the species with its climate and edaphic limits and Phytosociology.

2- Morphological and taxonomical description of the species.

3- Vegetative growth, flowering and fruiting of the species including its all Phenological details.

4- Developmental history and important aspect of its life cycle.

A- Effect of pre-sowing treatment and seed size on germination of the species.

B- Seed weight and average percentage of seed germination, viability and vigor of the seed.

C- Effect of sowing depth on germination.

5- Pot culture experiment.

A- Growth of seedling in different soil composition.

B- Effect of different water regimes on the growth of seedlings.

C- Effect of the quality and light intensity on the growth of seedlings.

D- Effect of growth hormone on seedlings.

6- Silvicultural treatment by-

A- Stem cutting.

B- Root cutting.

C- Coppice regeneration.

Phytosociological analysis of a plant community is an important aspect of ecological study of any piece of vegetation. It reveals the structural picture of the vegetation and helps in analyzing the community dynamics. The unique feature of various ecosystem of the mixed deciduous forest has always attracted ecologists. These ecosystems have evolved their own ways of complex biological processes and deserve attention as special ecological entities (Vidyasagaran*et. al,* 2004).

A thorough knowledge of the community can be best acquired if ecology of individual plant species, forming a constituting part of the community is studied (Joshi and Gupta, 1982). Vegetation analysis as the structure of the vegetation expresses most relevant results and is a flexible tool in the analysis of complex system (weed *et. al*, 1977). The vegetation at a particular site is the result of the interaction of various climate and bioedaphic factors, initially many species complete with each other to establish their hold on the vacant site after a great deal of struggle, completion and adjustment only a few are able to sustain themselves.

With the change in environment conditions, the vegetation cover reflects several changes in its structure, density and composition (Gaur, 1982). The most important structural property of a community is a definite quantitative relationship between abundant and rare species. The study of floristic composition and phytosociological attributes are useful for comparing one community with the other from season to season and year to year. Each of the species within the community has large measure of its structural and functional individualism and has more or less different ecological amplitude and modality. The species diversity reflects the gene pool and adaptation potential of the community.

The vegetation is not a random assemblage of individuals of many species, but it is the plants associated in community with definite structure and often in a regular specific composition. To have complete idea of the structure and composition of a community, it is essential to understand it is various analytical characters. Comprehensive forest conservation policy with practical implementations is utmost necessity in order to conserve the rapidly depleting forest recourses of the area.

Curtish and Mc Intosh (1950) utilized three quantitative characteristics to establish the relative status of different tree species, in the form of Importance value index (IVI) which gives an idea regarding the plant community in general and the status of individual species within the community. Analytical character viz. Relative frequency, Relative density, Relative basal area and IVI are very useful in the composition of two different forest communities.

From the information it is evident that there is a scope for studying the Phytosociological attributes of Bundelkhand region in view to their conservation status. Thus, the knowledge of the floristic composition and qualitative and quantitative

characteristics is helpful in understand the ecological implication and managing the forest ecosystem.

The term Phenological events mean the seasonal changes occurring in the life cycle of plants. It considers leafing, leaf-fall, flowering, fruiting and fruit-fall as periodic phenomenon. The science that deals with time of appearance of characteristic periodic events such as leaf shedding, flowering, fruiting etc, in the life cycle of plants in nature especially as those events are influenced by environmental factors. These studies are useful in determining the character of forest floor composed of different species and in the preparation of the suitable sampling plans for the later years of forest. Phenological studies include the interaction of climate factors with the periodic phenomenon in plants (Daubenmire, 1947). He related the phenological events with latitude and longitude.

Phenology is the study of production of plants parts by the individuals at a given time in a given area. Different species of plants differ in the seasonal periodicity and sequential patterning of their phenological activity. Environment has a profound effect on the phenology of plants. Phenological study is useful in combating afforation and in plant management, floral biology, estimate of reproductively and regeneration (Mulik and Bhosale, 1989).

Man due to its superiority in the ecological chain always associated with the changes in the surrounding flora and fauna. When Hunter-gatherer man started agricultural practices, noted various changes in the agricultural crops due to seasonal variations. Recently exhaustive works have started in the field of phenology of forest trees because Botany and especially forestry requires thorough knowledge of interaction of climate with the periodic phenomenon taking place in natural as well as afforested areas of the forests. These studies will foresters aware of seasonal and climatic changes, which affect the forest structure in terms of forest, cover biomass and regeneration etc.

Amenity plantation is an urgent need of the modern era of rapid industrialization and urbanization. It is needed to satiate the increased concern about environment conservation. However, it is very different to plan amenity plantation without knowledge of phenological calendar of selected species. It is important to the plant physiologist who is concerned with the factor, which control tree growth and

differentiation. It is of concern to ecological as a factor in plant succession and in other ways.

Seed can be considered as the starting organ in the life of a higher plant. It germinates to give rise to the seedling and eventually matures into a plant. The seed is viable even if kept as such for months or even years, while other organs of plants have relatively shorter longevity. Thus, formation of seed prolongs the life of a plant (Srivastava, H. S., 2003). A seed only a few milligrams in weight posses as admirable programme for creation of a huge tree weighting several tones. When appropriate conditions for seed germination are provided then starts its precession work in co-operation with the environment. Germination of seed is a critical phase in the life history of any species that evaluate the tendency of that species to spread in favorable condition for acclimatized.

Seed germination is an important determinant for the population of a species to maintain itself in the environment where they grow. Directly or indirectly, seeds are the sources of life sustain nutrient for man and other animals. Symbolically they represent renewal and illustrate the tenacity of life in the face of a hostile world. Seed germination can be defined as ‘‘those consecutive events which cause a dry quiescent seed in response to water uptake, to show a rise in its general metabolic activities and to initiate the formation of a seedling from the embryo’’. Seed germination is protrusion of embryonic axis from the seed to resume plant growth. The seed contains endosperm, cotyledons and embryo. The embryo grows to form roots and shoots during germination while endosperm provides nourishment for the early growth of root and shoot axis. The process involves amount of metabolic activities. This is preceded by the adsorption of water (Imbibition) by the dry seeds. The live embryo is potentially capable of development into an individual more or less similar to parent plant from which it originated.

‘‘Seed is a highly organized packet of energy that provides for the complete development of the primary plant body the emergent seedling (M. C. donough, 1977).’’The seed is well provided with reserve food that sustains the young plant until a self sufficient autotrophic organism can be settled ((Bewley and Black, 1978). The seed is a convenient until that retained energy and capable to suspend growth, the stored energy is easily transported and dispersed at the time of germination (AS. C. Leopold

and P. E. Kriedemann). The seed germination is the resumption of physiological activities by dormant embryo inside the seed. Mayer and Mayber (1963) defined germination as that group of process which causes the sudden transformation of dry seed into the young seedling. Process of seed germination variously effected by internal and external factors, such as light, moisture, temperature and soil or substratum effect the seed germination. The environment affect both the process of seed development as well as seed germination. Thus germination process is controlled by a combined influence of the environmental factors. Germination is reactivation of growth triggered by environmental stimuli as simple as available of water and oxygen and as complex as temperature, light, endogenous inhibitor and promoter interaction.

It is suggested that the environmental factors control germination by acting on specific sites of metabolic sequence (Mayer and Shain, 1974). Some problems also include in seed germination like, dormancy, poor germination, deterioration due to biological agents, storage and seedling diseases. Hence it is difficult to supply the well develop seedlings required in wasteland development. Without an adequate supply of good seeds of the required tree species and the study of their germination behavior and seedling growth phase, any growth phase, any task of artificial regeneration will not succeed.

Seedling growth is the most critical phase in the life cycle of a plant, as shortly after germination, seedlings have to face the extremes of a number of environmental factors such as pathogens, humidity, temperature etc. if any of these conditions become adverse, they become die. Leaf formation, chlorophyll development, adequate light, proper temperature etc. affect the successful establishment of the seedlings. Moreover, birds and grazing animals also harm seedlings. In nature high rates of seedlings mortality occurs in some plants. Under drought conditions most of the seedlings dry up and collapse. Only such seedlings that may produce elaborate root system able to reach deeper into soil have chances of their survival. The requirement of seedling establishment of trees in the forest greatly differs with those of seedlings of annuals, shrubs and climbers (Sharma, 2004).

The seedling phase is generally regarded as a short phase in the life span of a plant between the emergence of radical from the seed/fruit coat to the exhaustation of reserve food of the seed and the onset of normal nutritional patterns with the plant

(Pelton, 1953). The nutritional requirements and the interaction among many environmental factors play a complex and vital role in the establishment of a seedling.

Seedling growth of a species is affected by a number of climate and edaphic factors. The success of any forestation activity is dependent upon the survival and establishment of the seedlings. The assessment of favourable environmental conditions for the development and growth of a seedling may lead to their higher production and survival. Raising seedlings of tree species in nursery is a common phenomenon. The optimum level of production of seedling is the demand of plantation that is determined by supply of sufficient quantity of quality seeds.

According to Rutter (1956) the best single measure for the success of a plant in a particular environment is the rate of dry matter increase the photosynthetic energy capture. The dry matter growth of tree may well be understood through the study of their seedlings.

Growth is an essential character of life or of living organism and is by far the most complex of all the physiological processes. The pattern of plant growth varies mostly species to species and with the same species under unlike environmental conditions. The conditions that prevail very close to the ground is of considerable significance, since a plant is very sensitive to climate in its formative years. The major environmental inputs that impulse terrestrial systems include solar radiation, temperature, water and nutrients. Coupled with these environmental constraints are the plants own internal regulators, whose control is modified according to the environmental conditions. Thus, seedlings growth may define as, "A process which brings about a permanent change in any plant or its part in respect to its size, form, weight and volume". Growth in a higher plant is obviously a complex phenomenon. Although species vary enormously in their assimilative abilities, growth controls inherent in the plant still exert powerful effects over their general performance. Physical inputs sustain growth but biological regulation dictates the pattern of its utilization and ultimate expression.

Mankind has derived inspiration from the nature since times immemorial. The forests and its product have been playing a significant role in establishment and development of human generation. It is in the forest resources that a great potential for economic development of the nation exists. We can say that forest is the Green Gold

for the any nation. As well as the world population increased the demands of forest products have also been increased. We use forests without any plan of sustainable development. The over exploitation of forests have resulted many serious problems like, global warming, climate changes, erratic rainfall, drought, desertification, famine and a number of dangerous diseases of plants, animals and humans beings. Thus, reforestation is the demand of times. Plantation of forest trees by seeds is not enough to fulfill the need of badly degraded forest areas. Some other ideas like stem cutting, root cutting and Coppice cutting must also apply for this purpose. The silviculture is a scientific art that adroitly embellish the deformed forest and its component species (Saxena, 1989). Forests are unique and renewable natural resources. The problems arise than as to how the desired individual strain can be multiplied potentially very useful for replication clonal material and for the multiplication of stock for the plantation purpose. Clone after the advantage of genetic uniformity and the immediate availability of superior individuals for large scale plantation. The regeneration is either practically absent or inadequate mainly due to production of mostly non-viable seeds excessive browsing, intense and prolonged summer drought (Mathur, 1961).

With the increasing demand of tree improvement and for optimizing biomass production, the importance of vegetative propagation has increased. Much emphasis is being laid now on the artificial regeneration of tree species for social and agro forestry programmes. According to Ahuja, 1986, a multiplication by vegetative means offers the advantage of greater genetic uniformity and immediate availability of superior clones for plantation. According to Toumey and Korstain‘‘Silviculture is that branch of forestry, which deals with the establishment, development, care and reproduction of stands of timber’’. According to Smith, 1961 regeneration is the act of replacing old trees or renewal of a forest either naturally or artificially by vegetative propagation.

The usefulness of vegetative propagation can also be appreciated in the content of social forestry where emphasis is given to growing of trees more or less integrated with other form operation. For the rapid achievement of these programmes there is need to develop some economical and also time saving ways and means for the multiplication of nursery stock and the regeneration of coppice shoot through the cut stem. Silviculture is usually desirable and often a necessity (Champion and Griffithe, 1948), (Champion and Seth, 1968), but it should be emphasized that its practice to be most effective should be governed by ecological knowledge (Oosting, 1956). It is a planned silvicultural

treatment that is applied to a forest crop, throughout its life, so that it assumes a distinctive form. It deals with the removal of a forest crop, its replacement by a new crop of distinctive form and its tending. Silviculture begins with regenerating felling and including adoption of some suitable method of regeneration and tending of new crop, not only in its early stages but also throughout its life. It is concerned with the conduct of fellings, methods of obtaining regeneration and it's tending. Thus a silvicultural system is a specialized tool or techniques for achieving the objects of forest management.

Introduction of silviculture explains the importance of forestry and it reviews the basic characteristics of trees, stands growth and development essential to understand management activities of forest.

Objective:-

- To determine the Phytosociological survey of Banguan and Orchha forests for find out the different species found in mixed dry deciduous forest of Bundelkhand region.
- To evaluate a phonological survey of chief find tree species in mixed dry deciduous forest of Bundelkhand region.
- To calculated the seed germination in different conditions specially Lab, depth, Viability and Imbibition for agroforestry and medicine purpose.
- To determine the seedling growth in different condition like, soil composition, Light intensity, irrigation regime and hormonal treatments.
- To determine the Coppice regeneration in *Butea monosperma* for better propogation.

Scope of Research work

Traditional plant knowledge and cultural understanding are the focus of ethnobotany. Plant linguistics is an interdisciplinary field that studies the many facets of human plant interaction, including language, literacy, medicine, nutrition, archaeology, economivs and more. Therefore, ethnobotany may be used as an entry point to other fields of study. Given everything were covered so far, it should come as nbo surprise that ethnobotany is a branch of study that draws other disciplines and has many varied application. Thus, there is a vast opportunity to examine the relevance of

ethnobotany in the face of contemporary prigress and to provide them a specific task, which should involve.

The current research has the potential to play a pivotal role in the future for the protection of biological variety and long term economic growth. In this way, knowledge about regional flora may be preserved, restored and disseminated. Floristic innovations and assessments of conservation circumstances for different plant species benefit from this.

1.2 MORPHOLOGY:-

Identification of plants has been a thorny issue to many. Other has frightened it to one not very familiar with the greater part of vegetation. One of the plants has hardly character high enough to be distinguished.

Butea monosperma is a member of the family of Febaceae (Sub-family Papilionoideae). A medium to small sized deciduous tree 5-15 (max. 20)m high, 43cm dbh; straight and twisting with coarse grayish-brown, fibrils bark, containing reddish exudates; branchlets highly pubescent.

Leaves trifoliate: petiole 7.5-20cm long and small stipules, leaflets more or less leathery, lateral obliquately ovate, terminal rhomboid-obovate, 12-27x10-26cm, obtuse, rounded at apex, rounded to cuneated at base, with 7-8 pairs of lateral veins, stipellate.

Raceme structure, 5-40cm., towards the tip, on branchlets, which are usually leafless, calyx, campanulate, 4 short lobes, corolla, 5-7cm long, normal, curved-up



Figure No 01: An Autecological Exploraton of *Butea monosperma* with special reference to nursery growth and regeneraton behaviour.



Figure No 02: A close view of tree of *Butea monosperma* at flowering stage.

wings and keel, all the same length, blight, orange-red, rarely yellow, pubescent to a large extent.

Stalked, short brown hairs, (min. 9) 17- 24 x (min. 4) 4-6 cm, in an indehiscent pod, when ripe, in the lower part, flat with one seed in the apex. Flattened, tapered, about 3cm in length.

The leaves are lost off during the dry season. It is the leafless tree that produces flowers, which are very noticeable, at the beginning of the rainy season, and very prominent even in the forest. The flowering season is followed by new leaves emanating on the end of the leaves, initially of a pale green tinged with bronze. The most important pollinators are the birds.

ECOLOGY-

Butea monosperma is a tree that is native to tropical and subtropical climate. Scattered in the drier parts of India, whence they are typically gregarious in the woods, open grass-lands and wastelands. It is a common plains tree and can be found in pure patches in grazing land and other open areas and has not become extinct as it is resistant to the different types of browsing and also through reproduction through seeds and root suckers. The rainfall is mostly received during monsoon in the native habitat though autumn and the summer seasons are usually dry. The tree is most drought resistant and frost hardy and the leaves turn white and fall off.

BIOPHYSICAL LIMITS

Height: 1500m average, Annual mean temperature: 4-49 o C, Annual mean rainfall: 450-4500mm.

Soil type: It is able to cultivate the soils of different type like shallow and gravelly soil, black cotton soil, clay loams and even the salty or waterlogged soil. The seedlings mature rapidly in a loamy soil of PH 6-7 at high temperatures and relative humidity (Hocking, 1993).

PRODUCTS

Fodder: In India the young leaves are fodder to the buffaloes and they are the primary consumers of this fodder. The leaves are quite nutritious, bit the indices of digestibility are extremely low, and they are matched only to the ones of straws.

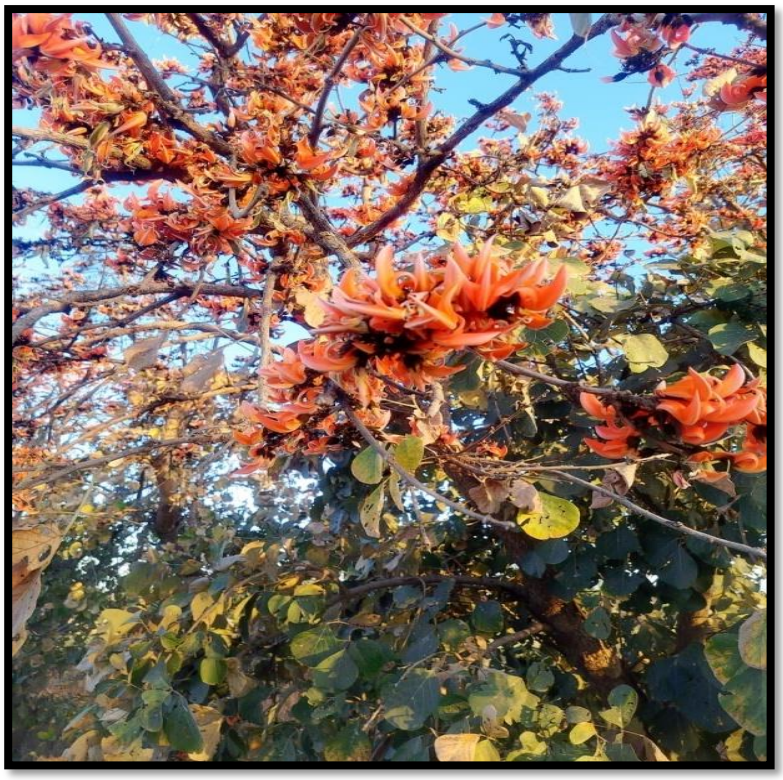


Figure No 03(a): A close view of plant twing of *Butea monosperma* at flowering stage.



Figure No 03(b): A close view of plant twing of *Butea monosperma* at flowering stage.



Figure No 04: Inflorescence of *Butea monosperma.*



Figure No 05: Bulk of pods of *Butea monosperma.*



Figure No 06: A flower of *Butea monosperma.*

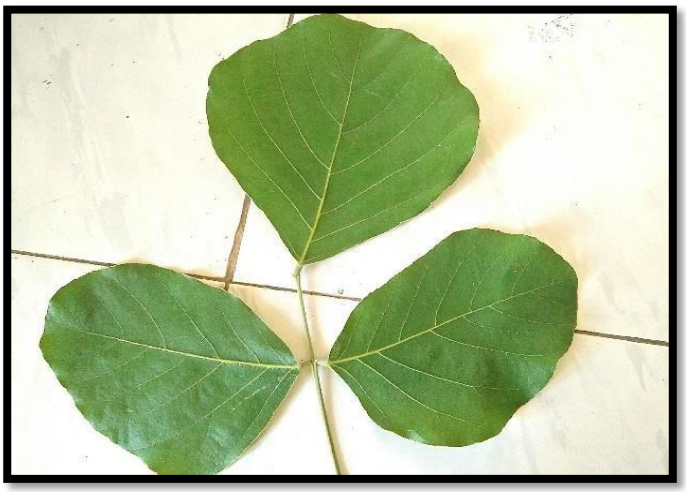


Figure No 07::Leaves of *Butea monosperma.*



Figure No 08: Morphology of seed of *Butea monosperma.*

Wood offers a medium grade fuel. Other times leaves are used to produce fuel. To make gunpowder, wood is grilled using charcoal.

Fibre: Rigid fibrous material which is produced of the inner bark, and is employed as cordage, in the caulking of the sides of boats, and in the production of paper.

Timber: Soft and not durable wood, light in weight, of about 570 kg/ m3 air dry, and of a fresh yellowish-brown colour, and often turning grayish in colour because it is apt to be sap stained. It is not significant and is applied to utensils occasionally.

Gum or resin: A red exudates is a compound that is produced out of the bark and hardened into a form of gum that is known as the Butea Gum or Bengal Kino. It can be used as a dye.

Tannin or dyestuff: It is a bright-yellow to deep-orange-red dye, known as butein, and composed of the flowers, and used to mark silk, and in instances of cotton. Hindus make use of this dye and put it on the forehead. The bark is used for tanning.

Lipids: The seeds are found to generate clear oil.

1.3 GEOGRAPHICAL DISTRIBUTION:-

Ecological visualization of the distribution of a species is always a fruitful study. The distribution of a species is regulated by Liebeig' law of limiting factor or law of minimum, which is now extended over to all environment condition or by Shelfords law of tolerance which states a species with a wide range of tolerance would be widely distributed. According to modern approaches of Smith (1966) the organisms are limited by a number of conditions often by an interacting among them. Particularly in the case of dominants which are common species according to Smith (1966), there is always a possibility of a number variants or ecotypes or ecological variants adapted to local condition.

Ecologically the geographical distribution of a species reveals the extent of dispersion in space as well as the extent of ecological success. It also gives a

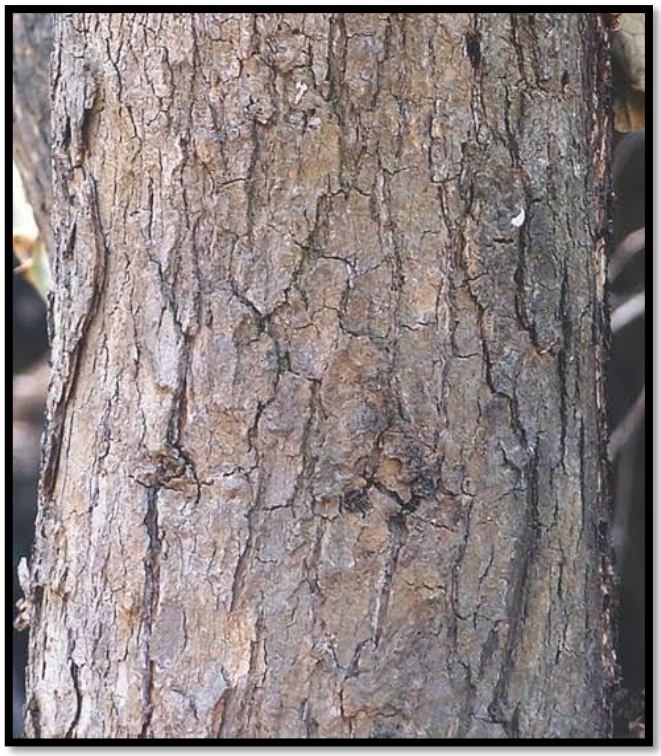


Figure No 09: Bark of *Butea monosperma.*



Figure No 10: A fully leafed plant of *Butea monosperma.*

predictive insight into the cause of this success, as more restricted the species is its spatial distribution, more dependent in becomes on the unit factors of its operational environment wider the distribution greater are possibilities for genecological interaction.

Butea monosperma is a species of *Butea* native to tropical and Sub-tropical pats of South Asia and Southeast Asia, ranging across Bangladesh, India, Nepal, Pakistan, Sri Lanka, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia and Eastern Indonesia. In India, Flame of the forest tree is a dry deciduous forest tree species, which can be spotted in Utter Pradesh, West Bengal, Jammu and Kashmir, Southern Rajasthan, Maharashtra and Madhya Pradesh. Due to consequence of tree this is declared as **State flower** of Utter Pradesh.

Butea Monosperma Shows the following records on its distribution. *Butea Monosperma* is not gregarious, but is scattered in mixed deciduous forests sometomes it approaches gregariousness in localities frequented by Monkeys. According to Troup (1921), its occurrence in deciduous forest throughout the greater part of India and Burma, ascending to 4000 ft. in the Himalaya, also in Ceylon.

R. N. Mishra reported the occurrence of this genus on Ramgarh hills of Rajasthan. According to Samvatsar, (1996) it is plant of Tropical and Warm Temperate regions. Brandis, (2007), reported its occurrence in Trans- Indus on the hills near Peshawar. According to Sharma (2002) it is common in hills slopes. According to Hooker (1984) its occurrence at central and eastern Himalayas to Ceylon and Malacca, ascending to 3000 fit. In Kumanon, wild and often planted. Lal (1998) reported its occurrence in the Dehradun and Saharanpur Forest, also found in low Svalleys up to 4000 ft. in Jaunsar and Garhwal valley up to Saia.

Chapter- 2

REVIEW OF LITERATURE

Enormous data of Phytosociological Studies of different forest type of India are available and structure of almost all types of forests has been worked out thoroughly. However, there is still paucity of data on performance, stability, and adaptability association and growth architecture of individual species. These attributes become more important when inter specific interaction is intense in the forest. Such interaction provides stability to one species in relation to other. The environment is important as it leads to its leads to its further aggregation which is cause of time constitutes succession.

In India the phytosociological studies were initiated by F. R. Bharucha and his students, especially in reference to the biological spectrum of Mahabaleshwar flora. Since then various phytosociological techniques have been employed to study the different forest communities and their relationship. Some important contributions are of Tuteja and Singh (1980), Shah and Bhat (1980), Verma and Das (1981), Gaur, (1982), Joshi and Gupta (1982), Menon and Shah (1982), Saxena and Shah (1982), Sharma and Gaur (1983), Yadav and Shah (1984), Joshi (1984), Sharma *et. al*, (1986), Nautiyal *et. al*, (1987), Lall (1988), Joshi and Tiwari (1990), Katewa, (1990), Saxena (1990), Sharma (1990), Dani, *et. al*, (1991), Singh,*et. al*, (1991), Saxena, *et. al*, (1992), Nagesware and Balasubramanian (1993), Subhi and Shakya (1993), Joshi *et. al*, (1994), Rao and Mishra (1994), Strasberg (1996), Swarupanandam*et. al*, (1996), Das and Lahiri (1997), Pandit *et. al*, (1997), Thakur and Chauhan (1997), Verma *et. al*, (1997), Nath, *et. al*, (1998), Gargya, *et. al*, (1998), Singh, *et. al*, (1998), Gularia, *et. al.*, (1999), Semval*et. al*, (1999), Vidyasagaram*et. al*,(2000), Cilliers and Bredenkamp (2000), Balaji and Nitant (2002), Baruah (2003), Watva*et. al*, (2003), Jha, (2004), Galav *et. al*, (2005), Negi and Nautiyal (2005), Naithani *et. al*, (2006), Reddy *et. al*, (2006), Bakshi *et. al*, (2007), Devi and Singh (2007), Patra, *et. al*, (2007), Rastogi and Rastogi (2007), Malik, N. Z., *et. al.* (2007), Khurana and Kalpana (2008), Kharkwal, G. (2009), Ahmad, I., *et. al*, (2010), Ajaib M., *et. al*, (2010), Ajaib M., *et. al*, (2012), Ashfaq, Nazir *et. al*, (2012), Shaheen and Shinwari (2012), Konatowska and Rutkowski (2019)

Theertha, P. C. *et. al.*, (2021) worked on pond ecosystem and observe that Flora is the breathing spores of ecosystem which holds the surface of earth to its heart. It is the green mirror of the ecosystem that absorbs toxic gases and makes the fresh. It ranges from the tiny *Wolffia species* (water meal) to giant Water lily. A total of 111 vascular plant 24 Order and 49 families were recorded. 110 angiosperms and 1 gymnosperms. Poaceae is the dominant family. Based on the IVI values, we can identify the richly and poorly established plant species. *Ludwigia grandiflora* registered the highest IVI value of 16.33 and it is the richly established plant species. Conservation is essential to protect biodiversity and to impede the ongoing and upholding loss of plant diversity. Tripathi, *et. al.* (2006) have studied the vegetation characteristics of Tropical Forests of Andaman Island and concluded that size variation was greatest in Inland forest of Andaman showing the highest degree of asymmetry. A thorough knowledge of the community can be helpful in understanding the ecological implication of the forest. It can furnish needful information for their management.

Flora is the simplest list of Plants occurring within a given region and they are the living organisms lacking power of locomotion which resides its whole life in any circumstances at a single spot (Ramachandram*et. al,* 1988). Ramachandram and V. J. Nair (1988) prepared flora of kannur and they recorded 1132 species from 3670 km. Sq. area in Kannur district. Flora has been a part of human life from earlier times. Phytosociological analysis insight the basic information of plant species like frequency, density, abundance, basal cover, relative frequency, relative density, relative dominance and IVI. The ultimate goal of Phytosociology is characterization for vegetation types based on analysis floristic compositions. The local plant act as the wealth of plant species. Most of the species have good medicinal value and it can be analyzed through Phytosociological studies. In recent times, part of medicinal plant in traditional health care has diverted the attention of researchers towards ethno-medicines (Qureshi *et. al,* 2014). Floristic catalogues are the source of botanical detail for a particular field and it serves as a useful point for numerous detailed teach (keith, 1988). The listing of species is easy and comparatively less time consuming (Saina *et. al,* 2009) and it provides important public outreach and fundamental information to use in addressing the biodiversity crisis (Funk, *et. al,* 2007). Climatic condition and soil type also have a good influence in the properties of different medicinal plant species. Therefore through the analysis of certain area, certain medicinal property of plant can

be detected. It is a fact that almost all the plant species have some medicinal property. This shows the important of need for conserving the flora.

Ray, J. C. and George Jojo (2019) studied Road side vegetations and observe that open to contaminations of diverse heavy metals and other gaseous pollutants and to physical disturbances of being trampled by pedestrians and crushed by vehicles continuously. Being a biodiversity rich region of the world, roadsides of Southwest India, are expected to be rich in unique pollution tolerant species. Tolerant plant in heavy metal polluted roadsides may be excluders or accumulators or hyper accumulators of the metals.

Phytosociological studied in forest of Bundelkhand region have been carried out by many workers viz. Jain (1981), kanodia (1981), Athya and Mishra (1981), Tripathi and Bajpai (1982), Tripathi *et. al*, (1983), Mahajan and Paliwal (1985), Saxena and Tripathi (1989), Chaturvedi (1992), Verma *et. al*, (1999), Krishana *et. al,* (2000) and Thakur and Khare (2008). These previous studies were mainly concerned with mixed forest types or the forest dominated by one or two species but comprehensive and systematic structure and floristic analysis is lacking.

A number of workers have studied the phenological behaviour of different forest plants from time to time. Several workers viz. Boojh and Ramakrishnan (1981), Ralhan *et. al.* (1985), Newton (1988), Ansari and Bhodola (1989), Mahadevan (1991), Balasubramaniam and Bole (1993), Khan (1999), Pandey, *et. al.* (2002), Chhangani (2004) and Khare *et. al.* (2007) has studied the phenology of different forest of different areas. Phenological studies in tropical semi-deciduous forests were made by Daubenmire (1972) in North Western Costa Rice and Popler*et. al.* (1980) in lowland of Costa Rice.

Some workers emphasized that the climate conditions affect the phenological events to a certain extent. Floral phenology and morphology of black cotton wood and *Populus trichocarpa* has been studied by Boes and Strauss (1994). There are a few detailed phenological studies related to the flowering from the seasonal tropics though much causal observation are fragmented or hidden in floristic or forestry account such as Menburge (1996).

Pandey, *et. al.* (2004) and Pandey (2002) have worked on the *Azadirachta indica* A. Juss. (Neem) and emphasized that neem exhibits great variation in qualitative and quantitative characteristics of growth as per the climate. According to Tiwari, (1992) Neem is rarely leafless but is in full foliage during summer month and tree flowers during March-May and Fruit thereafter.

Some other workers viz. Pandey and Sharma (1986), Navchoo and Kachroo (1986), Beniwal (1987), Negi (1989), Beniwal and Singh (1990), Dube (1991), Vinaya *et. al.* (1991), Rajput (1992), Mathur and Bhatnagar (1992), Singh and Singh (1992), Arjunan and Ponnammal (1993), Sudheendra, *et. al.* (1993), Sahai and Tandon (1993), Newstron and Frankie (1994), Arjunan, *et. al.* (1995), Semalty and Sharma (1996), Verma, *et. al.* (1999), Krishnan (2000), Linkosalo (2000) and Rawat and Nautiyal (2007) have worked on the phenology of different forest tee species.

Gunaga and Vasudeva (2002) have observed genetic variation for vegetative phenology in a clonal seed orchard of Teak. Chhangani, (2004) have studied the leaf phenology of plant of a dry deciduous forest on the Aravalli hills of Rajasthan and observed that this forest produced enough leaves even in the difficult and dry conditions top support animal. Tree phenology observation comprised of bud growth, leaf emergence, flowering, fruiting and leaf fall activities in relation to seasons with variation in environmental and climatic factors like temperature and precipitation (Moza and Bhatnagar, 2005). Anthropogenic carbon emission into the atmosphere has been held responsible for the rise of global temperature by 0.7^{o}C over the last century (Smith *et. al.* 2007). Variation in temperature and rainfall greatly influence phenophases of trees species with variations according to types (Stirnemann R. *et. al.* 2008, Thakur *et. al.* 2008). Irregular trends of precipitations and fluctuating temperature regimes (increased) have greatly affected the leafflush and leaf fall activities of trees at varying extent (Singh and Kushwaha, 2005). Phenological changes following climate changes have consequential effects on the production distribution, composition and their life cycles with serious economic and social implications (Sparks and Menzel, 2002, Badeck*et. al.* 2004). A number of studies have been carried out in many parts of India and worlds to understand the phenological behavior during the last few decades like Attri, P. K. *et. al.* (2022), Abu, asab, *et. al.* (2001), Kailash, S. et.al. (2014), Sparks and Menzel (2002), Yadav and Yadav (2000), Sehgal, v, *et. al.* (2011), Singh, S. L and Sahoo, U. K. (2019), Dutta G. and Devi A. (2015), Singh & Singh (1992), Chhetri, R.

et. al. (2020), Kaur, G. *et. al.* (2013), Dwivedi, A. K. *et. al.* (2015), Srivastava, P. and Singh, S. (2013), Singh and Kushwaha (2006), Reich, P. B. (1995), Fenner, M. (1998), Kushwaha and Singh (2005), Jadeja and nakar (2010) and Zhang, G. *et. al.* (2006).

Bhatnagar (1968) studied the phenology of forest trees in dry deciduous forests of sagar and divided the species into three phonological stages namely (i) with foliation and flowering periods discontinues (ii) with flowering and foliation continuous and (iii) with flowering overlapping foliation. Tripathi, (1984) and Chaturvedi (1993) have studied the phenological behavior o plant *Anogeissus pendula* and *Lagerstroemia parviflora* respectively.

There is a wide variety of seed in plants species due to several parameters i. e, size, weight and colours, internal and external structure (seed coat characteristics and appendages). The variations are not only interspecific but also intraspecific. It has been found in seeds of several species that the intraspecific differences characteristically reflect the differences in seed behavior. It has been observed that environment of the parent plant affects the size and weight of seeds and normally results in production of smaller and lighter seeds under unfavorable condition. Seed behavior (germination capacity, germination velocity and vigour etc.) is the cumulative effect of the genetic makeup and environmental back up of seeds (Pandey and Kandya, 1993).

The main purpose of grading is to improve is to physiological quality of the seed lot. Grading of seeds according to their size and weight is a common practice in a majority of agricultural crops as it has been shown to have an effect on yield. In forestry, this practice has been adopted in few species, because it is difficult to ascertain effect of seed size on seed size on seed germination and seedling quality in the field (Devendra, 2007). Seed grading by weight or size form a seed lot and density grading based on fitness of seed has been emphasized (Furguson and Turner, 1971).

The seed exhibits dormancy on account of its hard seed coat. Generally the percentage germination of seeds has been found to be very low. There are certain factors (intrinsic and extrinsic), which determine seed germination; critical among intrinsic factor are seed coat impermeability and status of the embryo. External environmental factors such as temperature and moisture can affect seed germination. The power of germination of *Butea monosperma* is lossed during the storage (Arya and Arya, 2006). The seed coat of *Butea monosperma* is very hard due to the advancement of aril and

crauncle during the time of megagameetogenesis. Seed coat imposed dormancy is a delaying mechanism, which prevents germination under condition that might prove to be unsuitable for establishment, thereby distribution germination both in time and space. Several authors have reviewed the physiology of seed coat permeability (Gutterman, 1985; Vazquez-yanes and Orozco- Segovia, 1993 and Takatay, 1994). It has been proposed that the species may have seed coat induced dormancy as observed in few forest species (Naidu *et. al,* 2000), where seed coat does imbibe water and remain ungerminable as moisture in not available to the embryo.

Many workers have applied the different presowing treatment for differentforesttree species. Aclose relationship between seed size/weight and seed quality has been documented for many tropical hard woods (Halos, 1983; Gupta *et. al,* 1983; Ponnammal *et. al,* 1993). Srimathi *et. al,* 1991, reported that medium size seeds performed better than large size seeds. Success of plantation depends on the quality of seedling. Seed weight have also been reported to be positively correlated with seedling vigour in some tree species (Gonzalews, 1993; Mutha *et. al,* 1994 and Harsh *et. al,* 2002). Seed size and weight are moderate character in plants. These two characters are dependent on a variety of factors including age of the parent plants (Covers and Steel, 1984) and day length. Bhagat *et. al,* (1993) observed in Horse chestnut ((*Aesculus indica*) that heavier seed weight class gave significantly more seedling dry weight than the medium weight class. Ponnammal, Arjunan and Antony. (1993) reported that seed germination growth and its biomass increased with increase in the seed weight and seed size.

A number of workers have studied the effect of pre-sowing treatment and seed size on germination of different forest plants. Several workers viz., Kandya (1989) in *Peltophorumferruginetum*, Bagchi *et. al,* (1990) in *Acacia* species, Kandya (1990) in *Cassia siamea,* Marunda (1990) in *Acacia nilotica* and *Acacia holosericea,* Sehgal and Singh (1990) in *Pistaciaintegerrina,* Siddiqi *et. al,* (1991) in *Heritiera fomes,* Singh and Sah (1992) in *Abies pindrow,* Vyakaranahal, *et. al,* ((1992) in *Tamarindus indica,* Chaturvedi, (1993) in *Lagerstroemiaparvoflora,* Sheelavanta*et. al,* (1993) in *Sesbania rostrata,* Singh *et. al,* (1993) in *Aeseulusindica,*Superne, *et. al,* (1993) in *Gloriosa superba,* Jerlin and vadivelu (1994) in *Acaciamellufera,* Manga and Sen (1995) in *Prosopis cineraria,* Sudhakara *et. al,* (1996) in *Ceiba pentandra,* Krishan and Toky (1996) in *Acacia nilotica,* Palani *et. al,* (1996) in *Albizia lebbeck,* Manga and Sen (1996)

in *Prosopis cineraria*, Quraishi *et. al,* (1996) in *Cleitanthyscollnus*, Yadav, *et. al,* (1998) in *Delbergia sissoo*, Vanangamudi *et. al,* (1998) in *Acacia nilotica*, Kattimani, *et. al,* (1999) in *Withaniasomonifera*, Nizam and Hossain (1999) in *Albizia saman*, Shaukat, *et. al,* (1999) in *Acacia nilotica*, Sharma, *et. al,* (2000) in *Pterocarpus marsupium*, Sharma, *et. al,* (2001) in *Acacia nilotica*, Chillar*et. al,* (2002) in *Acacia nilotica*, Gopikumar (2002), Sharma *et. al,* (2002) in *Toona ciliate*, Thakur, *et. al,* (2002) in *Grewia optiva*, Joshi and Dhar (2003) in *Haracleumcandicans*, Nayital and Mehra (2003) in *Albizia chinensis*, Bhardwaj, *et. al,* (2004) in *Anogeissus latifolia*, Chaturvedi and Das (2004) in *Acacia auriculiformis* and *Acacia nilotica*, Lavania and Singh (2004) in *Populus ciliate*, Jin *et. al,* (2006) in *Glycyrrhiozauralensis* and Srinivasan, Saxena (2007) in *Acacia Species* and Sudhakara and Jijeesh (2008) in *Tectona grandis*. These workers have reported the great impact of seed size on germination parameters of different species.

Singh, *et. al,* (2005), worked on *Pongamia glabra* and Nagabhushnam and Reddy (1999) on *Pongamia pinnata* pointed out that seeds treated with hot water ($50^{\circ}C$) exhibited highest germination (98%) than scarified and chemical treated seeds. Singh and Arunachalam (2002) have studied the effect of Pre-sowing treatment and seed size on germination in Legumonous tree species and observed that a significant positive correlation exist between seed size and germination rate of untreated seeds. Ghildiyal and Sharma (2005), worked on the two conifer plants *Pinus wallichiana* and *Pinus roxburghii* and found that H_2O_2 (Hydrogen per oxide) (1% for 24 Hours) treatment has reduced the germination period of these species 8 days and 10 days respectively. Mutha, *et. al,* (2004) and Kumar, *et. al,* (2001) have worked on *Albizia lebbeck* and observed that mechanical scarification gave the best results while long duration (15 minutes) of Sulphuric acid pretreatment was to be deleterious for germination and seed weight of 6-12gm and group of colour seeds gave highest germination percentage. Sharma (1996) also observed that the brown colour seeds of *Albizia chinansis* gave highest germination percentage.

Roy (1992) has use a well known seed germination Promotors i. e. Potassium nitrate and Thiourea for enhancing germination percentage in *Albizizlebbeck* and recorded highest germination rate, total germination, seedling growth and seedling vigour in 0.3% Potassium nitrate solution and 0.2% solution of thiourea had the highest effect on germination rate. According to Singh and Gupta ((1979) the soaking of seeds

of *Populus ciliata* in water for 24 hours and 2M sucrose solution for 1.5 hour there is a significant increase in percentage germination. Seed germination and seedling performance of Neem (*Azadirachta indica*) has been shown to be affected by seed size (Kumar, 2007), larger size fresh seeds showed significant higher mean germination time as compared to medium and small sized seeds.

Saini, et.al, (1999) have received the many pre-sowing seed treatment on germination of Tea and investigated that alternative effect of water heating and air cooling with a period of 6 and 10 minutes respectively repeatedly three time and gave highest germination while Masilamani and Annadurai (2003) and Masilamani and Dharmalingam (1999) used Potassium nitrate to overcome the dormancy of Teak (*Tectona grandis*) and revealed that soaking and drying of drupes for 5 days at an interval of 12 hours followed by soaking in 4.5% KNO_3 solution recorded 52.0% germination in mist chamber accounting for an increase of 39.0% over the control. Chacko, *et. al*, (1997) concluded that wetting and drying for 7 days and soaking in cow dung solution for 24 hours are recommended for enhancing germination in Teak.

Seeds of *Dichrostachys cinerea* shows better germination by treated with nitric acid for 5 minutes (Idu and Omonhinmin, 1997). Seeds of *Acacia nilotica* show maximum germination and seedling survival when they were soaked in 100% ethanol for 24 hours (Khere and Saxena, 2003). Seed of *Albizia procera* show maximum germination and Root/shoot biomass when treated with cold water (Ali, *et. al*, 1997). The germination and growth of seedling of *Terminaliachabula*was found maximum when the seeds were soaked in cold water for 21 hours before 5-week stratification in cow dung while *Terminalia bellirica* produced better result when the seeds were soaked in Concentrate Sulphuric acid for 12 minutes (Bhardwaj and Chakraborty, 1994). According to Lata and Verma (1993) the seed of Bhimal (*Grewia optiva*) shows better germination percentage when seeds were pre-soaked in hot water for 24 hours.

The size usually reflects the comparatively nutrient pool and energy of a seed, which effect the further growth and development while studying various factors influencing seedling growth in the nursery stage. It was considered necessary to understand the effect of seed size in the rate of seedling growth, so as to get healthy seedling for transplantation in the field. Therefore, large, medium and small sized seeds

of *Butea monosperma* were treated with sulphuric acid, dry heat exposures and mechanical scarification to determine the germination

Abscission and shedding of fruits is usually sign of fruit maturity and it might be assumed that it also indicates a high content of sound and mature seeds. This is not always the case. The first seeds or fruits that fall naturally are often of poor quality in which it is advisable to reject them and to postpone collection until the peak and the latter half of the season. In Thailand, first fruits of *Tectona grandis* starts to be shed in March but observation have shown that the most viable fruits are the last to be shad, so collection of fruit in April is recommended (Hedegart, 1975). The first fruit of *Dipterocarp* species that fall upon ripening are usually defective and collection should be delayed until the greater portion of the fruit has fallen. White (1994) has also studied pattern of fruit fall phenology.

In India the only way to collect tree seed, especially conifer seed, is to delay the collection until the bulk of the crop is ripe and to collect the cones before complete dispersal of seed. This method involves a huge loss of seed and labour cost, because most of the seeds have dispersed during collection of cones and as a consequence more labour is engaged to collect the required quantity of seed. The time of maturity is normally understand as occurring when the seed reaches its maximum dry weight at which nutrient are not flowering into the seed from the mother plant.

Seeds development and maturation studies are important because the seeds may be harvested in time, before ageing sets in to ensure good yield associated with viability, vigour and field performance. Seed bearing of many forest trees is rather irregular from year to year. *Tectona grandis* has generally good fruiting each year although exceptionally good seed years are observed in some localities on a three or four year cycle (Murthy and Krishan, 1973). Sujit, *et. al*, (1994) in *Ceiba pentandra* and Indira (2000) in Teak reported that seed size could not evoke any significant influence on germination of the seeds.

Relative size and number of the natural dispersal units affect the seed mass collection, which can be conveniently collected by man. In the case of 1-3 large seeds inside a dehiscent or indehiscent fruit (eq, *Aeseulus*, *Tectona*), collection can be done natural fall of seed or fruit from the ground. On the other hand, collection of fruit/seeds can be done only from the tree before the natural dispersal such as in *Adina cordifolia*,

because seed are so minute (11million per kg) and it would be impossible to collect them after dispersal. The method of determining how to collect seeds depends on the characteristics of the fruit like: size, number, position and distribution of fruit and resistance of peduncles to shaking, pulling, breaking or cutting, interval between ripening and opening. It must be states that good seed implies seed, which is both of high viability and is genetically well suited to the site and for the purpose for which it is planted, good seed handing is an essential complement to genetic improvement. We can obtain some minor forest products such as oil from Sal seeds by collecting them during the late phase of seed ripening (Sharma and Jain, 1981).

Tetrazolium testing has been an important useful tool in determination of viability in a number of species. Lakon (1942) was the first to introduce the topographical evaluation of the viability of seeds by staining them with tetrazolium salts. He observed that when tetrazolium (TZ) salts came in contact with the living tissue in seed embryos, the chemical was reduced to an insoluble red pigment (Formazan) and stained the tissue. Non-living tissue did not affect the reduction of the TZ salts. Always red stained tissue was alive and an unstained (White) tissue was non-living.

Smith (1952) made a detailed study of this reaction in Corn embryos and concluded that TTC (Triphenyl Tetrazolium Chloride) was catalysed by diphoshopyridine nucleotide linked dehydrogenises (malic and alcohol system) and was mediated by diphorase. He also found that aerobic dehydrogenases such as Xanthine oxidase also cataysed the reaction. The TZ test is thus a test for activity of these systems tends to parallel loss in seed viability. This method has gained population mainly because of its simplicity, ease and rapidity of application (Gera *et. al*, 1998). In the recent years, various Indian workers have worked in different aspects of Tetrazolium.

Gopal and Thapalial (1969) have used this method in some Indian tree seeds and found it very accurate. Agarwal and kaur (1975), and Pasha and Das (1982) also applies this method but on several agricultural seeds. Roy and Tiwari (1970) used TTB (Tetrazolium Tetrazolium Bromide) while Singh and Verma (1970) used some other derivatives of Tetrazolium for viability tests.

Babeley and Kandya (1990) have use tetrazolium choride for testing the seed viability of *Bauhinia variegate* and *Wrightia tinctoria*. Babeley and Kandya (1986)

working with *Lagerstromia parviflora* found that TTC test is reliable for the prediction of viability and vigour of seeds. Various research workers have successfully used it for topographical determination of seed viability (Gupta and Raturi, 1975, Kuo *et. al,* 1996, Masilamani and vadivelu, 1997). Mittal and Sharma (1981), Kandya and Babeley (1984), Singh (1985), Yadav *et. al,* (1986), Nagaveni and Ananthapadmanabha (1989). Sadhu and Kaul (1990), Singh (1992), Agarwal, (1995), Purohit *et. al,* (1996), Kruse, (1996), Purohit and Bisht (1999), Ghyare, (2005) and Singh and Tripathi (2008) applied this test for some forest tree seeds.

Kanak, (1999) have studied the effect of storage on seed viability in 26 Leguminous tees and concluded that the process of seed deterioration was faster and greater at ambient storage but the effect of temperate varied species to species.

Singh (1992), applied tetrazolium staining test for seed viability of two Indian tree species (*Pterygota alata* and *Ailanthus grandis*) and find out that the different pattern of staining indicated the percentage of viable seeds in different seed lots of forestry species undertaking the time consuming elaborate method of seed testing.

Karma (1976) has shown by X- ray radiography that several seeds which are apparently sound, healthy and intact, possess the insect them in various stages of development and this prevent the seeds from germination. Keeping this in view, it is desirable that the tetrazolium staining procedure be standardized for the species.

The success of afforestation and reforestation programme depends mainly on the availability o seedlings in the forest nurseries. The chances of raising plantation by natural means of by direct sowing are very remote. For arid and semiarid regions, rising of seedlings in nurseries is very essential for successful plantation. A good stock of seedling can increase the chance of survival of plants. A nursery operated on set planting and management practices is therefore an important asset in any forestry programme. The traditional practice of raising seedlings in nursery depends on various factors. Depth of sowing is one of the important factors which govern the germination percentage (Agarwal *et. al,* 1996). Harper and Obeid (1967) have studied the influence of seed size and depth of sowing on the establishment and growth of fiber and oil seed and observed that small and large sized seeds preferred shallow and deep sowing for their faster growth respectively. Mutha *et. al,* (1995) have studied the effect of depth on germination *Prosopis juliflora* and concluded that sowing seeds of about 10mm

depth gave the maximum germination, it also gave seedlings of high sturdiness quotient. Lal, *et. al,* (1997) have worked for determination of proper depth of seed sowing in *Michelia champaca*. Seeds of Kail (*Pinus wallichiana*) show better germination in depth of 15mm (Singh, *et. al,* 1973).

According to Singh, *et. al,* (1975) the germination percentage of Spruce (*Piceasmythiana*) decreased as the depth of sowing increased. The influence of depth of sowing on germination of *Sterculia urens* have investigated by Pandey and Khatoon (1999) and concluded that maximum germination (80%) occurred in Horizontal and Vertical orientation at 4cm and 2cm depth respectively. Nagarajan and Mertia ((2006) has received the effect of sowing depth on germination of *Colophospermum mopane* and investigated that seeds sown at 5mm depth showed significant germination. Singh and Singh (1984) worked in Silver Fir (*Abies pindrow*) and pointed out that 20mm depth of seed sowing exhibited highest germination. Seeds of *Azadirachta indica* show maximum germination at the depth of 3cm. (Kumar and Mishra, 2007). Masilamani *et. al,* (1999) have worked on influence of seed orientation and depth of sowing on Anjan (*Hardwickiabinnate*). Agboola (1995) observed in *Prosopis africana* that germination and emergence of seedlings was significantly favoured when seeds were sown in soil depth range of 2-6cm. Ghosh *et. al,* (1974) have made studies on three species of *Pinus* and pointed out that suitable depth of sowing varied from species to species. Chakrawati and Verma (1968) have observed non germination of seeds of desert grass when they are sown beyond 10cm. depth. Singh, *et. al,* (2005) have worked on *Pongamia glabra* and pointed out that seeds sown at the depth of 3cm. exhibited higher germination. Tripathi, (1984) has observed in *Anogeissuspendula* that 10mm depth of sowing is very suitable for germination. Chandra and Ram (1980), who have worked in Deodar (*Cedrusdeodera*) seeds and told that deeper sowing, delayed the emergence period and sometimes percentage germination was also affected.

Prasad and Chadlar (1990) studied the effect of sowing depth on the germination of some common forestry seeds and reported that the seeds of shallow depth have shown better result. Thus, the knowledge of optimum sowing depth and other nursery requirement help in obtaining adequate planting stock even with fewer amounts of seeds. Chaturvedi (1993) has received the effect of sowing depth on germination of *Lagerstroemia parviflora* and investigated that seeds sown at 1cm depth showed better germination.

The influence of extract of one plant parts to the growth of other plant is referred as allelophathic effect. It is very common event that affect the seed germination and even seedling growth of many plant species. Rao and Rajagopal (1972) studied the influence of seed coat and leaching on germination on dormant seeds of groundnut and concluded that the leaching of decoated seeds improved the percentage of germination and also the fresh weight. Ahlgren (1981) studied the effect of different forest litters on seed germination and growth and concluded that the various litter components stimulated or inhibited seed germination and seedling growth of some species. Sharma and Nathwat (1987) reported that the allelopathines present in *Argemone maxicana* had shown little effect on the seedling emergence of Brassica, Pennisetum, Raophanus and Triticum species, however, the later growth of each of the four species was badly affected. Saxena (1989) reported the leachate of *Acacia catechu, Acacia nilotica* and *Ergoristiscilliaris* have negative allelochemics whereas the leachates of *Anogeissus pendula, Buteamonosperma, Hotopteliaintegrifilia* and *Rungiarepense* were positive allelochemics. Chaturvedi (1992) have thrown light on the effect of leachate on germination of *Lagerstroemia parviflora* and reported that maximum germination (17.12) was found 200gm. Leachate dissolve 500ml solution and 48 hr.old leachate whereas it was minimum (4.75) 200gm leachate dissolve 500ml solution and 72 hr. old. According to Kaletha *et. al,* (1996) bark and leaf leachates of Grewia *asiatica, Ficus cumia, Bauhunia racemosa, Celtis australis* and *Quercus leucotrichophora* trees significantly reduced radical extension of food crops like, *Eleusine leucotrichophora, Zea mays,* Vigna unguiculata, Glycine max and *Echinochloa frumentacea*. Many workers have studied the influence of leaf leachates of germination tree species on the germination and seedling growth of different crops viz., Bisla, *et. al,* (1992) worked on leaf extract of *Eucalpytus* and *Popular* on the germination and seedling growth of winter crops. Mughal, (2000), worked on leaf leachates on *Morus alba* on germination and seedling growth of some pulses. Padhay, *et. al,* (1992), worked on *Eucalyptus* leaves on seed germination and seedling growth of Finger Millet. Verma and Haider (1998) studied the allelopathic potential of leaf leacheates of some forest tree species and concluded that leaf leachates of *Albizia procera* and *Ficus bengalensis* inhibited the germination and speed of germination while *Syzygiumcumini* leaf leachates promoted the germination. Khan *et. al,* (2001) have investigated the effect of leaf extract of *Populus* deltoid on germination and seedling growth of some vegetables and find out that 10% leaf leachate of *Popupus* had stimulatory effect on germination and

length of shoot of Tomato and Brinjal, length of root, number of secondary roots and vigour index exhibited effects with the increase in leaf leachate concentration, in case of Carrot (*Daucas carota*). According to Dave and Jain (2009) allelochemicals play major role in influencing the crop productivity through inhibitory or stimulatory interaction, media containing different concentration i. e. 1%, 3% and 5% of root of *Chenopodium album* showed stimulatory effect on growth of root and shoot of *Triticum aestivum* L. while those of leaf extract showed inhibitory effect on shoot and root growth. The beneficial allelopathic effect of any weed or crop another weeds can be exploited to prepare eco-friendly, cheap and effective green herbicides, similarly the nagetive allelopathic effect of many weeds or crops on another crop can be utilized to develop growth promoting substance (Oudhia and Tripathi, 1998).

The process of water imbibitions is affected by nature of seed coat and its permeability to water, which in turn affects the process, which leads to quick and better germination as it is reported in a number of plant species. Largen and Lwanga (1969) have studied the effect iof prolonged seed soaking on seedling growth of Pisum sativum. Chatterji and Mohnot (1968) reported that imbibition affects germination of seed to a considerable extent. From existing literature it appears that there is a scarcity of data on seed germination of tropical forest trees in relation to inbibition. It has close relation with hydration of seed protoplast and other metabolic activities due to which dormant embryo of seed restores its activities and germinates.

The growth and development of any ecosystem depends on the environmental factors like temperature/humidity, the incoming solar radiation and also on the availability of moisture and nutrients.

Soil is one of the most important ecological factors. Plants depend for their nutrients, water supply and encourage upon the soil. For production of quality planting stock, ideal potting mixture should have better aeration, good water holding capacity, porosity, low bulk density, low in silt, clay and ash content and promote firm plug formation (Miller and Jones, 1995; Chakrabarti et. al 1998,). In modern forestry, it is important to produce quality seedlings by inducing morphophysiological changes in the plants for making them competent enough to bear the shock of field planting and enhance their productivity.

Potting medium is the most important input for containerized seedling production as it plays a key role in producing uniform and healthy seedlings. Apart from the selection of proper ingredients, it is necessary to maintain the porosity of the potting mixture so that proper development of roots could occur. The media should be rich enough to sustain seedlings for about 90-120 days. Growth and measurement made in nursery phase provide an idea to estimate possible performance of plant under field plantation (Goel, 1989). A good potting medium is characterized by light weight, friability, easy blendability, good water holding capacity, drainage, porosity, slight acidity, low bulk density, free from fungal spores and insect and low inherent fertility etc. The growth and quality of forests, whether naturally occurring or artificially created depends basically on the physical and the nutrient status of the soil, work on seedling establishment, survival and soil characteristics in relation to seedling growth is lacking.

Different ratio of soil mixture have been recommended by various workers for different species viz. Roy, (1986) in *Albizia amara*; Bahuguna and Lal, (1990) in *Acacia nilotica*; Beniwal and Dhawan, (1991) in *Anthocephalus chinensis*; Dhadhwal and Singh (1992) in *Leucaena leucophala;* Pyare and Karnataka (1993) in *Quercus leucotrichophora*; Mishra and Jaiswal (1993) in *Grevilla robusta*; Nayital, *et. al,* (1995) in *Bauhinia variegate*; Srivastave, *et. al,* (1998) in *Eucalyptus*; Woods, *et. al,* (1998) in *Sweiteniamacrophhylla*; Savio, *et. al,* (1999) in *Casurinaequisetifolia* and Ginwal, *et. al,* (2001) in *Acacia nilotica*.

According to Sharma, et.al, (2004), soil, sand and FYM at a volumetric ratio of 2:1:2 was found to be best among the tried combination for *Acacia auriculiformis* seedlings. FYM was found to be best medium for raising healthy and vigorous seedling of *Leucaena* (Dhar, *et. al,* 1992). Bhatnagar (1965) worked on the growth behavior of soil seedlings in different Sal forest soils. Yadav, *et. al,* (1982) observed better growth performance of *Tectona grandis* seedlings in Black soil.

Common problems associated with traditional nursery practices are bulky and poor nutrient mixture, poor water holding capacity, root coiling, less root fibrosity, more variability in seedling growth and anticipated poor survival and after growth in field. The above limitations can be overcome by raising seedlings organic rich potting mixtures. Ginwal, *et. al,* (2002), worked on *Delbergia sissoo* and pointed out that plant grows very well in sand and compost combination (20% Sand+ 80% Compost)

followed by other combination of Sand, Soil and Compost in the ratio of 1:1:3. Devendra, *et. al,* (2007) used three germination media viz. top of germination paper (TP), between of paper (BP) and fine sterilized Sand at 90±3% relative humidity in a seed germinator for 21 days, for evaluation the proper media for germination of seeds of *Azadirachta indica* and opened that among media, between paper (BP) was found the best in which maximum germination value was recorded. Sand media was found inferior as compared to top of paper. Tiwari and Sexana (2003) reported that soil, sand and FYM in 1:2:2 and 1:2:1 ratio indicated higher growth, dry weight and quality index of seedlings of *Dalbergia sissoo*. Singh, *et. al,* (2000) studied the effect of soil media on germination of three species and concluded that mixture of sand, FYM and soil in equal ratio (1:1:1) shows maximum germination percentage in *Delbergia sissoo* (91%), in *Prosopis cineraria* maximum percentage (90%) was recorded in 2: 1:1 and in *Acacia nilotica* maximum germination percentage (84%) was observed in 1:2:1 ratio.

Bahar and Singh (2007) studied the influence of media on germination of *Mesua ferrea* and recommended that sand is good medium for germination the species in controlled conditions. Verma, et.al, (2006) studied the effect of lime stone mine spoil and forest soil based potting media on growth performance of different tree species *(Bauhinia variegata, Robinia pseudoacacia, Eucalyptus hybrid, Grewia optiva*and *Toona ciliata*) and observed that 1:5 and 1:2 was found to be most effective with regard to survival, growth and biomass production parameters for all the five species. Studies on mixing of a normal soil in mine spoil have performed by many workers viz., Dadhwal, et.al, (1993); Paulsamy, *et. al,* (1996) and Panwar and Bhardwajm (2000). The potting medium consisting Sand: Soil: Compost in the ration of 40: 10: 50 shows best seedling growth of *Santalum album* in terms of height, collar diameter, total dry weight, shoot dry weight, root dry weight and root\shoot ratio (Annapurna, et.al, 2007). Khare and Mishran (1981) have studied the growth performance of *Butea monosperma* seedlings in relation to soil and found black soil as most suitable for the growth of this species at the seedling phase.

Jeglum (1979) studied the effect of seed bed types and watering frequency on germination and growth of Black Spruce. Anthony and Cheyeom (1969) has observed poor growth of *Pinus caribaea* seedlings in Clay soil due to its nutrient status and porosity as compared with peat soil. Eavis and Payne (1969) have identified the importance of a number of soil factors, upon the growth performance of root at early

stage. Seth and Srivastave (1972) have also studied the importance of different of different soil factors in relation to root development. LikewiseLasmarias (1979) has reported that the garden soil and sand mixture (2:1) and sand humus mixture (1:1) appeared to be most satisfactory potting media for the growth of Supa. Tripathi, (1984) has observed growth performance of seedlings of Kardhai (*Anogeissus pendula*) in relation to potting media and find out the sand to be the best while red soil as second best growth medium in the early phase of life of this species. According to Chaturvedi, (1992), the growth performance of *Lagerstroemia parviflora* at stage found better in a combination of Red+ Black soil (one part red + one part black) followed by Black soil and Sand (1:1 ratio with volume). The porosity of the supporting medium was found crucial in the early development stages of this species. Maithani, *et. al*, (1988) reported better germination, height and growth of Acacia nilotica seedling in soil mixture having 1:2:1 ratio of Sand, Soil and FYM. The best seedling growth of *Casuarina equisetifolia* was observed in potting mixture consisting of Sand, Compost, burnt rice husk and Charcoal in the 30:10:50:5 ratio (Rathore, *et. al*, 2004) while according to Sundararaju and Bharathi, 1989 use of high ratio of soil as compared to FYM i. e, 4:1 in Polythene bags (10×20cm) required 6-8 months to obtain plantable seedlings of *Casuarina equisetifolia*.

Light intensity is another factor that influences the growth of seedlings. The basic requirement for seedling growth are adequate supply of nutrient, appropriate regime of moisture, suitable temperature, good porosity of soil. The influence of light (intensity and quality) has a great significance on the germination of seeds and growth of seedlings. With the help of light, seedlings performance the process of photosynthesis in which electromagnetic energy is converted to chemical energy that can be used for various biosynthetic processes. In the simper terms, photosynthesis is the conversion of light energy into chemical energy. The effect of light on germination has been known to vary considerably with the seeds of different species. Some seeds germination after being given a brief illumination, while some are in different to the presence or absence of light during germination (Schmidt, 2000). A high light intensity also has an important effect of raising leaf temperature some whatapose the prevailing temperature, of the surrounding atmosphere and may thus influence photosynthetic indirectly by its effect as thermal condition within leaves (Chaturvedi, 1992). Consequently influence the timber quality many plant species are shade loving and light

demending during their early phase of life. The quality of light also influences the rate of germination and seedling growth. In lettuce seeds, the growth is stimulated by red light and inhibited if the seeds are subsequently illuminated with far red light. It has been concluded that the effect of light on seedling growth is phytochrome mediated (Srivastava, 2003).

The light condition plays an important role in establishment of seedlings. The influence of light intensity and quality on the growth of plants has been studied by many workers in dfferent species viz. Beniwal *et. al,* (1990) in *Toona ciliata*, Bahuguna and Lal, (1992) in *Celtis australis*, Saxena *et. al,* (1995) in *Delbergia sissoo,Acacia catechu* and *Casuarina equisetifolia,* Naidu, *et. al,* (1998) in different deciduous tree species and Khan, *et. al,* (2002) in *Mesua ferrea*

Luna and chamoli (2008) have studied the impact of light upon tree species (*Albizia procera, Eucalytustereticornis* and *Acacia catechu*) and concluded that plants under shade produce better growth and biomass parameters than under direct sunlight.

Bakshi (1952) has observed the effect of preliminary period of darkness on the percentage of seed germination of *Anthoshiluscriocephalus*. Variation of the duration of light exposure affects the plant growth intense light promotes a high rate of transpiration and may cause dehydration of Protoplasm (Dash, 2001).

According to Aswathanarayana et.al, (1993) germination, seedling growth, vigour index and seedling dry weight were decreased with shade in *Hardwickiabinata* and *Dalbergia sissoo,* However *Albizia lebbeck* and *Prosopis julifloraresponded* well to shade with regards to germination and seedling length. Advantage of artificial shading during nursery stage in terms of seed germination, seedling survival and growth of few tropical tree species was reported by Bush and Auken (1987). The seedlings, could survive the prolonged drought period after planting as the root nursery itself (Josiah and Jones, 1992).

Vyas and Nein (1999) have studied the effect of shade on the growth of *Cassia ungistifolia* and reported that increased plant height, number of nodes, mean inter nodal length and various growth parameters and the promotary effect was more prominent at 25 percent shade. According to Saju, *et. al,* (2000), species are different with regard to their shade responses, the growth performance and seedling parameters like, diameter,

leaf area, leaf size, root and shoot weight and chlorophyll content of *Tectona grandis* and *Grevillea robusta* was better in full sunlight than in shade while*Allianthustriphysa* seedlings performed well under shade.

Chaturvedi and Bajpai (1999) have studied the effect of different light conditions on germination and seedling growth of some selection forest tree species viz. *Bridelia retusa* (Spreng), *Holarrheneantidysenterica* (Wall), *Lagerstroemia parvoflora* (Roxb.) and *Wrightia tinctoria* (R.Br.) and considered that root length was found maximum under semi-shady conditions in *Bridelia retusa* and *Holarrhenaantidysenterica* and in contrary to this the length of root was reported higher in *Lagerstroemia parviflora* and *Wrightia tinctoria* in full sunlight conditions. According to Kumar, *et. al,* (2007), the seed germination and seedling growth o*f Azadirachta indica* remained unaffected with light condition

Tiwari*et. al,* (2000) have thrown light on the effect of different light conditions on seedling growth of some selected leguminous forest tree species viz. *Albizia odoratissima, D. latifolia, Ptericarpus marsupium, H. binnata* and *O. delbergioides*and suggested that the root/ shoot ratio and plant length was maximum under full sunlight condition in all the species expect *Albizia odoratissima* where root/shoot and plant length was maximum in semi-shady condition, they concluded that the species which showed better growth in full sunlight condition may be light demander during their early phase of seedling growth.

Shirley (1929) studied the influence of light intensity and light quality on the growth of plants. Loach (1957) has worked out the shade tolerance in tree seedlings. Robert (1971) found that in Red Oak (*Quercus rubral* L.) the tallest seedlings grow in 30 percent light. Gupta and Basu (1980) studied the influences of light and shade on *Solanum khasianum* Clarke, and concluded that the height of the plant is maximum in light condition and number of fruit and size of fruit was also greater in light than dark. Pathak, *et. al,* (1983), during the study of *Laucaena leucocephala* Lam. found that the seedlings raised under 45% light conditions showed better height and total dry matter. Milton (1982) studied the effect of shading on nursery grown Acacia seedling. Okati (1972) studied on the growth rate of some African forest tree seedlings in shade. Chaturvadi (1992) also reported the same results of 45% light on growth performance of seedlings of *Lagerstroemia parviflora*.

Water is the most important medium necessary for life. Moisture appears to be the most important functional constituent of biological cell affecting almost all vital physiological processes. Water is directly transparent to radiation and it can conduct the temperature well than compare to the other transparent substances. Most of the metabolic reactions of the plant are performed with the help of water. Water has dielectric constant due to own unsymmtically structure. Water plays a vital role in the photosynthesis. Mainly water acts as an important solvent for plant life. It is indirectly related to the cell division and various other functioning. Like other ecological factor, water requirement of different species differ. But in most plants excessive dryness and wetness both are harmful. In soil a balanced content of water allows a suitable level of soil air, it indirectly controls the growth performance of seedlings.

A number of studies on soil moisture, water supply and aeration in relation to seed germination and growth of seedlings of many species have been carried out by many workers (Piussi, 1970 in *Picea abies*; Shanker, 1970 in *Trichodesma amplexicaul*; Mc Donough, 1979 in *Quaking aspen*; Bheemaiah, et. al 1997 in *Tectona grandis)*. Jeglum (1979) studied the effect of bed types and watering frequency on germination and growth of Black Spruce. Singh, *et. al,* (1989) studied the effect of irrigation on green and dry matter production in summer forage. Tree growth has been shown to be adversely affected by inadequate amount of water nutrient (Seiler and Cazell, 1990 and Sharma, 2002).

According to **Bheemaiah (2004)** the growth of Teak can be increased substantially with irrigation at the interval of ten days. The scarcity of sufficient soil moisture and adequate nutrient supply are the major constraints to establish healthy plantation in many parts of the country (Sharma and Sharma, 2004). The increase in above ground biomass might be due to the application of nutrient and moisture in combination and strong positive interaction (Cromer, *et. al,* 1984), which enhances better utilization of applied nutrient owing to adequate moisture availability, which ultimately result in better growth. These finding are in close conformity with observation of Cole, *et. al,* (1990). Seth and Srivastave (1972) pointed out a close relationship among water supply and nutrient uptake of plant on Sal seedlings.

Shukla and Kasera (2004) have thrown light on reference of irrigation on Khejri (*Prosopis cineraria*) and reported optimum growth parameters at monthly

irrigation after establishment of plant. Orjha, *et. al,* (2000) have studies the effect of irrigation on spearmint plant. Drought is detrimental to growth performance of plants at any stage and is reported to cause decrease in water potential, osmotic potential and relative water content in plants (Thakur, *et. al,* 1998; upreti, *et. al,* 1999; Thakur, *et. al,* 2000). Water is one of the most critical constraints, which restricts establishment as well as subsequent growth potential of tree species (Sood and Thakur, 2006).

Tripathi and Saxena (1986) have worked on growth performance of *Anogeissus pendula* seedlings in relation to different irrigation condition and summarize that the better growth was found in alternate day irrigation followed by daily irrigation condition. Irrigation at alternate days was also found most suitable for the growth of seedlings of *Lagerstroemia parviflora* (Chaturvedi, 1992). Better metabolic activities in plant capable of maintaining higher water potential have been reported for various tree species (Rose, *et. al,* 1993; Lopushinsky, 1990; Chien, *et. al,* 1999; Husain, *et. al.,* 2000; Correia, *et. al,* 2001 and Weigh, 2001).

In an attempt to enhance seed germination and seedling growth in economic plants, there is usually a back up with hormonal treatment. The categories of plant growth hormone associated with seed germination and seedling physiology are the Gibberallic acid (GA_3), Indole acetic acid (IAA), Ethylene, Kinetin etc. (Agboola and Adedire, 1998, Fasidi, *et. al,*2000). Growth regulators have attracted much attention in the recent years for their role in growth and development of plants. They play a major role in controlling different phases of plant life including shoot and root growth. The important phases of plant growth which is effected by growth hormone are, phase of cell formation, phase of elongation and phase of maturation. In the recent past, many growth regulatory substances have been tried to boost the growth of nursery stock of various forest tree species, with varying degrees of success. Of all these growth regulatory substances, gibberellic acid (GA_3) has been most generally reported to stimulate growth of seedlings of many forest tree species (Nanda, 1969, Chandra and Chauhan, 1976, Singh and Nanda, 1981, Arya *et. al,* 1994, Grazesik, 1995 and Gautam and Bhardwaj, 2001).

The response obtained frequently depended on many factors such as the kind or variety of plant used, the part of the plant treated and its stage of development, the amount of hormone observed and the kind of hormone applied. Gibberellic acid is

known to influence a number of physiological processes in plants in our country. This growth hormone has been tried against several agricultural and horticultural crops and their response studied in many plant species. According to Pal, *et. al*, (1991) in *Dalbergia sissoo,*seventy five days old seedlings were sprayed with 100 mg/l solution of GA_3, strongly promoted the growth of stem and total number of leaves, but it suppressed the growth of branches and leaf abscission. Seeds of Melia azedarach when soaked in 200 ppm of IAA have been found to give better seedling growth compared to other concentration of IBA and GA_3 (Banerjee, 1998).

IBA in different concentration has been shown to have a significant effect on the growth parameters of *Leucaena leucocephala* seedlings (Adedire and Oladede, 1991). Vaish (1965) found that soaking *Allium cepa* seeds in IBA solution increased seedling growth. Singh and Nayyar (2000) reported the application of mixture of Gibberallic acid and IAA in Bamboo (*Dendrocalamushamiltonii* L.) and concluded that the combination of both hormone proved to be more effective than their individual application. High concentration of sucrose (25%), Ethrel, GA_3 and IAA (25ppm each) are more suitable while both concentration of IBA (10 ppm and 25 ppm) are equally favourable for the pollen germination and seed growth in *Prunus cerasoides* (Gaur and Sharma, 1985). Joseph (1996) has studied the effect of growth regulators and chemical treatments on post harvest life of *Ixora coccinia* and *Vinca rosea*.

Lavania, *et. al,* (2006) has received the effect of gibberallic acid on seed germination and growth of *Pinus wallichiana* and opened that the application of 300 ppm GA_3 for 24 hours or 200 ppm GA_3 for 36 hours shows the highest shoot and root growth. The treatment of GA at 1000 ppm on *Acacia nilotica* gave significant height growth, shoot and total dry weight in comparison to all other treatment (Bhatnagar and Singh, 1981). Edofin, *et. al,* (2004) have thrown light on effect of some growth hormones on seed germination and seedling growth of some savanna tree legumes and summarized that 0.01-0.04 ppm IAA enhanced growth in *Albizia lebbeck, Perkiabiglobosa, Prosopis Africana* and *Senna siamea*and 0.01- 0.05 ppm GA_3 enhanced growth in *Parkia biglosa* and *Prosopis africana*. Bhagat, R. (1994) and Ghyre (2005) received the effect the GA_3 on growth of *Acacia catechu* and find out that GA_3 stimulated growth while untreated seeds did not show any growth.

Tripathi (1984) have studied the effect of growth regulators on *Anogeissus pendula* seedlings and investigated that 25 ppm concentration of IAA was most effective as it gave good results of height growth as well as dry weight of seedling and to obtain better results with IBA, investigation should be carried out with concentration suich as 1000 ppm or more than that. In *Chrysanthemum*, GA_3 stimulated stem elongation and hastened flowering but TIBA (Tri-iodobenzoic acid) caused a significantly short stem and delayed flowering than control (Mohariya, et.al, 2003). Bhatnagar and Talwar (1978) studied the interrelationship of different ppm of IAA, GA and other growth regulator on height, growth and diameter increament of seedlings in *Pinus caribaea*.

Singh, *et. al,* (1995) has received the response of plant growth regulators on seedling growth of *Artocarpus heterophyllus* and investigated that mixture of IBA+ NAA was most effective as compared to IBA and control. Kiran *et. al,* (2001) Studied the effect of Gibberallic acid on seedling growth of *Givotiarottleriformis,* a forest tree on the verge of becoming extinct from the forest of Andhra Pradesh. Ghyre (2005) also studied the effect of Gibberellic acid on seedling growth of five timber tree species.

Massilamani and Vadivelu (1997) during the study of Anjan *(Hardwickiabinata*), observed 200 ppm of Ethrel gave better results. In order to overcome the inherent biological problems connected with seeds, vegetative propagation could be tried as potential means of production of quality planting stock. Sharma and Pandey (1999) reported that in *Delbergia sissoo,* IBA 5000 ppm showed significant effect on all the parameters regarding rooting behavior. Some seeds have poor and delayed germination and growth due to the presence of inhibitor compounds in the seeds (Vijayalalitha and Loda, 1997). Singh and Chander (2001) have suggested that rooting percentage in *Azadirachta indica* was suppressed with increased auxin concentration and hardiness of the cutting in all treatment, rooting percent increased with increased number of days after planting. Masisalmamni and Dharmalingam (2002) have recorded the highest percentage of germination at 250 ppm GA_3 treated seeds in *Grevillea robusta*. Mishra and Jaiswal (2000) have studied the effect of plant bio-regulator and potassium nitrate on seedling of Bael (*Aegle marmelos*) and suggested provenance variation in *Casuarina* species with references to germination and growth.

The present work is proposed to fill these lacunae to some extent by exploring the growth and establishment behavior of *Butea monosperma* and by studying the interaction and interrelationships between the growth of seedling and its environment. The present study involves the following experiments.

1- Germination and growth of seedlings in different soil types.
2- Effect of different light conditions on seedling growth.
3- Effect of different regimes of irrigation on the growth of seedlings.
4- Effect of growth hormone on seedlings.

Research on vegetation propagation may be directed towards development of a variety of methods for producing and multiplying genetically uniform trees, vegetative propagation in genetical research and forest improvement was extensively discussed by Nienteedt*et. al,* (1958). Out of the various methods of vegetative propagation of forest tree species the one most likely to success on a large scale is the rooting and branch cuttings. Stem or branch portion are generally very good material for rooting purpose, because they usually have undifferentiated tissue, which may initiate of root primordia. The potential for increased genetic gain through vegetative propagation of forest trees has been demonstrated by a great number of silviculturists Ye, (1984), Kulkarni, (1986), Shamet and Kumar (1998). Khan and Tripathi (1986), studied the effect of stump diameter and height of four tree species and concluded that the sprouting from stump of medium diameter survive better than those from stumps of smaller or large diameter and height. Pireira*et. al,* (1984) have observed in *Eucalyptus* that the shoot produced from the top half of the stumps had greater survival than those from the bottom half. Mamanteo and Verecion (1984) studied on the coppiceing of Oak tree and concluded no significant difference among total height, diameter of stump and sprout production.

The number of sprouts per stump wsa not related to light intensity but it has some correlation with forest type reported by Johanson (1987). Singh and Yadav (1988) suggested that the *Cassia siamea* and *Pongamia pinnata* both have good coppicing ability and their large scale plantation could be encouraged.

Silvicultural practices have great impact on forestry management and conservation. Lowell, *et. al.* (1989) studied the coppice regeneration in Oak stands and reported that treated or thinned stumps show better growth and height, dbh and volume

as compared to similar dominant sprouts in unthinned plots. Marca, *et. al.* (1998) have also worked in ageing holm Oak (*Quercusilex* L.), and concluded that regeneration from seed showed a significant correlation with vegetative propagation. Keim, *et. al.* (2006) have thrown light on stump sprouts in height graded baldcypress water tupelo swamps in the Mississippi delta and found that the majority of stumps could not produce surviving sprouts, smaller diameter stumps and baldcypress sprout growth was greatest on drier sites with less competition from overstory trees, surviving baldcypress stump sprout had high growth rates, but were not regularly spatially distributed within stands and many had advancing decay from stumps into sprouts. A large scale plantation of *Cassia fistula* and *Pongamia pinnata* could be encouraged by its good coppicing ability (Singh and Yadav, 1988). According to Grunwald and karschon (1974), tree growth of *Eucalypytus camaldulensis* varied with the origin of the seed, thereby determining the amount and rate of coppice regeneration of the cutting. The number of coppice shoots height of the tallest shoot and biomass were directly related to tree height and growth before coppice cuttings.

Kathiravan, *et. al.* (2009) have focused on determination of suitable cutting size for vegetative propagation and comparison of propagules to evaluate the seed quality attributes in *Jatropha curcas* Linn., concluded that *Jatropha curcas* propagate through seed recorded better performance related to plant biometric and seed quality characteristics compared to cuttings, which includes early flowering and more flower than the seed crop. Tripathi and saxena (1987) have thrown light on regeneration on *Anogeissus pendula* and reported best regeneration on plateau followed by slope and base, but the regeneration at base is very poor. Handa, *et. al.* (2005) applied the growth hormone (IBA and NAA) on stem cutting of *Albizia lebbeck*, and suggested that IBA was more effective than NAA in inducing rooting in this species and maximum rooting success was achieved with IBA at 400ppm concentration. According to Verma and Puri (1996) the lower doses od Auxins triggered the rooting of cutting of *Delbergia sissoo* (Roxb.), the best treatment found was the 100ppm of IBA in spring season.

A number of workers have studied the behavior of vegetative propagation of different forest plants. Several workers viz. Badoal, *et. al.* (1993) in *Solanum torvum* (rangaigan), Bhardwaj, *et. al.* (1993) in *Terminalia bellirica* and *T. chebula* Retz., Gupta, *et. al.* (1993) in *Delbergiasissioo*, Ravichandran, *et. al.* (1994) in

Casurinajunghauhnina, Shamet and Khosla (1996) in Cedrusdecidara, Singh and Mahajan (1998) in Teak and Bakshi, *et. al.* (2007) in *Delbergia sissoo.*

Diameter of sprouting stump also plays a key role as sprouts of medium diameter survive better than those from stumps of large diameter and height (Khan and Tripathi, 1986). Yeboah, *et. al.* (2009) have studied the stem cuttings in Shea (*Vitellaria paradoxa*) and concluded that combination of wood type (soft, semi-hard and rejuvenated Coppice shoot), sucrose application at 0, 15 and 25% seradix powder hormone (active ingredient Indole butyric acid) at 0 and 8000ppm. Cutting of Coppice dipped in 15% sucrose solution gave significantly higher rooting and longer roots than both softwood and semi-hard wood. High levels of suitable sugar and total free phenols were recorded for coppiced cuttings which resulted in better rooting performance than the other wood types. Singh and Dhillon, B. S. have studies to rooting and sprouting in stem cuttings of *Citrus jambhiri* by using IBA and cyclophosphamide (CP), and summarizes that the % of cutting callused and the amount of callus per cutting were significantly higher in cyclophosphamide followed after one day with IBA treatment, Whereas the percentage rooting was significantly higher in IBA followed by cyclophosphamide after seven days. Moreover, the average number of roots per cutting, length and diameter of root the percentage of buddable stocks were also significantly greater with IBA followed by cyclophosphamide after seven days in comparison to control and all other treatment. In all the instances the controls failed to roots. Ojha, *et. al.* (2008) have thrown light of coppice management of Sal (*Shorea robusta*) forests in the Terai of Nepal and evaluate that high dbh range coppice can play a significant role for development of Sal forests. Local community must choose appropriate simple coppice management option in their Sal forests, if fodder and fuel wood production in short rotation is the objectives of the forest management.

Chapter- 3

MATERIALS AND METHODS

Bundelkhand is an area, which is between the Indo-Gangetic plan on the north and the Vindhya Range on the south, and falls between the latitudes of 23 º 8 W -26 º 30 W and longitudes of 78 º 11 W -81 º 30 W. It is light raised upland because it has barren and hilly topography with few vegetation cover but previously it was wooded. The plain of Bundelkhand is traversed by three mountain ranges (Vindhya, fauna and Bander chains) with their highest level never exceeding 600 meters above the sea level. On these is to be superimposed the more detached hills, which suddenly rise above an otherwise level surface, and offer, by the strictly and nearly impossible seldom of its steep side, effective sites of strong-holds, and bastions of native rulers. It is also north-easternly inclined, the rivers flowing in it or falling on it being turned off to a final outlet in the Yamuna River.

Bundelkhand has a major number of towns which are; Jhansi, Datia, Gwalior, Lalitpur, Sagar, Damoh, Panna, Banda, Hamirpur and Chhattarpur. However, the best place in Bundelkhand to visit is the Khajuraho, located in a cluster of 10th century temples, some of which are entirely devoted to the fine living and eroticism. Panna is known of great Diamonds, and Kalinjar known of a lagge and beautiful stronghold. Bundelkhand is the most common area that the Hindi dialect is spoken. The area is mainly a Hindu one. Jainism possesses some historical significance and it boasts of many Jain Tirthas in this region viz., Sonagiri, Devgarh.

Bundelkhand rivers are important such as the Sindh and Betwa rivers, Tons, Dhasan and Chambal. The weastern border of Bundelkhand is the kali sindhu that breaks in malwa. This river is parallel to the course of Betwa, and even eastward. The rivers which are navigable are only two and they include Yamuna and the Ken. Although streams are abundant, they are unsuited to the work of irrigation, but in a very minor measure, unless the channels are deepened and the banks are steepened, which is done by the means of Ponds and canals. These artificial lakes are usually constructed by piling embankment over the inferior heads of the valleys, and thus causing the water to pass through them.

Bundelkhand region is spreader over 71618 km sq. The forest area of Bundelkhand covers 12.10 lakh hectares of land and accounts for 17.28 percent of the total reported region. Out of this, the Madhya Pradesh part occupies 9.63 lakh hectare (79.6%) and Utter Pradesh 2.47 (20.40%).

Around the Bundelkhand region, the forest was numerous times found covering the area until the close of the 18th century. The wood and agricultural expansion demands increased after the 18th century leading to the increasing deforestation. The discovery of green revolution that ensued subsequent to the independence of the country and the population growth added even more plots of land under plough increased the pressure on the power of wood based energy even more. All this coupled with poor management of the region and the unscrupulous commercial logging as sanctioned by the government has seen the area covered in forest cover dwindle in the region by a large margin.

Remains of dry Dhak, Teak, miscellaneous and thorn forests were now left. The rest of the existence is Mahuhahichirongi, khardai, dhau and Khair trees. Sculpture landscape primarily consists of scrub forest (Siari, Khatai, Gunj, Bel and Ghout tree) and scrub brush of which the most are open forest with large tracts of land which are regarded as wastelands. The domineering type of soil is a mixture of Black, Paduaa and Red the latter is rather newcomers, shallow and gravely textured And not capable of holding the moisture well. These are topsoil erosion and deforestation which allow causing the acute ecological degradation of a significant part of the area and the absence of land productivity. Soil erosion is a historical occurrence that results in the increase of gullies due to the aggravated condition brought about by the Hilly nature, high speed of the winds and poor quality of the soils.

The forest vegetation of Jhansi and its adjoining area is transitional between the south tropical dry deciduous type and the North tropical dry deciduous type. Forest in Jhansi cover 6.48 percent of its total geographical area and it is about 280m above the sea level.

Study site-

Site-I **Banguan forest** of Jhansi range. This forest is situated on the eastern side of Jhansi-Mauranipur road and is nearly 16 km. from Jhansi. About 180.70ha

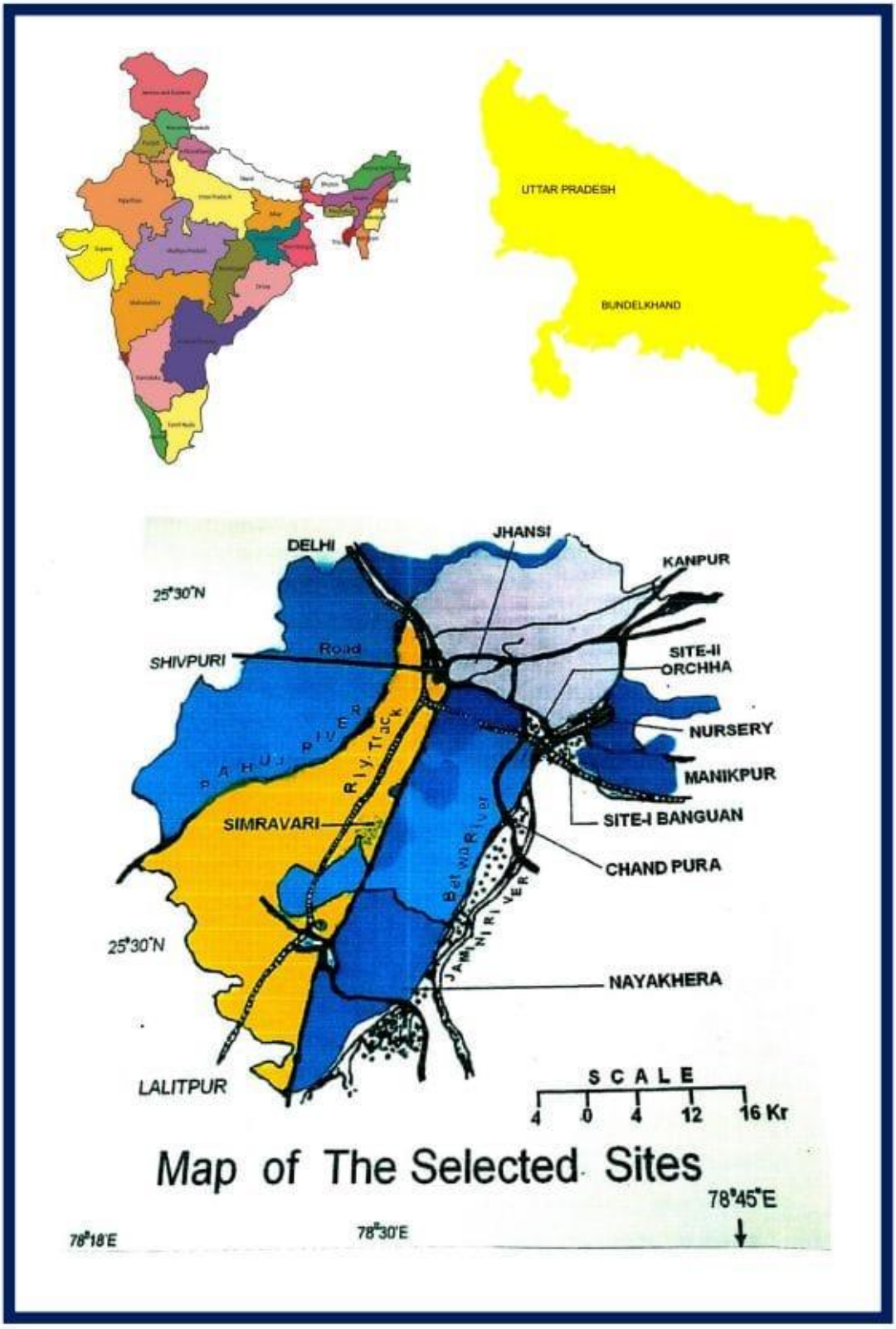


Fig. 3.1 Map of the selected sites (Site-1 Banguan and site-2 Orchha)

area of the forest is reserved and in general the forest is tropical mixed dry deciduous type.

Site-II **Orchha forest**of Orchha range. Orchha forest is located at east of Tikamgarh in the Orchha- Tikamgarh road and is nearly 15km. from Jhansi.

Nursery

For germination, seedling growth and silvicultural studies the author made use of the Banguan forest nursery with the permission of the forest department, Jhansi. The nursery is situated on the eastern Bank of the river Betwa and is about 15km. from Jhansi on Jhansi-Mauranipur road.

Edaphology

Edaphic factors include the structure and composition of soil alongwith its physical and chemical characteristics. Soil instead of being one thing, is in fact a complex made up of several components. The soils of the Bundelkhand region in general are poor in nitrogen, low and medium in phosphate and medium to high in Potassium. These soils are broadly grouped in Red and Black soils. The Red soil further classified into Raker soil and Padua soil. Black soil is also classified into two subgroup, Kabar and Mar soil. This classification was performed on the basis of their texture and colour. Kabar and Mar soil (Heavy soil) black in colour and capable of retaining moisture, this soil constitutes about 25% of the total area. Padua soil (medium soil), light greyish in colour and well drained, the area under this type of soil is about 40%. Rakar soil (light soil)- reddish in colour and consisting of gravels. This soil is very poor in fertility and comprises about 35% of the total area. The soils of the Bundelkhand region reflect following patterns.

1- Red soil in hilly portion giving an eroded appearance.

2- Brown soils rich in $CaCo_3$ (calcium Carbonate) and gravel layers found on level plains and upland near catchment areas.

3- Black and plain with high percentage of clay on low-lying areas under restricted drainage.

Bundelkhand soils are residual in nature and are formed in situ from the parent material in general. Red soils are originated from the parent rocks like geneiss and granites. Some time they are also formed from sand stones. The parent material for

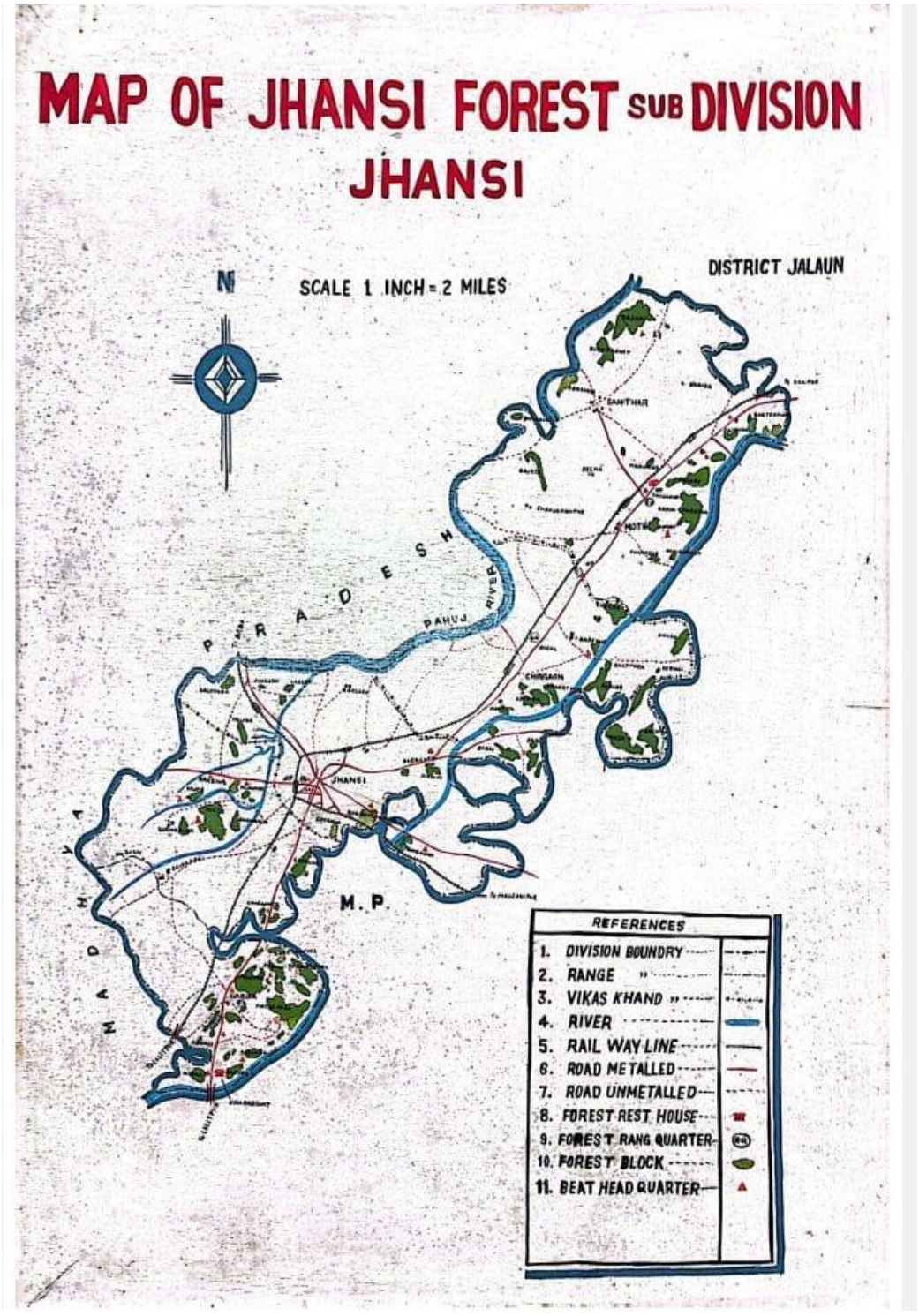


Fig. 3.2 Map of Jhansi forest

Black soil is limestone and partly transporated. Rock mineral of the parents materials of Bundelkhnad soils comprised of Quartz, Feldspar, Hornblende, Chlorate and Mica, dominant soilnforming factors besides parent material are topography and climate.

Topography

Topographical factor is concerned with the physical geography of the earth in the area. A series of parallel ridges mostly in the northern direction and with an average height about 280m above sea level in general and exceeds over 450m in some cases. The hypsometric curve of the regions shows that about 67.7 percent of the areas are less than 300cm and 28.7 percent lies between 300 and 400m, with small area 3.6 percent above 450m. Surface rocks are predominantly granite of the lower Pre-cambrian period. Sandstone, shales and limestone of high quality, along with sills and the famous pink Archaean geiss rocks, are also found in this region. The land for most of the part is rocky, however, there are patches of fertile black soil in between various hills and hillock. The tract presents an undulating terrain. The area has a gentle slope towards north. Due to absence of any important mountains, hill rangrs or river, it is difficult to demarcate the geographical area in definite terms.

Betwa, Pahuj and Jaminin are the main tributaries of the river Yamuna, flowing through ther tract. The banks of these rivers are flanked by most of the forests of the region.

Climate

On the basis of temperature of air, light, rainfall, humidity of air, the climate of the study area can broadly be termed as seasonal. The year is divisible into three distinct seasons viz., rainy, winter and summer.

Rainy season starts from late June and continueupto starting of October. Average rainfall per year is 800-900mm but most of water was loss due to runoff and no proper planning of water conservation. July and August are the months of maximum rainfall. Winter rainfall is very irregular in this area. The scant winter rainfall is useful for the cultivation of the Rabi crops, but it is usually inadequate without access to supplement irrigation source. Rainy season is succeeded by winter which lasts till February. This season has low temperature, moderate retative humidity. In winter season the temperature dropping as low as 3^{o}C. The summer season starts from March

but temperature begins to rise in late February and continue till June. Peaks period of summer season is May-June. Hot breezes locally known as Loo and are common during this period. The temperature becomes reached above 45^0C during the summer months and with low relative humidity. During the summer seasons high temperature in the plain cause low pressure areas that induce movement of the monsoon.

Rainfall

The year 2023 and 2024 experiment total 556.9mm and 1120.6mm rainfall distributed over 40 and 64 rainy days respectively which were 40.503 percent below and 19.722 percent above the average rainfall (936mm) of the region. Moreover, the number of rainy days was not well distributed.

In the year 2023 the maximum rainfall was recorded in June (143.3mm) followed by July (140.3mm) and September (119.8mm). In winter only 50.6mm rains were received in 5 rainy days. Absence of rains was observed during March, October and November.

The year 2024 experienced early onset of mansoon which started in the last week of May (21^{th} standard week). The maximum rainfall was received (640.8mm) in June followed by July (321.8mm) and September (114.4mm). In the month of January, February, March and December absence of rain was observed. In winter only 16.00mm rains was received.

Temperature

In the year 2023 the mean monthly maximum temperature recorded was 41.7ºC in month of May followed by 40.2ºC in April and minimum 6.0ºC during December followed by 6.1ºC (January). In the year 2023 the Mean annual maximum and minimum temperature were recorded 32.817ºC and 17.241ºC respectively.

During 2024, the higher temperature 40.1ºC recorded on June and the lowest of 4.7ºC was noticed on January. In the 2024 the mean annual maximum and minimum temperature were received 31.976ºC and 17.033ºC respectively.

The summer usually begins by the middle of March, extends upto the end of the June and ends with the onset of mansoon. The severity of the heat during day time is aggravated by strong hot and generally dustless winds which persists throughout May and June and is characterized by comparatively clear and dustless sky.

Biotic influence

The forests of Bundelkhand region are mainly use for grazing, fodder, firewood, agricultural implements, timber and fencing etc. The low productivity of these forests are due to misuse of forests like over grazing and human interference so there is need to think about their improvement.

Human and domastic or bagadon animal have a large influence on the vegetation of these forests in its various stages of development. Animals like Monkeys and Langoors often break the lopped leading shoots. Young seedling, coppice and saplings of the plants were very much affected due to extensive and unlimited browsing and grazing of livestock like, Sheep, Goat and cattle. Reptiles like, snakes and rodents move from one place to another in forests, this activities cause a harmful effect or sometimes even death to the perennial plants by exposing their roots. All these and other factors have contributed to the declining productivity of the forest at an alaming rate.

Forest fire is also triggered the environment of forest. Periodic burnings have led to the development of bare grassland or bare areas that are scattered over the forestland. Frequent jungle fires have also resulted in the invasion of exotic, fire-tolerant, ubiquitous weeds such as *Lantana camara* and *Spergura arvensis*.

Table-3.1 Average monthly climatic conditions on Jhansi during the study area (2023-2024)

(From courtesy of Indian Grassland and Fodder research Institute, Jhansi)

Month	Temperature		Relative Humidity		Rain Fall		Wind Velocity
	Max.	Min.	Period- I	Period- II	mm	Rainy Days	Km./hours
January							
A	24.1	06.1	87	42	1.8	-	2.5
B	22.0	4.7	87	40	00	-	2.52
February							
A	26.3	10.2	88	44	39.2	-	4.0
B	26.7	5.1	84	28	00.0	-	3.1
March							
A	32.4	13.1	79	28	00	-	4.4
B	34.8	13.2	76	22	00	-	3.8
April							
A	40.2	20.7	55	23	2.0	-	5.9
B	39.4	20.0	50	20	0.8	1	6.8
May							
A	41.7	25.7	53	27	15.1	2	7.7
B	40.1	24.5	58	35	21.9	4	7.7
June							
A	39.1	27.3	67	45	143.3	5	10.1
B	33.6	25.0	85	67	640.8	20	6.8
July							
A	33.7	25.4	87	64	140.3	13	7.9
B	32.1	25.2	91	75	321.8	19	4.8
Auguest							
A	33.0	24.9	90	66	85.8	9	6.0
B	32.6	24.8	91	71	2.5	5	3.4
September							
A	34.1	23.4	90	58	119.8	6	3.3
B	33.8	23.7	87	60	114.4	8	5.0
October							
A	35.0	13.8	78	26	00.0	-	2.8
B	34.7	17.3	83	44	2.4	2	3.8
November							
A	30.2	10.0	88	29	00.0	-	1.8
B	28.1	11.6	86	40	16.0	5	2.6
December							
A	24.0	6.0	88	40	9.6	1	2.3
B	25.8	9.3	87	43	00.0	-	2.7
Annual							
A	32.817*	17.24*	79.16*	41*	556.9	40	4.891*
B	31.976*	19.45*	80.41*	45.417*	1120.9	64	4.419*

Legends - *= Mean Annual, A= 2023 B= 2024

Phytosociological studies were carried out through Quadrate methods. The both banguan and Orchha forest were divided in the equal compartment arbitrarily and 400 quadrates of 10X10 m size were placed at equal distance in parallel lines. The study was carried out in November 2023. Three analytical character viz. Relative frequency, Relative density, Relative basal area were considered for the calculation of Importance value Index of each species (Curtis and Cottom, 1962). The formulae for determination of these parameters are given below.

$$\textbf{Relative Frequency} = \frac{\textbf{Frequency of Species}}{\textbf{Sum of frequency value of all species}} \boldsymbol{x\ 100}$$

$$\textbf{Relative Density} = \frac{\textbf{Density of Species}}{\textbf{Sum of Density value of all species}} \boldsymbol{x\ 100}$$

$$\textbf{Relative abundance} = \frac{\textbf{Basal area of a Species}}{\textbf{Sum of Basal area of all species}} \boldsymbol{x\ 100}$$

$$\boldsymbol{IVI = \ RF + RD + RA}$$

The similarity between the forest stands (Banguan and Orchha) was determined by using the formula of community co-efficient as per Kulezynski (1937).

$$\boldsymbol{CC = \frac{2W}{a+b} X\ 100}$$

Where

CC =community co-efficient,

W = sum of the lower frequency percentage of the common species in forest A and B.

a = frequency values of all species in Forest A (Banguan).

b = frequency values of all species in Forest B (Orchha).

The spacial distribution of species in stands has been derived from Whitford index of A/ F ratio (Whitford, 1949). The A/ F ratio if below 0.025 indicates regular distribution, between 0.025-0.05 indicates random distribution and when above 0.05 indicates a contagious distribution (Curtis and Cottom, 1956).

The procedure of phenological observation was followed after Bhatnagar (1968). For the study of Phenological events of forests the sites were visited on a definite date and the phenological characteristics such as leafing, flowering, fruiting, Leaf fall and fruit fall were noted in all the 11 species. The information about all species was tabulated at the end of the season. The study was carried out for a period of one year from August 2023 to July 2024. Twenty five adult and healthy plants distributed at different part of each site were considered to note the phenological changes.

Seed collection

The period between seed maturation and dispersal is often short, whereas the effect of climate in a given year may displace the dates of seedling by several weeks from the average. In the temperature zone an early spring and dry summer can cause very early seed ripeing, whle strong, dry winds cause rapid dispersal of the ripe seeds. Cool, wet weather on the other hand may delay ripening and dispersal by weeks or months (Stein *et. al,* 1974). In dry tropics there are similar annual variations in the dates of the onset of the dry season and of the rains. It is therefore, necessary in each year to check the correct timing of collection by examination of the crop itself.

There are three general methods of collecting the Pods/Seeds of *Butea monosperma*.

Type A- Mature Pods/Seeds- are considered to these, which fell by slight hand- jerk or on their own possibly by the formation of Abscission layer.

Type B-Mature Pods/Seeds- which have been collected directly from parent tree by hand plucking.

Type C-Mature Pods/Seeds- which have been collected directly from soil surface.

Pods of *Butea monosperma* were collected from healthy and young tree having cbh between 47cm. to 68cm. from Banguan and Orchha forest of Bundelkhand region during March to April 2023. Seeds were extracted from the Pods and dried in open sunlight for 7 days, than stored in airtight polythene bags at room temperature (15^{o}-30^{o}C).

Seed germination studies

Seed weight and size with Pretreatments

The seeds were picked by putting the seeds into three categories based on their weight Large (0.21-0.30gm), Medium (0.11-0.20gm) and (0.05-0.10gm). Both mechanical handling of the seeds and acting of the chemicals were undertaken on the seeds. Seed germination was also experimented on the effect of temperature. Various pre-sowing treatment made are summed up to be as following.

1- A small portion of the seed coat was scarified at the distal end of cotyledon using a nail clipper.
2- The concentrated H_2SO_4 (98%) was poured in the seeds and allowed to stay in the presence of the seeds of 5, 10, 15 minutes after which the seeds were rinsed using approximately 3 minutes of tap water.
3- Dry heating was done when the seeds were put in preheated 60^oC, 80^o C and 100 o C oven in 15, 30 and 60 minutes and then seeded.

The seeds were treated on the seeded polythene bags of 25 X 10 cm. of botanical garden, P. K. University, Campus Shivpuri and followed by the sowing of the seed. The experimental design was in complete randomization and four replicates of a hundred seeds of each of the treatment were tried. The germination statistics are collected and processed.

Viability

The tests were performed in Jan. 2023. Four working samples were taken from each seedlot and sample divided into two sub-samples, one are used for germination and other for tetrazolium test. In both the tests, four replicates of 100 seeds were taken. 2, 3, 5 triphenyl tetrazolium choride was dissolved in the phosphate buffer solution of 7 PH. The concentration of TTC salt was 0.1%. Seeds of *Butea monosperma* were filed by the acid treatment. Seeds were dipped in Concentrate H_2SO_4 (98%) for 10 minutes. Acid treatment with concentrate H_2SO_4 for 10 minutes shows 100% germination (Singh and Arunachalam, 2002). Seeds of *Buteamonosperma* have hard seed coat and thick endosperm. Treated seeds were soaked in water for 24 hours at room temperature (25^oC) for imbibitions. After imbibition of seeds the help of forceps filed seed coat and endosperm out.

Decoated seeds were kept in 0.1% tetrazolium solution in beakers, which were kept in darkness in an oven at 35ºC for 20 hours (ISTA, 1983). It is well-established fact that most of the enzymes show better activities at 35ºC. During this period seeds received red color in various patterns. After staining the TTC solution was drained off and seeds were washed several times with water. Evaluation of color intensity was done on the basis of distribution of stain in various parts of the embryos.

For germination test, four replicates of 100 seeds each were used from each seed lot. Filed seeds were kept for germination on top of 3 layered moistened sheets of filter paper in seed germinator at 27±2ºC. Daily counts for new germination were made and percentage germination was calculated after 10 days.

The numbers of coloured (viable) and uncoloured (non-viable) seeds were recorded. The percentage viability of seeds was calculated as follows.

$$\textbf{Viability} = \frac{\textbf{Total number of viable seed}}{\textbf{Total number of seeds examined}} \boldsymbol{x100}$$

Depth of Sowing

Pods of *Butea monosperma* were collected from Banguan and Orchha forest of Bundelkhand region in March to April, 2023. Seeds were extracted from the Pods and stored in polythene at room temperature (15-35ºC). The tests were performed in August, 2023. Seeds of *Butea monosperma* were treated by the acid treatment. Seeds were dipped in Concentrated H_2SO_4 (98%) for 10 minutes. Acid treatment with Concentrate H_2SO_4 for 10 minutes shows 100% germination (Singh and Arunchalam, 2002). Seeds of *Butea monosperma* have seed coat and thick endosperm. Treated seeds were soaked in water for 24 hours at room temperature (25ºC) for imbibition.

Effect of depth of sowing on percent germination was studied in Botanical Garden, P. K. University Campus. The treated seeds were sown in Polythene bags of 25cmX10cm sized. Seeds were sown at six depths of 1cm(D_1), 2cm(D_2), 3cm(D_3), 4cm(D_4), 5cm(D_5) and 10cm(D_6). The soil for filling the Polythene bags was obtained from Banguan forest and was sieved to remove gravels. Sand and decomposed humus (Farm yard manure) were mixed with soil in the ratio of 1:1:2 before filling the bags. The experiment was set up in completely randomized design and replicated twice. Regularly watering was done in the experiment. During the experiment number of days

taken for the emergence of first seedling and completion of germination were recorded in all the treatments. At the end of the experiment the germination percentage in each case was calculated.

Leaf leachate

25, 50, 100gm fresh and healthy leaves of *Butea monosperma* were soaked in 500ml distilled water for 24 and 48hr. The filtrate of the solution is known as Leaf Leachate. This leachate was stored in bottles. 100 seeds in four replicate were placed in Petridish at room temperature. The substratums were regularly kept moist with their respected leachate test solution. However, the control was moistened with distal water only. The experiment was performed in the month September 2023 at Ecological laboratory of P. K. University, Shivpuri.

Imbibitions

Twenty five treated seed of *Butea monosperma* were weighed and surface sterilized with 0.001 M $HgCl_2$ solution (Laeson and Lwang, 1969) for five minutes and rinsed five times with sterized water. Seeds were places in beaker containing sterilized water for 3, 6, 9, 12, 24 and 48 hrurs for imbibitions on low temperature incubator (27±2^{o}C). Five replicates were taken for each duration. Seeds were reweight after soaking and percentage of water imbibibed was calculated. The imbibibed seed were placed in moist sterilized paper in germinator at 27±2^{o}C along with twenty five unsoaked seeds as control. Observation were made daily for ten days.

Soil Composition

Four soil type's viz., Sand, Black soil, Red soil and Padua soil were considered in the experiment. These four soil types were mixed in different volume proportions. Thus, in all 15 soil compositions were prepared. These were filled in perforated polythene bags of 25X10cm. size. Each media was filled in 15 polythene bags which were placed in open sun light (Joseph and Freezaillag, 1969). Only two seeds and imbibe seeds were sown in each polythene bags of all potting mixture. Sufficient and regular watering was done daily. The experiment was continued for six months and than seedlings were removed from polythene bags with intact root system for further analysis of fresh and dry weight, shoots length, root length, S/R length ratio and Photosynthetic area (PSA). The seedlings were dried in oven at 60^{o}C for 3 days (72 hours) and weighed

separately to determine the percentage of moisture content of root and shoot and dry weight of the seedling.

To quantify the morphological quality of seedlings, the quality index (QI) was calculated following Dickson et.al, (1960.)

$$\mathbf{QI} = \frac{\mathbf{TW}}{\frac{\mathbf{H}}{\mathbf{BD}} + \frac{\mathbf{SW}}{\mathbf{RW}}}$$

Where,

TW = total dry weight of seedling (gms),

H = Seedling height (cm.),

D = collar Diameter (mm.),

SW = seedling shoot dry weight (gm),

RW = root dry weight (gm.) of seedling.

Sturdiness Quotient (SQ) was calculated dividing the seedling height (cm.) by collar diameter (mm.) according to Roller (1977).

Light condition:-

The experiment to observe the effect of different light condition on seedling growth was conducted in Banguon forest nursery. Three light conditions i.e, semi shady or under tree canopy (I), Full sunlight or open (II) and imbibe seeds (150) were sown in perforated polythene bags of 25X10cm. size. Forest soil, sand and organic fertilizer (FYM) in the ratio of 2:1:1 was used for experiment. Two months old seedlings were transferred in large perforated polythene bags of 75X25cm. size. Therefore polythene bags were shifts in full sunlight, semi-shady condition (under tree canopy) and in shady condition (under hut lobby) providing them approximately 100, 45 and 20 percent light respectively. Fifty polythene bags were used for each treatment. Regular watering was done to these sets to provide sufficient moisture level. The experiment was continued for 10 minutes. The measurement of light intensity was using by Lux meter from time to time

Irrigation:-

The well established seedlings (of about one month old) were used to observe the effect of different irrigation. The experiment was conducted in Banguon forest

nursery. The size of polythene bags, soil composition and sowing method was same as in the above experiments. Polythene bags were kept under tree canopy. Three irrigations I- Daily, II- Alternately and III- Twice/week tried on seedlings. 50 polythene bags were used for each water regime. The experiment was continued for 12 month

Growth hormone:-

Raised and transplanted seedlings in polythene bags were used for the experiment. The well established seedlings (of about one month old) were used to observe the effect of response of growth regulators on seedling growth. The experiment was carried out in Banguon forest nursery during the period of June, 2023 to November, 2024. 40X25cm. size perforated polythene bags filled with forest soil, Sand and organic manure in ratio of 2:1:1 were used for experiment. Indole acetic acid (IAA), Gibberellic acid (GA) and Indole butyric acid (IBA) each at six concentrations (25,50,100,150,200,250ppm) was prepared afresh. These test solution were exogenously applied on the exposed part of the seedling with the help of hand sprayer. 12 Sprays were provided in 6 months at the intervals of two week each. Treated and imbibed seeds were sown in each in each polythene bag. 15 Polythene bags were used for each treatment and twice replicated.

Seedlings under potting medium and growth hormone were terminated after six months and experiment of light condition and irrigation regimes were harvested after 12 months and very carefully transporated to the laboratory for taking the measurement of a number of parameters. Following growth parameters were recorded, shoot length (SL), root length (RL), Plant length (PL), Total number of leaves per seedlings, shoot and root fresh weight with the help of electric balance, shoot and root dry weight (SDW and RDW) (fresh shoot and root was oven dried at 60^{o} C for 72 hours), shoot/root dry weight ratio, photosynthetic area (PSA) with the help of graph paper, moisture content % of shoot and root were calculated by following formula.

$$\textbf{Moisture content of shoot or root} = \frac{\textbf{Fresh weight of shoot or root} - \textbf{Oven dry weight of shoot OR ROOT}}{\textbf{Fresh weight of shoot or root}} \boldsymbol{X}\ \mathbf{100}$$

Table-3.2 Abbrebiations used in the experiments performed at nursery to represent growth parameters of seedlings in relation to different treatments.

S. No	Soil Composition	Light Condition	Irrigation	Hormone
1	(S_1) Pure Padua	(L_1) Full Sun Light	(I_1) Daily	(H_1) 25ppm/IAA
2	(S_2) Pure Red	(L_2) Semi-Shady	(I_2) Alternately	(H_2) 50 ppm /IAA
3	(S_3) Pure Sand	(L_3) Shady	(I_3) Twice/Weekly	(H_3) 100 ppm /IAA
4	(S_4) Pure Black	-	-	(H_4) 150 ppm /IAA
5	(S_5) Black+ Padua	-	-	(H_5) 200 ppm /IAA
6	(S_6) Red+Padua	-	-	(H_6) 250 ppm /IAA
7	(S_7) Sand+ Padua	-	-	(H_7) 25 ppm /IBA
8	(S_8) Sand + Black	-	-	(H_8) 50 ppm /IBA
9	(S_9) Red+ Black	-	-	(H_9) 100 ppm /IBA
10	(S_{10}) Sand+ Red	-	-	(H_{10}) 150 ppm /IBA
11	(S_{11}) Sand+Red+Black	-	-	(H_{11}) 200 ppm /IBA
12	(S_{12}) Red+Black+Padua	-	-	(H_{12}) 250 ppm /IBA
13	(S_{13}) Red+Padua+Sand	-	-	(H_{13}) 25 ppm /GA
14	(S_{14}) Red+Sand+Black	-	-	(H_{14}) 50 ppm /GA
15	(S_{15}) Red+Sand+Black+Padua	-	-	(H_{15}) 100 ppm /GA
16	-	-	-	(H_{16}) 150ppm /GA
17	-	-	-	(H_{17}) 200ppm /GA
18	-	-	-	(H_{18}) 250ppm /GA
19	-	-	-	(H_{19})Control

Following silviculture experiments were performed in June,2024.

1- Branch cutting.
2- Root cutting.
3- Coppice cutting.

Branch cutting

The experiment was laid down by cutting of one year old branch. The size of cutting was 20cm in length and 1cm in breadth. A sharp knife was use to cut the branches so that bark of cutting may not split. These cuttings were planted in polythene bags keeping a small portion having one or two buds above the soil and the rest inside. Wax was applied to the exposed cut ends of the cutting in order to avoid desiccation.

No hormone or other chemicals were applied. Thereafter polythene bags were shifted semi-shady condition (about 20% light condition) and in full sunlight (100 % light) condition. 50 cutting per treatment were taken for experiment. Observations on rooting potential of the cutting were taken at monthly interval. At each time ten cutting were considered for observation. These were randomly selected and dug out carefully from their respective polythene bags. The experiment was performed at Banguon forest nursery.

Branch cutting

20cm long root cutting with uniform girth of 1cm were collected from the roots of *Butea monosperma* plants growing in Babina forest. Secondary roots were excised and the composite samples of the cutting were planted in raised beds by keeping them in vertical position, with one third portion is exposed and two third portion is varied in soil. 100 cutting were used, no hormone or any other chemicals were applied on the root cutting. Beds were irrigated regularly at weekly intervals. Each time the cuttings were randomly picked out and were keenly observed for their rooting behavior.

Coppice regeneration

In the month of June, 2024 stumps of different girth classes were cut for the study of coppice regeneration. In the last week of July new sprouts were begin to arise which were regularly examined for a number of parameters till the end of September. Later on the intensity of lopping was fixed o the basis of the coppice number $C_1(1)$, $C_2(2)$, $C_3(3)$, $C_4(4)$, $C_5(5)$, $C_6(6)$. The entire coppice left in stump considered control

per stump. Five replicates were taken in to consideration for each class. These coppices were allowed to grow upon their stumps in natural conditions. After completion of 12 months, coppice were harvested for the measurement of different growth parameters such as coppice length, circumference of base and Apex, photosynthetic area, dry weight and moisture content.

Chapter- 4

RESULTS AND DISCUSSION

The composition of forest as regard to Percentage frequency, density, abundance, frequency class and IVI of each species per hac. of Banguon and Orchha are given in the Table 5.1 and 5.2 respectively.

A total 15 species were present in Banguon forest and 19 species in Orchha forest. The 8 species were found common in both forest viz. *Butea monosperma, Cassia fistula, Tectona grandis, Flacourtia indica, Holoptelia integrifolia, Acacia leucophloea, Carissa carandas and Capparis aphylla*. The *Alangium lamarkii* was found to be most frequent species in Banguan forest whereas in Orchha forest it was lacking. This might have due to microclimatic and edaphic variation at the two sites. *Tectona grandis* appears to be second dominant species at both the forests. *Capparis aphylla, Butea monosperma* and *Holoptelia integrifolia* were noted more frequent in Banguan forest as compared to Orchha forest. *Cassia fistula* which is a miscellaneous tree occurs at both the forest. *Wrightia tinctotia* and *Azadiracta indica* were totally absent in Orchha Forest. In Banguan forest *Zizyphus xylopyrus, Terminalia arjuna*and *Cordia myxa* completely absent. In view of the above the Orchha forest appears rich as regard to species diversity than Banguan forest most provably this variability should have associated with reserve nature of Orchha forest. *Butea monosperma*, which is the common species in both the forest, has higher average height (8.670cm.) in Banguan forest. The average height of *Butea monosperma* in the Orchha forest is 9.5cm.

Density gives the numerical strength of a community. In Banguan forest *Alangium lamarkii* had the highest density (7.6 individual/ hec.), followed by *Tectona grandis* (3.45 individual/hec.). At Orchha forest *Tectona grandis* had the highest density (18.05 individual/ hec.). *Butea monosperma* had 1.2 individual/ hec. Density other species of Orchha have density less than 1.

The abundance gives the number of individuals of a species in a habitat. On Banguan forest *Alangium lamarkii* has highest abundance value (7.6). Other highest abundance species are *Wrightia tinctoria* (5.842) and *Butea monosperma* (4.871). On Orchha forest *Tectona grandis* has highest Abundance value (18.05). Other higher

Abundance species are *Eugenia jambolana* (6.5) and *Terminalia arjuna* (6). Other species of Orchha forest is have Abundance between the ranges of 1 to 2. The higher dbh value in Banguan forest is reported in *Butea monosperma* (56.78cm.). Other higher dbh value in Banguan forest in *Alangium lamarkii* (27.95cm.) and *Cassia fistula* (33.28cm.) in Orchha forest the highrtdbh value is reported in *Butea monosperma* (56.6cm) and *Cassia fistula* (35.38cm.).

Importance value index (IVI) represents the extent of dominance of a species in the community. In Banguan forest *Alangium lamarkii* represent highest IVI value (46.113) followed by *Butea monosperma* (33.459) and *Tectona grandis* (26.686) respectively. At Orchha forest *Tectona grandis* represent highest IVI value (138.135). The analysis of distribution pattern of individual species on Banguan and Orchha forests indicated that among the three distribution patterns viz. regular, random and contagious, the contagious distribution was found most common in the area. The dominance of contagious distribution may be due to the fact that a majority of trees species reproduce vegetatively in adding to sexually and most of the species occur low frequency and high Abundance.

The value of community co-efficient of the two forests was reported to be 53.537% that indicated marked dissimilarities of the species composition.

Table- 4.1 Vegetation characteristics of Banguan forest

Name of species	FR	Den.	AD	FC	A/F ratio	RF	RD	RD	IVI
Acacia leucophloea Willd.	47%	0.85	1.789	C	0.038	6.041	2.283	3.023	11.347
Alangiumlamarkii	100%	7.6	7.6	E	0.076	12.853	20.416	12.844	46.113
Albizia odoratissima Benth	7%	0.075	1	A	0.142	0.899	0.2014	1.690	2.790
Anogeissus pendula edgew.	45%	1.75	3.889	C	0.086	5.784	4.701	6.572	17.057
Azadiracta indica Adr. Juss.	7%	0.075	1	A	0.142	0.899	0.2014	1.692	2.7904
Butea monospermaRoxb.	97%	4.75	4.871	E	0.502	12.467	12.760	8.232	33.459
Capparis aphylla Roth	67%	2.725	4.037	D	0.060	8.611	7.320	6.822	22.753
Carissa carandas Linn.	5%	0.5	1	A	0.2	0.642	0.134	1.690	2.466
Cassia fistula Linn.	15%	0.15	1	A	0.067	1.928	0.4029	1.690	2.733
Flacourtia indica Burm. F. Merr.	60%	1.425	2.375	C	0.039	7.712	3.828	4.013	15.553
Holopteliaintegrofolia Planch.	45%	1.125	2.5	C	0.055	5.784	3.02	4.225	13.031
Laucaena leucocephala Benth	30%	0.75	2.5	B	0.083	3.856	2.014	4.225	10.095
Tectona grandis Linn.	77%	3.45	4.451	D	0.057	9.897	9.267	7.522	26.686
Wrightia tinctoria R. Br.	47%	2.775	5.842	C	0.124	6.041	7.454	9.87	23.365
Zizphusoenoplia Mill.	27%	0.5	1.818	B	0.067	3.470	1.343	3.072	7.885

FR- Frequency (%), Den. - Density, AD- Abundance, FC- Frequency class, RF- Relative Frequency, RD- Relative Density, RD- Relative dominance

Table- 4.2 Vegetation characteristics of Orchha forest

Name of species	RF	Den.	Ab	FC	A/F ratio	RF	RD	Rd	IVI
Acacia leucophloea Willd.	57%	0.95	1.652	C	0.0289	14.004	4.108	3.249	21.361
Aegle marmelos Correa.	10%	0.125	1.25	A	0.125	2.457	0.540	2.456	5.453
Albizia odoratissima Benth	2%	0.025	1	A	0.5	0.491	0.108	1.966	2.565
Butea monospermaRoxb.	65%	12	1.846	D	0.0284	15.987	5.189	3.630	24.806
Capparis aphylla Roth	7%	0.075	1	A	0.1428	1.719	0.324	1.966	4.009
Carissa carandas Linn	10%	0.15	1.5	A	0.15	2.457	0.648	2.950	6.055
Cassia fistula Linn.	27%	0.3	1.090	B	0.403	6.633	1.297	2.143	10.073
Cordia myxa Linn.	5%	0.025	1	A	0.5	0.491	0.108	1.966	2.565
Diospyros melanoxylon Roxb.	7%	0.075	1	A	0.1428	1.719	0.324	1.966	4.009
Eugenia jambolana Lom.	5%	0.325	6.5	A	1.3	1.228	1.405	12.784	15.417
Flacourtia indica Burm. F. Merr.	32%	0.625	1.923	B	0.0600	7.862	2.702	3.782	14.346
Holopteliaintegrofolia Planch.	7%	0.05	0.666	A	0.0951	1.719	0.216	1.309	3.244
Melia azedarach Linn.	5%	0.05	1	A	0.2	1.228	0.216	1.966	3.41
Mitragyna parviflora Roxb Korth	7%	0.1	1.333	B	0.1904	1.719	0.432	2.556	4.707
Tectona grandis Linn.	100%	18.05	18.05	E	0.1805	24.579	78.054	35.502	138.135
Terminalia arjuna Bedd.	2%	0.15	6	A	3	0.491	0.648	11.801	12.94
Terminalia belericaRoxb.	27%	0.325	1.181	B	0.0437	6.633	1.405	2.322	10.36
Zizphusoenoplia Mill.	25%	0.4	1.6	B	0.064	6.142	1.729	3.147	11.018
Zizyphusxylopyrus Willd.	10%	0.125	1.25	A	0.125	2.457	0.540	2.456	5.453

FR-Frequency (%), Den. –Density, Ab. –Abundance, FC-Frequency class, RF -Relative Frequency, RD -Relative Density, Rd. -Relative dominance

Leafing

The field observation about the average time of initiation and completion of the event of leafing for the different species are given in Table- 4.3.This study of phenology suggests that changes in the forest largely take place in the summer as evidence by phytophase of plants. Some of the trees change their phytophase on winter monsoon, whereas few species change phytophase in all seasons. The period of leafing (i.e. unfolding of leaf buds and expansion of lamina) is divisible into two groups (I) summer leafing and (II) Rain leafing. The majority of the species (About 95%) of the forest belongs to the second category.

Arjuna *et. al.* (1995) found that emergence of new leaves delayed 15-30 days due to more humidity and low temperature. The replacement strategy during summer months appears to minimize stress by leaf fall at such period and maximize photosynthetic activity during wet worm season of the year through flushing. The variation is probably due to climate like, rainfall, environment condition and geomorphologic situation.

In *Butea monosperma* the initiation of new leaves starts in the beginning of April, thus it comes in the first category of leafing. The initiation periods continues till the end of June after which the leaves attain their full size. Early leaves were small, light green in colour. During the month of October the colour of leaves (about 90% of total) changed to dark green.

Leaf-fall

The leaf fall observation is presented in the table-4.3. In the present study leaf fall was found to be seasonal and different tree species shaded their leaves at different intervals during the season. On the basis of two major leaf fall tendency two major leaf fall period were recognized viz., winter leaf fall and summer leaf fall.

Winter leaf fall- winter leaf fall period covered months from October to March. Species in which leaf fall occurred during this period were *Aegle marmelos*, *Acacia leucophloea* and *Flacourtia indica* etc. However, majority of the species have completed this phenomenon in winter season.

Summer leaf fall- summer leaf fall period covered moths from February to April. In the present study *Butea monosperma* shaded their leaves during this period.

Many workers in different forest stands of the world have also made the observations on leaf fall. It have been well explored that in a forest leaf fall is generally determined by environment factors such as moisture status of soil temperature and relative humidity. Longman and Jenik (1974), Raemakers*et. al.* (1980) and Reich and Borchert (1984) have observed that many tropical deciduous and dry deciduous trees shad their leaves during dry season depending on the degree of drought and flush soon afterward or in early monsoon.

Butea monosperma belongs to the first category of leaf fall. The leaf fall of this species started in mid winter season in the beginning of February and by the end of April about 60% leaves were shad. The tree becomes leaf less in second week of May.

Flowering

The observation about the time of beginning and completion of flowering of different tree species are given in Table 4.4. Summer and rainy season were found as two main periods for initiation of flower, however, very few species started this phenomenon in January and February but majority of species flowered in the hot season, which starts from late February and lasts till late June or early July. *Alangiumlamarkii, Aegle marmelos, Butea monosperma, Flacourtia indica, Cassia fistula, Holoptelia integrifolia, Mitregyna parviflora and Wrightia tinctoria* flowered in summer. Otjher species complete their flowering in rainy season.

In *Butea monosperma* the flowering initiated in the Month of March and completed till the end to April. Flower 2-2.5cm across, bright yellow, odourless branched racemes produced on bare trees. Flower colour is Violets. Flowering in months of April have been noted as abnormal cases.

The observation on phenology of present study suggests that changes in the forest largely take place in the summer season as evidence by phytophases of plants. Some of the trees change their phytophases in winter or monsoon season.

Fruit-fall

The observation about the time of initiation and completion of fruit fall for various species are given in Table-4.5. Two major periods of the fruit fall i. e. winter fruit fall was observed in the months of October to February and the summer fruit fall covered the month from March to June. *Alangium lamarkii* is the only exceptional

species, which does not belong to either categories of fruit-fall since the fruit-fall of this species occurs during rainy season. Most of the tree species (About 55%) have completed this phenomenon in winter season.

In *Butea monosperma*, the fruit fall initiation started in early May and continues till June. Fruit maturation process were started July and completed till last August, therefore fruit fall were occurred. The fruit fall of this species started in September and completed till end of October. In rare cases the fruit may remain attached to their tree in October too but the percentage of such tree is very less (8%).

On the basis of above studies the following conclusion could be made.

(I) The leafing period of forest species can be divided into two groups e. g. Summer and rain leafing. Most of the species (About 95%) complete this phenomenon during summer season. *Butea monosperma* also belongs to this category.

(II) The leaf-fall takes place in two phases i. e. winter and summer out of which, majority of the species belongs to the first phase. *Butea monosperma* belongs to the first phase.

(III) The floweing period of the forest species is divisible into classes i. e. summer and rain flowering. Nearly 70% species flowered during summer. *Butea monosperma* belongs to the first class.

(IV) Winter and summer season are recognized as two major periods of fruit fall in this forest. About 55% species show their fruit fall during winter season. *Butea monosperma* also belongs to this category.

Table- 4.3 Leafing behaviour of forest tree species

S. No.	Plant species	Month of beginning	Month of completion	Duration of events (months)
1	*Acacia leucophloea*	May	June	2
2	*Aegle marmelos*	March	May	3
3	*Alangiumlamarkii*	May	August	4
4	*Anogeissus pendula*	April	June	3
5	*Butea monosperma*	April	June	3
6	*Cassia fistula*	April	June	3
7	*Flacoutia indica*	April	June	3
8	*Holopteliaintrigrifolia*	March	May	3
9	*MitragynaParvifolia*	March	May	3
10	*Tectona grandis*	June	August	3
11	*Wrightiatintoria*	March	May	3

Table- 4.4 Leaf-fallbehaviour of forest tree species

S. No.	Plant species	Month of beginning	Month of completion	Duration of events (months)
1	*Acacia leucophloea*	January	March	3
2	*Aegle marmelos*	December	March	4
3	*Alangiumlamarkii*	February	March	2
4	*Anogeissus pendula*	January	March	3
5	*Butea monosperma*	February	April	3
6	*Cassia fistula*	January	March	3
7	*Flacoutia indica*	November	Mid February	4
8	*Holopteliaintrigrifolia*	December	March	4
9	*MitragynaParvifolia*	December	March	4
10	*Tectona grandis*	December	March	4
11	*Wrightiatintoria*	December	February	3

Table- 4.5 Floweringbehaviour of forest tree species.

S. No.	Plant species	Month of beginning	Month of completion	Duration of events (months)
1	*Acacia leucophloea*	July	September	3
2	*Aegle marmelos*	May	June	2
3	*Alangiumlamarkii*	March	April	2
4	*Anogeissus pendula*	August	September	2
5	*Butea monosperma*	March	April	2
6	*Cassia fistula*	March	April	2
7	*Flacoutia indica*	March	April	2
8	*Holopteliaintrigrifolia*	January	February	2
9	*MitragynaParvifolia*	May	July	3
10	*Tectona grandis*	July	September	3
11	*Wrightiatintoria*	May	June	2

Table- 4.6Fruit-fallbehaviour of forest tree species

S. No.	Plant species	Month of beginning	Month of completion	Duration of events (months)
1	*Acacia leucophloea*	February	May	5
2	*Aegle marmelos*	Mid May	Mid July	2
3	*Alangiumlamarkii*	July	August	2
4	*Anogeissus pendula*	January	March	3
5	*Butea monosperma*	May	June	2
6	*Cassia fistula*	February	May	4
7	*Flacoutia indica*	June	July	2
8	*Holopteliaintrigrifolia*	April	June	3
9	*MitragynaParvifolia*	February	May	4
10	*Tectona grandis*	January	April	4
11	*Wrightiatintoria*	February	March	2

The seed of Butea monosperma was subjected to various pre-treatment in order to enhance the percentage of germination. It is interesting to note that, all the treatment were quite successful in percentage of seed germination increase. These were singly found in Table-4.2.

Mechanical scarification, which is pre treated by removing a small part of seed coat on the distal end before sowing results in more seed germination (36.3) than seed germination (16.7) in medium sized seeds with none in small sized seeds. Other sizes of the seeds showed low germination. The perusal of the results has concluded that it increased the germination of the medium sized seeds due to better imbibitions of water through the seed coat and the gaseous exchange. Terminalia Indica was observed to be highly effective in mechanical percentage (100 percent germination percentage in big sized seeds) (Singh and Arunchalam, 2002). The seed germination of Acacia concina is achieved through scarification treatment to result in the early, even, and optimal germination (Bahar and Naithabi, 2006).

The seed germination (table-4.7) high germination (100%) was enhanced when the seed was treated with the acid (10 minutes) of large sized seed and medium sized seed but low germination was observed when the acid was applied to all the seed sizes (15 minutes). Thus, the right moment to initiate the dormancy of Butea monosperma to be broken with the help of aid treatment (Con. H_2SO4) is 10 minutes. Acacia aurea showed better germination with 30 minutes of concentrate of H_2SO_4 until 83 percent (Natarajan and Rai, 1998). The germination rate of the seeds of Acacia nilotica was achieved to 90 percent after 60 minutes following the treatments by the H_2SO_4 (Zodape, 1991). It was found that when seeds of Atropa belladoma were treated with 75 percent of H_2SO_4 after 2 minutes of treatment followed by 30 percent sodium hydroxide (NaOH) after 5 minutes of treatment, the seeds germinated well (Bisht and Kediyal, 1995). Pre-treatment with hot water and Con. H_2SO_4 were also found to enhance germination of 802 and 85 percent of the *Enterobium cyclocarpum* and *Hymenaea courbaril* respectively (Brahman, 1996). Acid treatment with concentrate H_2SO_4 for 5 minutes also satisfactory only to large sized seeds (100%) but not to other sized seeds. The above results of the different workmen of the different species do pretty much agree with that which is being discovered to-day at work. The effect of the seed sizes and weight on seed germination behavior and growth of Acer oblongum,

Kydia calyciana, *Terminalia tomentosa* has been studied by Negi and Todaria (1997). The treatment of the conditions of 10 minutes only with Concentrate H_2SO_4 in their present research was, however, a very effective strategy and led to the increase of the germination of the seeds up to 100%. This germination may have been the principle that caused the seed coat of the seed to be completely opened by the water. Sasithorn, et. al., (2005) also arrived at the same findings.

Rate of germination differed significantly between dry heat treatment as well as incubation periods. In *Butea monosperma* the germination response to various dry heat treatments was not good. In general, dry heat treatment at 60^{o}C gave better results than other temperature. Temperature exposure for 30 minutes and above proved lethal in *Butea monosperma*. Temperature is an important factor for seed germination because various biochemical reactions in reserve food of the seed depend on temperature. The data on germination percentage of seeds at various temperature treatments was not significantly. Low temperature may inhibit the catabolic activity and temperature high than the optimum tends to bring about the destruction of metabolic process by inactivating some enzymes and denaturing proteins.

Proper selection of seed lot was found to be crucial for the initial germination and growth. Bold seeds gave better performance than light seeds. Optimum pre-treatments were found to Synchronize germination, which in turn improves the seedling size, grade and quality.

Table-4.7 Effect of Seed treatment on seed germination of *Butea monosperma*

Treatment	Categories of Seeds		
	Large	**Medium**	**Small**
Scarification (Mechanical)	21.1 (3.1)	36.3 (4.2)	0 (0)
Sulphuric acid			
5 minutes	100 (9.1)	66.7 (8.3)	50 (6.3)
10 minutes	100 (16.7)	100 (12.5)	83.3 (6.7)
15 minutes	50 (8.3)	66.7 (8.3)	66.7 (11.1)
Dry heat, 60^{o}C			
15 minutes	50 (3.33)	33.3 (2.1)	50 (3.1)
30 minutes	66.7 (6.1)	33.3 (4.2)	16.7 (2.8)
60 minutes	0 (0)	33.3 (3.3)	16.7 (2.8)
Dry heat, 80^{o}C			
15 minutes	33.3 (1.5)	16.7 (1.3)	33.3 (2.6)
30 minutes	31.3 (4.2)	16.7 (3.3)	0 (0)
60 minutes	16.7 (1.7)	16.7 (2.1)	16.7 (1.7)
Dry heat, 100^{o}C			
15 minutes	16.7 (2.8)	16.7 (1.1)	16.7 (2.1)
30 minutes	16.7 (3.3)	0 (0)	0 (0)
60 minutes	0 (0)	0 (0)	0 (0)
Control	0 (0)	16.7 (1.1)	0 (0)

The principle for assessing the viability of seeds by TTC staining is just to measure the stained/unstained area of the seeds. But most important is to concentrate on the intensity of stain and the parts of seed (embryo proper + Cotyledons) which are having staining. Staining of cotyledonary tissue of embryonic portion is equally important as that of the embryo proper. Virtually intensity of stain is directly proportional to the quantity of active enzymes in the seed whereas, locus of staining indicates the location of these enzymes, making those cells detectable as living.

Laboratory germination percentage of seeds of *Butea monosperma* used in tetrazolium test is present below.

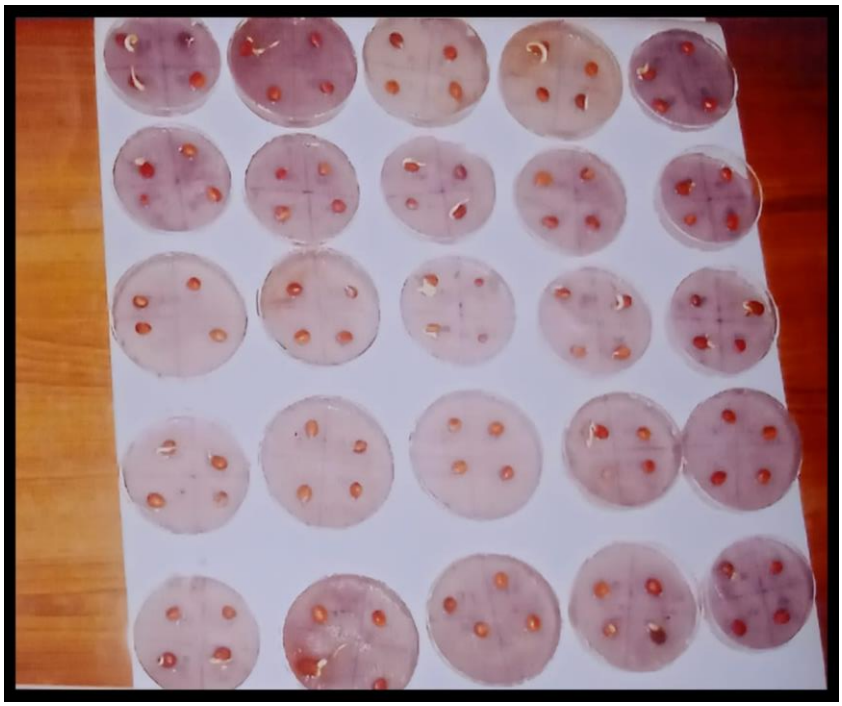


Figure No 4.1: Germinaton of seed of *Butea monosperma* in laboratory condition.

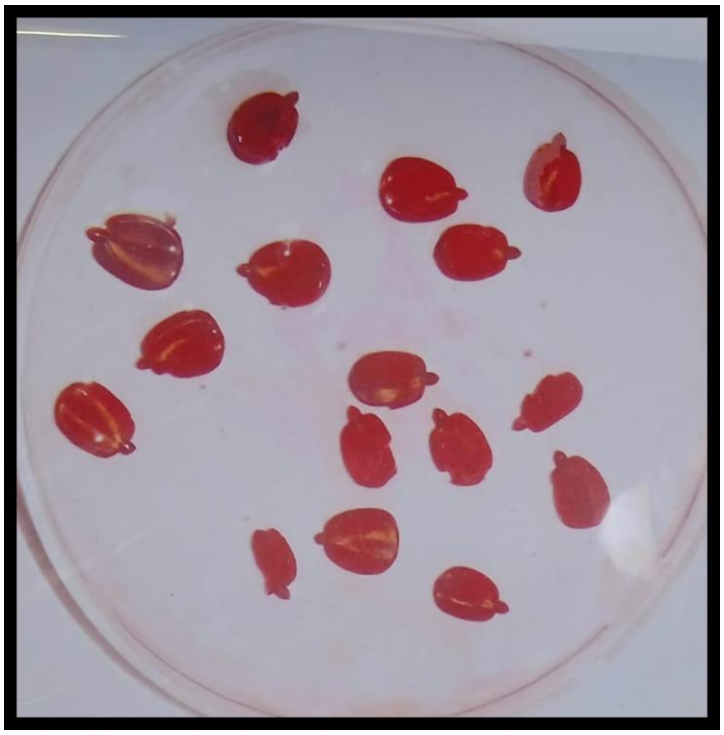


Figure No 4.2: Viability test in seeds of *Butea monosperma.*

Table-4.8: Showing germination percentage in Laboratory condition

Seed lot No.	Storage Container	Temperature (ºC)	Laboratory germination (%)
21	GB	10-35	88.00
27	GB	10-35	98.00
29	GB	10-35	94.00

GB = Glass Bottles

Tetrazolium selection is a colourless one which when imbibed by the seed tissues interferes the reduction process of living cells and accepts hydrogen from dehydrogenase resulting in the production of a red stable and non- diffusible substance, triphenylformazan in the living cells which makes it possible to distinguish the red colored living parts of seeds from colorless dead ones.

Various categories of stained embryos as results of TTC application are given in Table-4.8 and Graph-4.1. The percentage figures were added successively until the value nearest to the germination percentage of the seed lot was obtained. These categories were expected to form viable categories. Varying categories of dead tissues are found in different zones in some seeds. Position and the size of the dead area in the embryo determine wheather the seeds are viable or non-viable. Loss of activity of particular enzymes system is an indication of a functional characteristic of TTC solution.

From the Table-4.9 it is clear that the viability percentage obtained by tetrazolium test and Laboratory germination percentage have a close association in all the seed lots of the species. Purohit *et. al.,* (1997) also noted close relationship in results of germination test and TTC test in different provenance of *Albizia procera* seeds. An increase or decrease in germination is reflected quite accurately by the tetrazolium test which provides a convenient method for predicting germination in a shorter time. Older seeds of reduced viability were clearly grouped in separate categories by tetrazolium staining. Dead tissues of the older seeds clearly exhibited the pattern of deterioration of seed tissue during storage. One can understand that why some seeds is becoming non-viable. Using such a standardized test with keen identification of the staining pattern that indicates the viability seed analysts of forest department can produce results of freshly collected as well as stored seeds of *Butea monosperma* mush more rapidly than that by standard germination.

In the present investigation, viable and non-viable categories were classified on the basis of proportion of living and non-living tissues of embryo. Germination of the seed is an important phase in the ecological life history of any species, in that, it determines the potential of the species to spread gives favorable conditions for establishment. The germination is effected by the internal condition of the seed and various external factors to discuss the performance and to reasonably estimate the germination percentage.

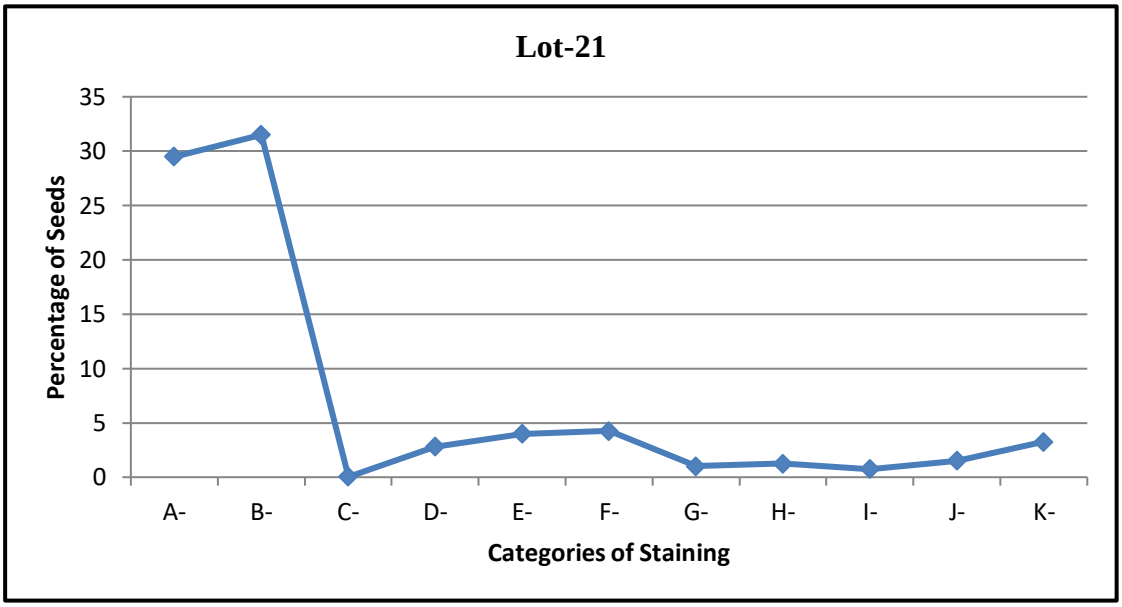
Table-4.9 Topogarphical pattern of Tetrazolium staining received by various seeds of *Butea monosperma.*

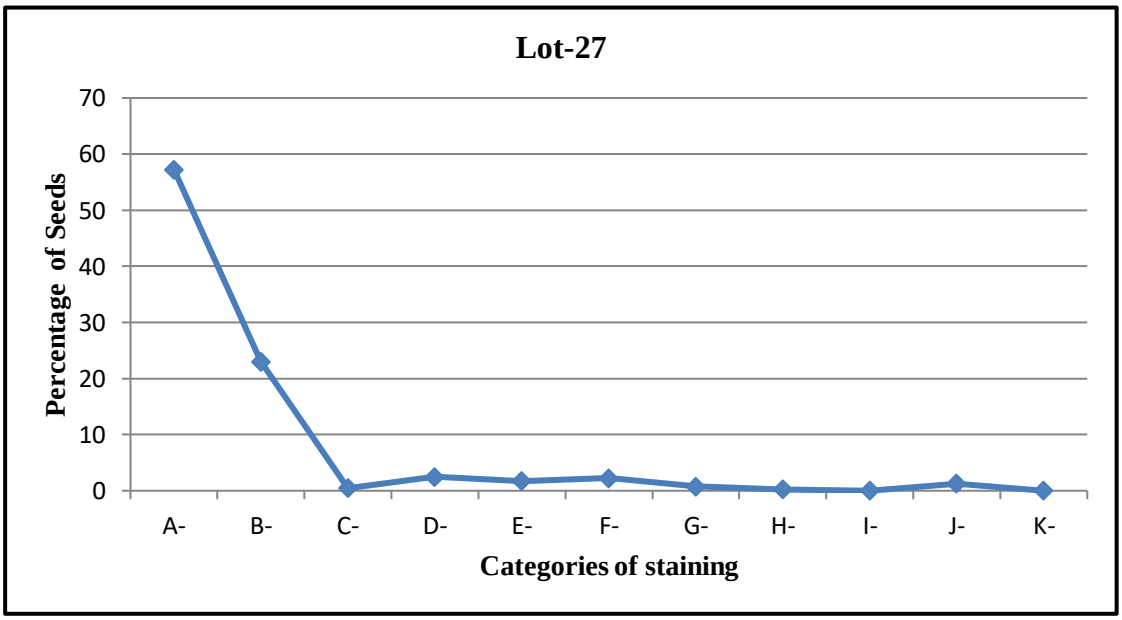
Category	Pattern of Staining	% of Seeds		
		Lot-21	Lot-27	Lot-29
A-	Embryo completely stained.	29.50	57.25	60.00
B-	Minor unstained areas on cotyledons opposite to the radical.	31.50	23.00	21.25
C-	Unstained areas alongwith the edge of cotyledons except the radical end	0.03	00.5	0.25
D-	Embryo completely stained, central portion of cotyledons dark colored.	2.80	2.50	1.00
E-	Embryo stained except tip of radical and small unstained patches on cotyledons.	4.00	1.75	2.50
F-	About half portion of cotyledons unstained.	4.25	2.25	3.25
G-	Radical and half portion of cotyledons unstained.	1.00	0.75	1.25
H-	Embryo stained in milky red colour, cotyledons not expended.	1.25	0.25	0.00
I-	Embryo stained abnormally dark red, cotyledons not expended.	0.75	0.00	0.50
J-	Embryo almost completely unstained.	1.50	1.25	1.75
K-	Embryo insect attacted.	3.25	0.00	0.00
	Total	100	100	100

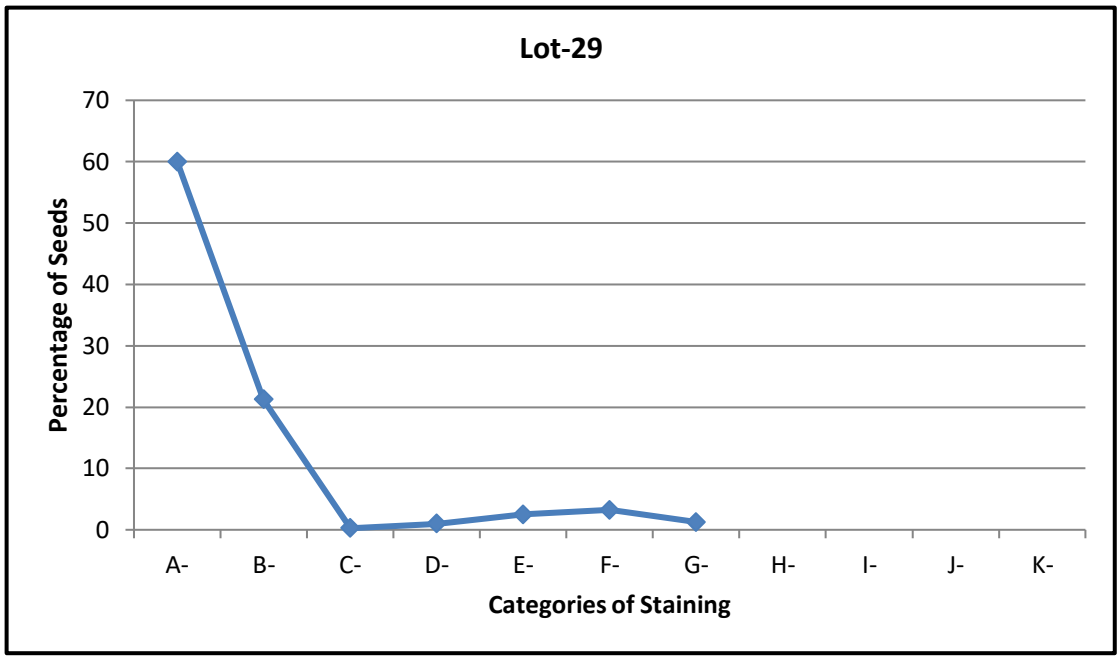
Table-4.10 Comparison between Laboratory germination percentage and viability of seed determined by Tetazolium test

Seed lot No.	Percentage viability		Percentage germination in Laboratory	
	Mean	±SE	Mean	±SE
21	90	0.41	88	0.41
27	97	1.06	98	0.91
29	98	1.08	94	0.88

Graph- 4.1 Topographical pattern of Tetrazolium staining received by various seeds of *Butea monosperma*







The effect of depth of sowing on germination of seeds indicates that the percentage germination varied from 35% to 80% (Table-4.11). the percentage germination increased as the depth of sowing increased from D_1 to D_2 but a further increased in depth beyond D_2 to D_5 a gradual derease was recorded.

Low germination percentage of D_1 in comparison to D_2 may be probably due to decrease of moisture content in surface soil. The minimum and maximum days required for emergence of first seedling were 4^{th} and 6^{th} for D_1 to D_5 treatment reapectively and follow an increasing trend with increase in depth from D_1 to D_5. The average number of Days for emergence of forst seedlings varies from 4.46 to 7.14 (Table-4.12).

Similarly the number of days for copmpletion of germination was found to increase with increase in depth of sowing. The minimum and maximum period (in days) for completion of germination was recorded from 7^{th} to 11^{th} in D_1 to D_5 respectively. A depth of D_6 no seedling could emerge. It appears that seed germination at higher depth might be spending most of their reserve dry weight in emergence. Seed sown at optimum soil depth have rapid rate of emergence while the seeds sown in deeper region have to struggle for emergence and hence the rate of their emergence become slower.

The decrease in percentage germination with increase in depth from D_2 to D_5 may be probably due to the suppression of juvenile part of plumule, which would not be able to make their way though the thick soil layer and might have resulted in the depth to tender emergence plumuile. Moreover the increasing depth might have not permitted sufficient aeration due to comparatively more water logged condition at these depths. The higher rates of emergence were found near the surface. On the basis of this information it can be inferred that for better germination Of *Butea monosperma* seeds depth of about 2cm. is optimum.

Table-4.11 Data of emergence, duration of germination period and percentage germination of *Butea monosperma* seeds as affected by different depths of sowing (Each value based on an average value of 4 replicates.)

Treatment	Depth of sowing (cm)	No. of days for emergence of first seedlings (A. V.±S. E.)	No. of days for completionof germination (A. V.±S. E.)	Percentage Germiantion
D_1	1	4.46±0.62	7.25±0.47	65%
D_2	2	5.00±0.25	8.35±0.35	80%
D_3	3	6.53±0.40	9.00±0.27	70%
D_4	4	6.75±0.46	9.75±0.22	45%
D_5	5	7.14±0.18	10.75±0.28	35%
D_6	10	No Germination couldobserved		

The results on the allelopathic effect of the *Butea monosperma* on the germination of seed are given in Table-4.12 and Graph-4.2. The perusal of data of Table 4.12 and Graph-4.2 indicates the effect of allelochemic on seed germination is negative. The maximum germination percentage (65%) was found in 25gm leachate dissolved 500ml solution and 24hr. old leachate whereas it was minimum (45%) 100gm leachate dissolve 500ml solution and 48hr. old while it was 94% in control.

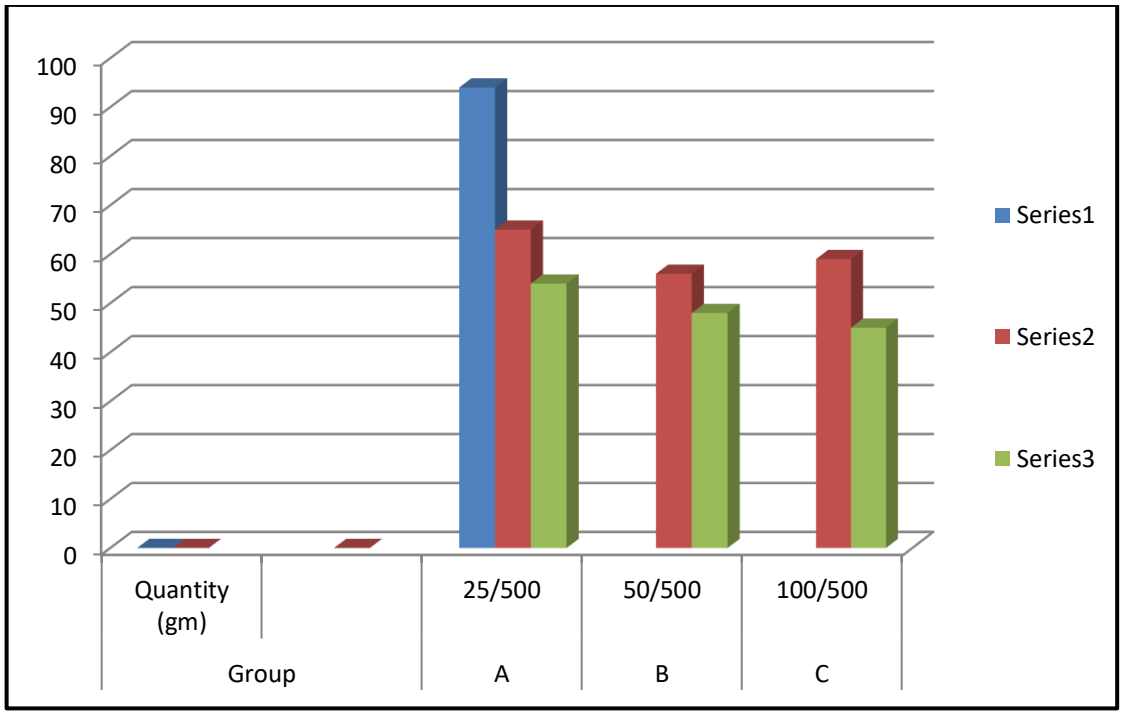
The concentration of leachate and leaching hours seem to harmful effect in germination of *Butea monosperma* seed. This may be due to variation in rate of leaching

ions of different charge and also chemical bonding between these ions. According to Nagaraja, N. G. (1998) the leaves of Butea monosperma have mineral like K, Na, Ca, Mg, Fe, Mg, Zn, Cr, Ni and Co. The element Na and Ca content get reduced in the leaves of *Butea monosperma*. The reduced content of Na and Ca may be due to rapid uptake by the pathogen for its growth as reported by Allen and Arnin (1955). The poor germination of seeds of *Butea monosperma* were occurring perhaps the rapid translocation of pathogen utilized for its metabolic activities. The increase on concentration of different ions in leachate might have effected the imbibitions of seeds, which resulted in the poor germination.

Table-4.12 Effect of leaf leqachate on germination of seed of *Butea monosperma*

Group	Quantity (gm)	Control	Germination percentage (period of leaching)	
			24 hours	48hours
A	25/500	94	65	54
B	50/500	-	56	48
C	100/500	-	59	45

Graph-4.2 Effect of leachates on germination.

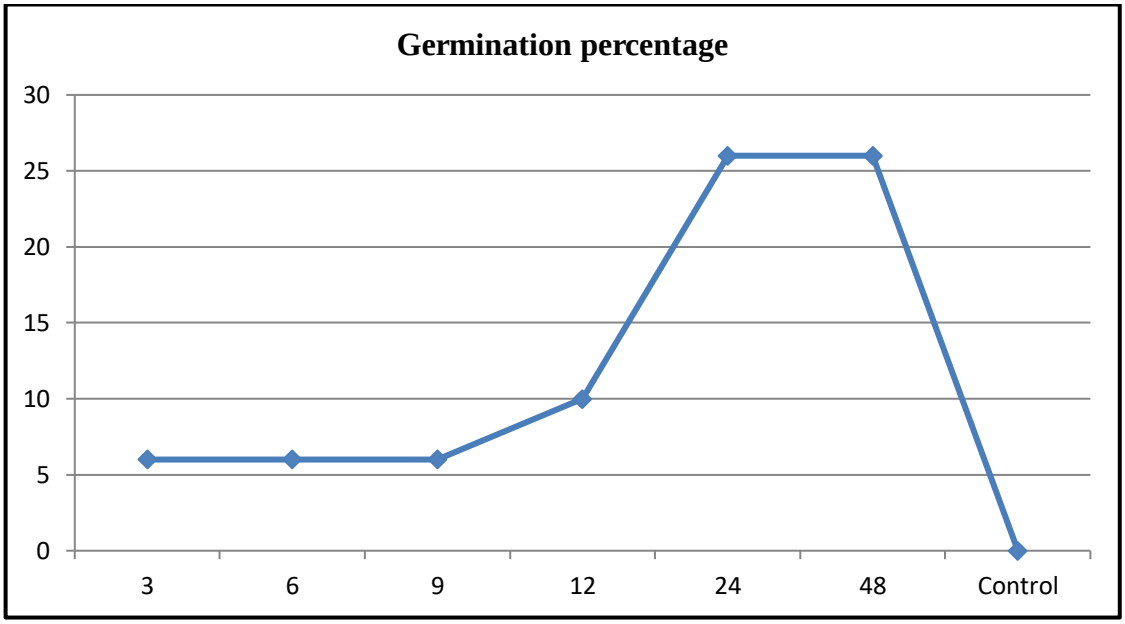


The data of percentage germination of seeds of *Butea monosperma* as affected by imbibitions period are given in Table-4.13. Theaverage maximum imbibition was observed in 48 hours. Basicallyimbibitionsdepnds on seed size, weight, nature of seed coat and its composition, permeability of covering and others (Bewley and Black, 1978). In control condition the seeds were not survive. As well as duration of imbibitions were increased the percent germination were also increased. Seeds do not resume the physiological activity until they imbibe certain amount o water. Oxygen uptake od seeds increase soon after water is imbibed and respiratory activity generally follows the pattern of water uptake (Kozlowaski, 1971) Moreover, there is optimal substrate water status for maximum percentage germination (Gupta and Kumar, 1977). Water status not only depends on nature and composition of seed coat but also on imbibitions time which alters the various metabolic activities chiefly involving the synthesis of enzymes for gene replication and growth (Osborne, 1973) provide all other factors are not limiting. In the absence of water, the enzymes become inactive. As soon as the water is absorbed the enzyme become active. The above results are also in confirmation with the studies made by Yadav and Mishra (1982) and Tripathi (1984).

Table-4.13 Water absorption (Percent of initial weight) and germination percentage of seeds

Duration of Imbibition	Germination percentage (values are mean±SE)
3	6(19.24)
6	6(23.27)
9	6(23.64)
12	10(27.68)
24	26(32.53)
48	26(34.12)
Control	**00**

Graph 4.3: Duration of Imbibition.



The data of seedling growth in relation to different Potting media is given in Table-4.14 (A to G) and Graph- 4.4 to 4.7 which revealed that the average maximum length of root (29.1cm.) was in sand+ black (1:1 ratio by volume) and it was minimum (7.15cm.) in black+ Padua (1:1 ratio by volume). During the course of study no growth of seedlings was detected in the potting medium no. S_{13}, and no plausible interpretation can be given for such discrepancy, but it is inferred that the lacking of growth of seedling in the said mixture, the reason should have associated with insect damage at early stage of seedling emergence. S_{13} [Red: Padua:Sand (1:2:1)] has been disturbed and performance of seedlings could not be evaluated. The maximum average dry weight of root (0.516gm.) was observed in a soil mixture Red+ Black (1:1 ratio by volume) followed by 0.496gm. (Sand+ Black) whereas the minimum root dry weight (0.264gm.) was recorded in Red + Padua mixture (1:1 ratio by volume). It is known that a number of environmental factors affect the growth of dry weight of plants. In black soil, it was high as such soils have high percentage of organic matter, minerals, water and aeration which are most favorable condition for growth of any plants. The maximum moisture percentage (123.043%) in root obtained in pure red and it was minjimum (63.5%) in Sand + Red (1:1 ratio by volume). The maximum moisture percentage (128.611%) in shoot was recorded in Sand and Padua (1:1 ratio by volume) and it was minimum (53.04%) in Red +Black (1:1 ratio by volume).

The growth in the initial phase of plant is observed in the form of length, it is normally seen in shoot height. Experiment under different soil composition declared that a mixture of Sand + Black soil (1:1 ratio by volume) was best in attaining the maximum average shoot length (15.235 cm.) and dry weight (0.315gm.) while as contrary the poorest dry weight was recorded in a composition of Pure Padua. The seedlings grown in this media also produce minimum shoot length (5.753 cm.) and dry weight (0.171 gm.).

The Photosynthetic area (PSA) (cm^2), which is a good indicator of photo absorptive surface, helps the seedlings in early establishment and better growth after planting. The highest average photo synthetic area (45.6cm^2) was reported in the seedling grown in mixture of Red+ Black soil (1:1 ratio by volume) followed by 41.155 cm^2 with a mixture of Red + Black soil (1:1 ratio by volume) and a minimum 15.05cm^2 was observed in Sand + Red (1:1 ratio by volume).

Awing and Hamzah (1986) found that effect of potting mixture on height, diameter, root/shoot ratio and total dry weight of *Acacia mangium* seedlings varied with various soil mixtures. The total length of seedling (38.8cm.) was maximum in a mixture of Sand+ Black (1:1 ratio by volume) followed by 37.4cm. in Red + Black (1:1 ratio by volume) and biomass were also maximum (0.816gm.) in a mixture of Sand + Black(1:1 ratio by volume). The minimum (12.65cm.) total length of seedlings was reported in Black + Padua (1:1 ratio by volume).

The maximum shoot/root length ratio (1.53cm) was reported in the seedling grown exclusively in Pure Sand and it was minimum (0.325) in pure Padua, whereas the maximum (0.991) Shoot/Root dry weight ratio was observed in Red + Black+ Padua (1:2:1 ratio by volume) and same was minimum (0.489) in Red+ Black (1:1 ratio by volume).

The seedling growth and dry weight parameter indicated wide response on the gradient of soil mixture. The range of Collar diameter (CD) did not show much variation. It is evident from the observations Sand + Black (1:1 ratio by volume) followed by Red +Black (1:1 ratio by volume) which largely favoured the growth of roots and number of secondary roots along with shoot in the initial stage of seedling growth. It will be highly porous and will allow better growth of roots by allowing deeper

penetration in such soil medium. The enhanced growth of roots will also help in the favourable growth of above ground parts of seedling by supplying them water and appropriate nutrients. The better performance of overall growth of seedlings in potting media No.9 could be explained with better aeration, appropriate moisture supply and sufficient nytrient status of the composition of the medium.

Table-4.14: Growth performance of seedlings of *Butea monosperma* at the age of six months in relation to different potting media.

(A)

Various seedling measurement	Pure Paduaa (S_1)			Pure Red (S_2)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	16	4	11.6±2.016	17	5	9.1±2.278
SL(cm.)	6	4.25	5.73±0.396	15	8	11.34±2.429
RL(cm.)	29.5	14.2	23.01±5.07	24	11	17.4± 3.294
PL(cm.)	35.5	19.9	30.53±5.95	39	19	28.74±5.734
S/R L ratio	0.338	0.423	0.325±0.178	0.625	0.727	0.662±0.728
SDW (gm.)	0.36	0.05	0.171±0.035	0.40	0.15	0.249±0.031
RDW (gm.)	0.57	0.08	0.269±0.080	0.79	0.1 2	0.323±0.056
PDW (gm.)	0.93	0.13	0.443±0.137	1.19	0.27	0.576± 0.089
S/R DW ratio	0.64	0.625	0.648±0.450	0.506	1.25	0.572± 0.89
Collar Diameter	6	2	4.09±1.177	7	4	6±2.812
%M.C. in Shoot	81.834	48.4	67.019±1.813	89.54	44.81	65.730±2.110
%M.C. in Root	69.352	47.57	58.197±3.893	75.57	32.151	68.043±2.309
PSA (cm^2)	51.5	28.5	31.1±17.154	57.65	21.25	15.275±3.107

(B)

Various seedling measurement	Pure Sand (S_3)			Pure Black (S_4)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	25	5	11.33±4.809	11	9	7.5±2.025
SL(cm.)	21	8.5	9.7±0.784	13	6	11.5±0.625
RL(cm.)	34	5.6	20.28±4.179	21	12	16.35±4.64
PL(cm.)	55	14.1	23.58±4.973	34	18	27.85±5.425
S/R L ratio	1.20	1.51	1.53±0.191	0.619	0.51	0.715±0.152
SDW (gm.)	0.47	0.15	0.266±0.050	0.310	0.07	0.234±0.032
RDW (gm.)	0.69	0.12	0.369±0.115	0.528	0.12	0.320±0.046
PDW (gm.)	1.08	0.26	0.6380.170	0.802	0.19	0.484±0.072
S/R DW ratio	0.681	1.25	0.720±0.434	0.643	0.583	0.515±0.712
Collar Diameter	9	2.3	4.42±1.905	6	2	4.02±1.189
%M.C. in Shoot	81.5	38.297	63.108±2.414	80.584	46.465	69.420±3.130
%M.C. in Root	71.303	48.230	59.519±1.573	81.527	25.526	59.026±3.202
PSA (cm^2)	73.71	24	23.925±5.508	51.5	2.5	31.52±4.29

(C)

Various seedling measurement	Black+Padua (S_5)			Red+Padua (S_6)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	10	4	6.5±1.074	16	9	13.5±2.047
SL(cm.)	10	5.7	7.52±0.245	11	5	8.65±0.379
RL(cm.)	24	6	7.15±4.040	19	7	12.05±4.025
PL(cm.)	34	11.7	12.65±4.345	30	12	20.61±4.429
S/R L ratio	0.461	0.45	0.706±1.30	0.578	0.714	0.724±0.099
SDW (gm.)	0.310	0.15	0.210±0.307	0.380	0.110	0.205±0.354
RDW (gm.)	0.566	0.19	0.375±0.427	0.581	0.181	0.264±0.181
PDW (gm.)	0.874	0.34	0.586±0.739	0.960	0.29	0.469±0..630
S/R DW ratio	0.554	0.789	0 .564±0.718	0.655	0.62	0.776±1.960
Collar Diameter	6	2	5.4±1.438	5	3	3.25±1.003
%M.C. in Shoot	88	29.457	64.559±3.041	81.845	31.575	56.070±4.182
%M.C. in Root	70.578	38.752	53±2.021	68.578	35.827	55±3.022
PSA (cm^2)	38.25	10.5	15.40±1.540	51.5	11.6	19.65±4.31

(D)

Various seedling measurement	Black+Padua (S_7)			Sand+Padua (S_8)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	20	7	13.4±1.943	24	9	15.9±3.756
SL(cm.)	13.5	10	11.75±0.597	31.7	6.5	15.235±1.517
RL(cm.)	33	12	20.9±4.036	38.5	11	29.1±8.502
PL(cm.)	46.5	22	32.64±4.657	70.2	17.5	38.8±10.11
S/R L ratio	0.409	0.83	0.562±0.149	0.445	0.723	0.42±0.125
SDW (gm.)	0.451	0.110	0.275±0.053	0.520	0.14	0.315±0.068
RDW (gm.)	0.730	0.171	0.368±0.078	0.841	0.12	0.496±0.1317
PDW (gm.)	1.22	0.38	0.643±0.136	1.36	0.23	0.816±0.198
S/R DW ratio	0.616	0.447	0.572±0.218	0.559	1.67	0.635±0.518
Collar Diameter	9	3	4.56±0.999	11	3.1	6.59±1.146
%M.C. in Shoot	96.034	56	81.611±2.596	88.833	54.548	75.004±1.460
%M.C. in Root	72.176	38.727	61.968±1.527	76.176	34.584	58.190±0.130
PSA (cm^2)	62.75	31.25	27.5±5.875	71.25	21.5	41.55±4.824

(E)

Various seedling measurement	Red+Black (S_9)			Sand+Red (S_{10})		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	19	12	15.7±1.047	15	12	13.45±2.135
SL(cm.)	19.5	6	8.35±0.397	8	3	6.25±0.278
RL(cm.)	35	13.5	22.51±3.836	15	8	18.35±3.025
PL(cm.)	54.5	19.5	37.4±4.45	23	11	24.60±3.343
S/R L ratio	0.285	0.445	0.438±0.105	0.534	0.374	0.340±0.198
SDW (gm.)	0.48	0.14	0.251±0.351	0.370	0.17	0.247±0.367
RDW (gm.)	0.93	0.17	0.516±0.131	0.492	0.19	0.295±0.131
PDW (gm.)	1.41	0.35	0.77±0.525	0.860	0.36	0.545±0.502
S/R DW ratio	0.571	0.84	0.489±2.35	0.760	0.894	0.837±2.80
Collar Diameter	9	2	4.92±1.312	7	2	4.35±2.055
%M.C. in Shoot	90.548	64.285	53.04±2.796	94.425	36.430	56.402±5.250
%M.C. in Root	71.588	28.862	49.790±1.012	58.571	21.817	35.5±1.012
PSA (cm^2)	79.5	21.5	45.6±7.449	29.25	13.65	15.05±2.525

(F)

Various seedling measurement	Sand+Red+Black (S_{11}) (1:2:1))			Red+Black+Padua (S_{12}) (1:2:1)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	11	7	10.10±2.05	15	9	14.5±2.051
SL(cm.)	17.5	8	12.3±2.650	11	6	8.67±0.378
RL(cm.)	24	12	20.9±4.036	19	7	12.51±4.250
PL(cm.)	41.5	20	33.25±3.666	30	13	20.61±4.429
S/R L ratio	0.729	0.667	0.689±0.731	0.578	0.857	0.693±0.189
SDW (gm.)	0.41	0.17	0.275±0.051	0.380	0.111	0.261±0.355
RDW (gm.)	0.73	0.19	0.368±0.078	0.580	0.190	0.266±0.162
PDW (gm.)	1.14	0.36	0.554±0.087	0.96	0.310	0.528±0.528
S/R DW ratio	0.561	0.895	0.748±0.879	0.655	0.584	0.991±0.785
Collar Diameter	6	3	5.5±0.789	6	4	5±1.01
%M.C. in Shoot	96.545	47.430	78.034±2.745	95.846	32.567	56.070±3.18
%M.C. in Root	51.134	26.151	47.986±2.342	68.582	37.715	52.01±1.031
PSA (cm^2)	52.65	22.28	19.55±4.824	53.54	23.710	2.66±5.33

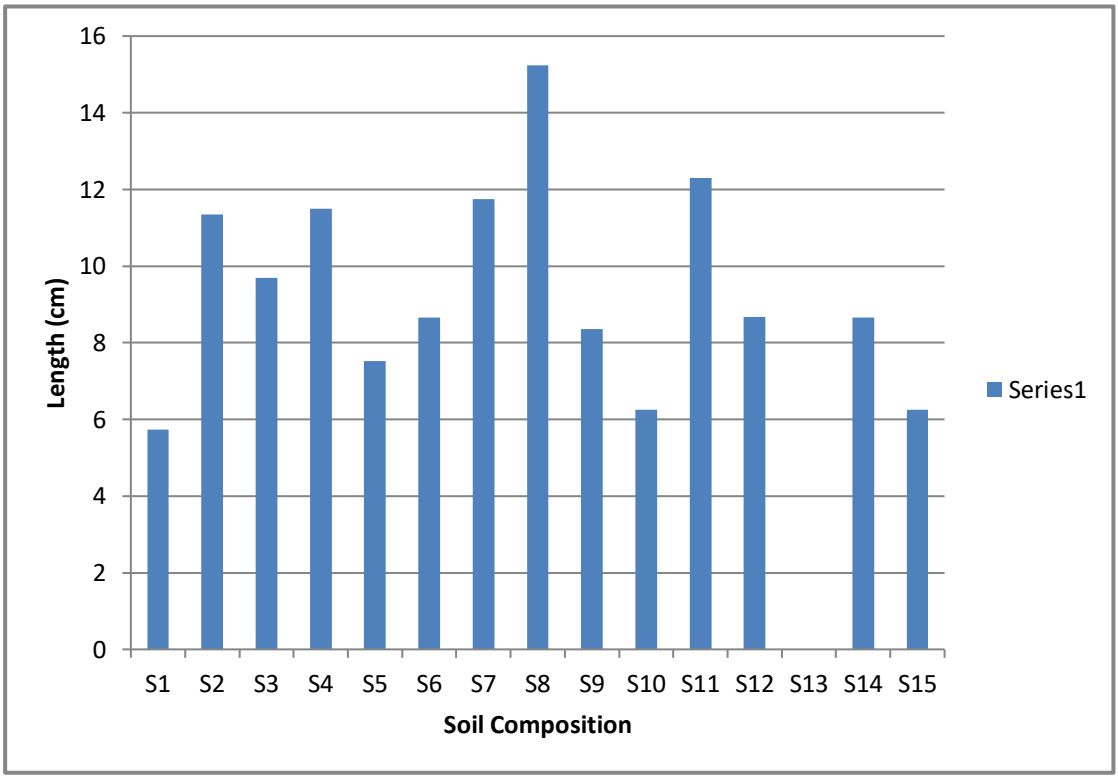
(G)

Various seedling measurement	Red+ Sand+Black(S_{14})(1:2:1)			Red+Sand+Black+Padua (S_{15}) (1:1:1:1)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	13	8	10.25±2.047	15	11	13.44±2.135
SL(cm.)	11	6	8.65±0.378	7	3	6.25±0.289
RL(cm.)	18	8	11.05±3.051	15	9	19.35±3.025
PL(cm.)	29	14	18.81±3.429	22	12	24.70±3.414
S/R L ratio	0.611	0.75	0.782±0.134	0.467	0.333	0.322±0.155
SDW (gm.)	0.380	0.11	0.207±0.355	0.371	0.17	0.247±0.367
RDW (gm.)	0.57	0.19	0.265±0.184	0.566	0.19	0.375±0.427
PDW (gm.)	1.15	0.30	0.472±0.540	0.937	0.36	0.624±0.749
S/R DW ratio	0.667	0.579	0.782±0.718	0.655	0.894	0.659±0.894
Collar Diameter	5	2	4.25±2.43	6	3	4.5±2.001
%M.C. in Shoot	95.854	31.755	56.919±4.184	96.425	36.430	56.402±5.250
%M.C. in Root	81.512	39.827	65±1.022	80.578	35.752	61.5±2.021
PSA (cm^2)	50.25	12.6	23.65±5.31	39.35	28.45	19.65±7.156

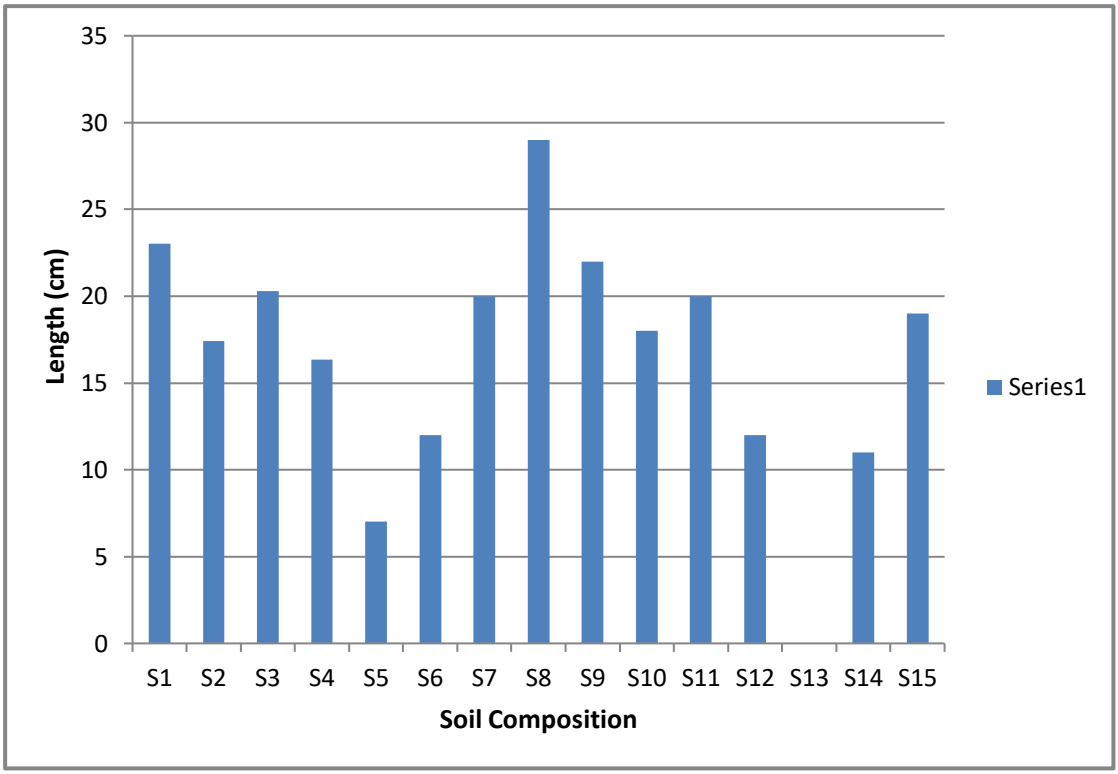
Table-4.15: Represents the value of Quality Index and Sturdiness Quotient of Seedlings in different potting media

Potting Media	Quality Index	Sturdiness Quotient
S_1	0.0421	9.8802
S_2	0.1039	4.791
S_3	0.0556	10.746
S_4	0.0632	6.927
S_5	0.2019	2.342
S_6	0.0658	6.341
S_7	0.0813	7.157
S_8	0.1075	6.953
S_9	0.0950	7.601
S_{10}	0.0839	5.655
S_{11}	0.0813	6.063
S_{12}	0.1039	4.122
S_{13}	- - - - - - - - -	- - - - - - - - -
S_{14}	0.0906	4.425
S_{15}	0.1039	5.489

Graph- 4.4: Effect of Soil Composition on Shoot Length.



Graph- 4.5: Effect of Soil composition on root length.



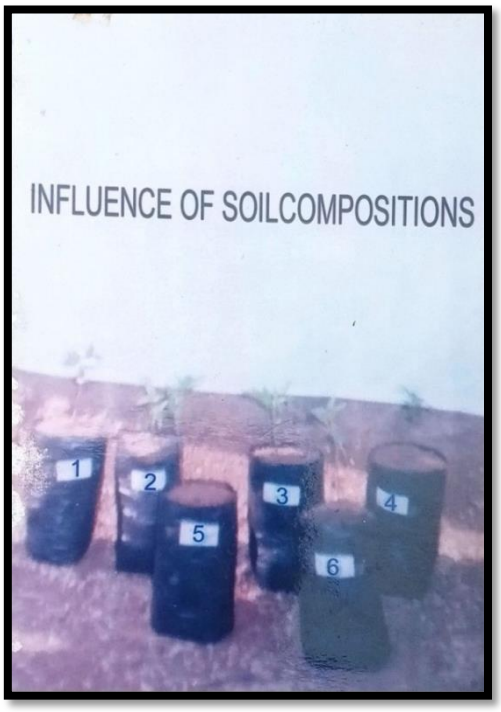
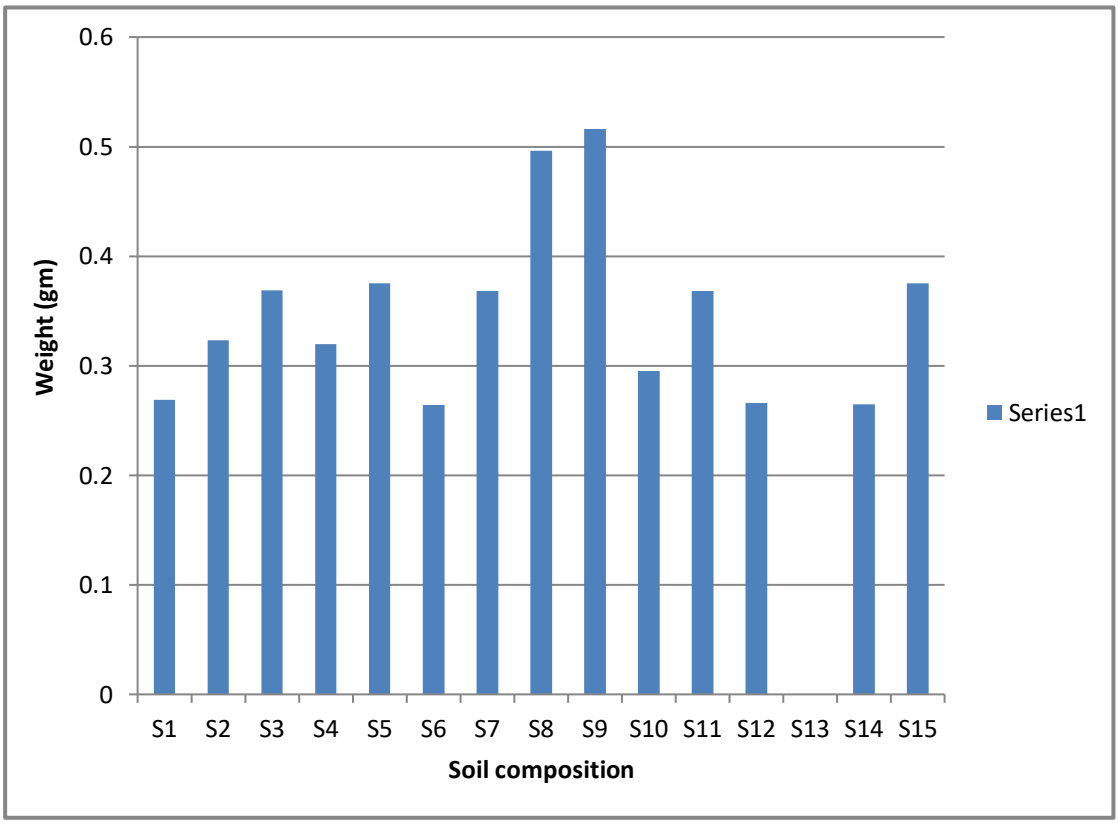


Figure No 4.3 : The growth performance of six months old seedling of *Butea monosperma* in seed + Black soil (S_8).

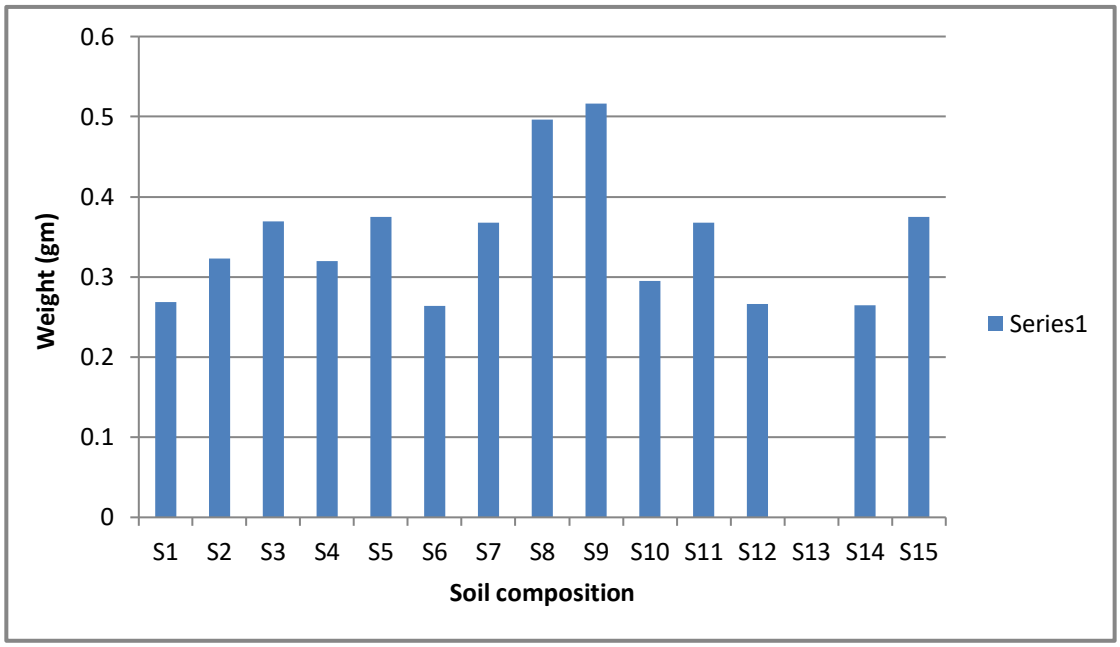


Figure No 4.4: The growth Performance of six months old seedling of *Butea monosperma* in sand + Padua (S_6).

Graph- 4.6: Effect of Soil composition on the biomass production of Shoot.



Graph- 4.7: Effect of Soil composition on the biomass production of Shoot.



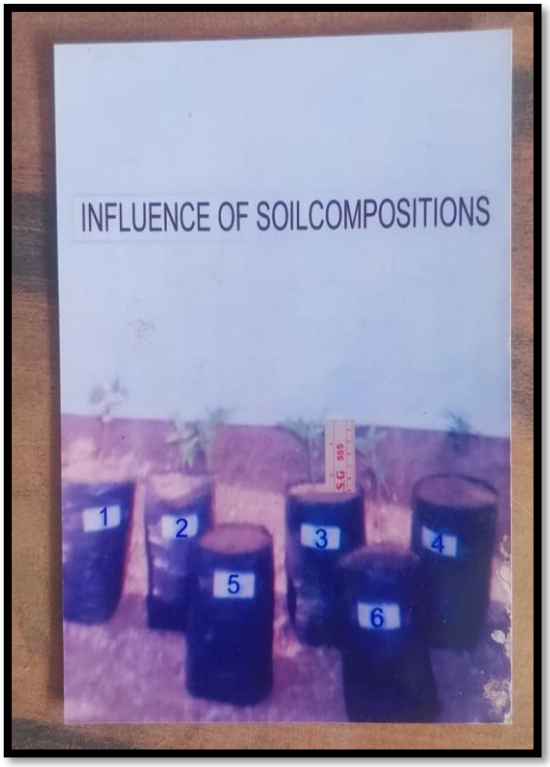


Figure No 4.5: The growth performance of *Butea monosperma* in Sand + Red.



Figure No 4.6: The growth performance of one year old seedling of *Butea monosperma* in canopy light.

The results of effect of three different (20, 45, 100) light intensities on seedling growth are given in Table-4.16 and Graph-4.8 to 4.12. A perusal of Table 5.16 indicates that, an average maximum length of root (65cm.) and shoot (48.5cm.) was obtained in 45 percent light (II) (under tree canopy) condition, while the minimum was 20 percent (III) i.e. 20.9 cm and 8.35 cm. respectively. The root and shoot dry weight also followed similar pattern. The maximum root dry weight (2.992 gm.) was obtained in 45 percent light (II) followed by 1.685 gm in 100 percent light (I) and minimum (0.992gm.) in 20 percent light condition. The ratio of shoot/Root dry weight ratio show a different trend, as it was maximum (0.635gm.) in 20 percent light (III) and decrease gradually in 45 percent light (II) to 100 percent (I) light condition respectively.

The maximum dry weight (4.822 gm.) of the seedling was found in 45 percent light followed by 100 percent (3.012 gm.) and 20 percent (0.443 gm.) light respectively. The average maximum moisture percent of shoot (81.08%) and root (86.38%) were also observed in semi-shady light condition (45 percent) and it is minimum in (61.197%, Shoot and 66.190% root) 20 percent (III) light condition.

The maximum photosynthetic area shows a different trend, as it was maximum (291.2cm^2) in 100 percent (I) (Full sunlight) followed by 45 percent (245cm^2) and 20 percent (60.2cm^2). Maximum length of seedling 99cm. was found in the seedlings grown under 45 percent (II) light intensities while average minimum length of seedlings was reported 31.25cm. in 20 percent (III) light condition. This behavior may be due to the moderate humidity and favourable microclimatic conditions under 45 percent light. The growth under full sunlight was not satisfactory in *Butea monosperma*, which may be due to increased temperature and decreased moisture in soil. Many workers (Bhargava, 1951 and Mathur, 1956) have indicated essentially of partial or lateral shade in the earlier stage of seedlings of certain species to protect them from drought.

The maximum shoot/root length ratio shows an increasing trend gradually in 45<100<20 percent light condition. The number of leaves was observed higher (31) in 45 percent light followed by 100 (21) and 20 (11.5) percent light intensities. The maximum average collar diameter was recorded (14.59cm.) in 45% (Semi-shady condition), followed by 100 percent (10.90cm) and 20 percent (8.09cm.).



Figure No 4.7: The growth performance of one year old seedling of *Butea monosperma* in semi – shady condition.



Figure No 4.8: Effect of daily irrigation regimes of one year old seedling of *Butea monosperma.*

The average growth remained higher under 45 percent light followed by 100 and 20 percent light. This behavior may be due to the moderate humidity and favourable microclimatic conditions under 45% light, Tripathi, 1984 has also reported the same response of light condition on seedling growth of *Anogeissus pendula*Adgew at early stages.

The environmental factors such as temperature and soil moisture are modified to same extent in shady condition. The trend of shoot/root growth and shoot/root dry weight ratio in seedling of *Butea monosperma* may be due to the needs of the species with response to the microclimatic requirements viz. temperature, humidity, microbial flora and soil condition.

The absolute light condition may have an adverse effect on the growth of seedling due to increased temperature and decreased moisture in soil.

Table- 4.16 (A) Effect of different light condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements)

Various measurement of seedlings	Light condition (Full sunlight)		
	Max.	Min.	AV±SE
Total no. leaves of Seedlings	32	19	21±3.705
SL(cm.)	48.75	35.50	39±3.07
RL(cm.)	61.50	41	46.75±3.502
PL(cm.)	110	76.50	84.55±6.365
S/R L ratio	0.792	0.889	0.723±0.427
SDW (gm.)	1.96	0.48	0.91±0.702
RDW (gm.)	2.05	0.34	1.685±0.262
PDW (gm.)	5.12	0.64	3.0±120.566
S/R DW ratio	0.976	0.823	0.446±0.679
Collar Diameter	17	6	10.90±2.312
%M.C. in Shoot	81.094	65.57	69.01±2.592
%M.C. in Root	89.176	39.724	76.58±4.025
PSA (cm^2)	361.5	144.3	219.2±14.898

Table- 4.16 (B) Effect of different light condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements)

Various measurement of seedlings	Light condition (Semi-shady)		
	Max.	Min.	AV±SE
Total no. leaves of Seedlings	43	21	31±5.765
SL(cm.)	65.25	49	48.5±2.560
RL(cm.)	69.75	53	65±8.836
PL(cm.)	135	102	99±4.405
S/R L ratio	0.865	0.925	0.844±0.472
SDW (gm.)	2.04	0.280	1.63±0.136
RDW (gm.)	3.682	0.442	2.992±0.265
PDW (gm.)	6.62	2.720	4.822±0.125
S/R DW ratio	0.618	0.606	0.615±0.513
Collar Diameter	22	5.2	14.59±3.146
%M.C. in Shoot	98.667	73.08	81.08±4.92
%M.C. in Root	110.35	80.168	86.38±2.26
PSA (cm^2)	342.5	143	245±19.648

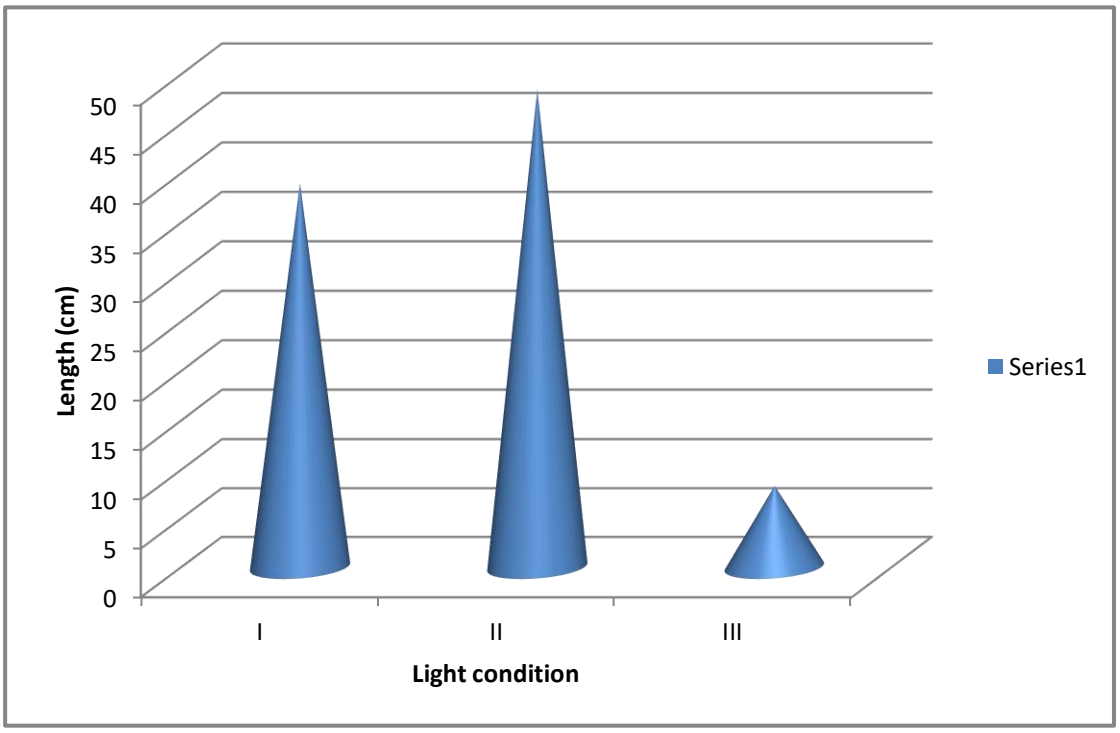
Table- 4.16 (C) Effect of different light condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements.)

Various measurement of seedlings	Light condition (Shady)		
	Max.	Min.	AV±S.E.
Total no. leaves of Seedlings	14	9	11.5±2.05
SL(cm.)	19.5	6	8.35±0.397
RL(cm.)	24	10	20.9±4.03
PL(cm.)	43.5	16	31.25±3.57
S/R L ratio	0.812	0.61	0.298±0.098
SDW (gm.)	0.69	0.25	0.342±0.07
RDW (gm.)	1.14	0.64	0.992±0.265
PDW (gm.)	1.71	0.194	0.442±0.137
S/R DW ratio	0.605	0.115	0.635±0.437
Collar Diameter	9	4	8.09±2.277
%M.C. in Shoot	78	58.61	61.197±2.81
%M.C. in Root	79.352	60.571	66.190±5.893
PSA (cm^2)	98.5	51.5	60.2±21.308

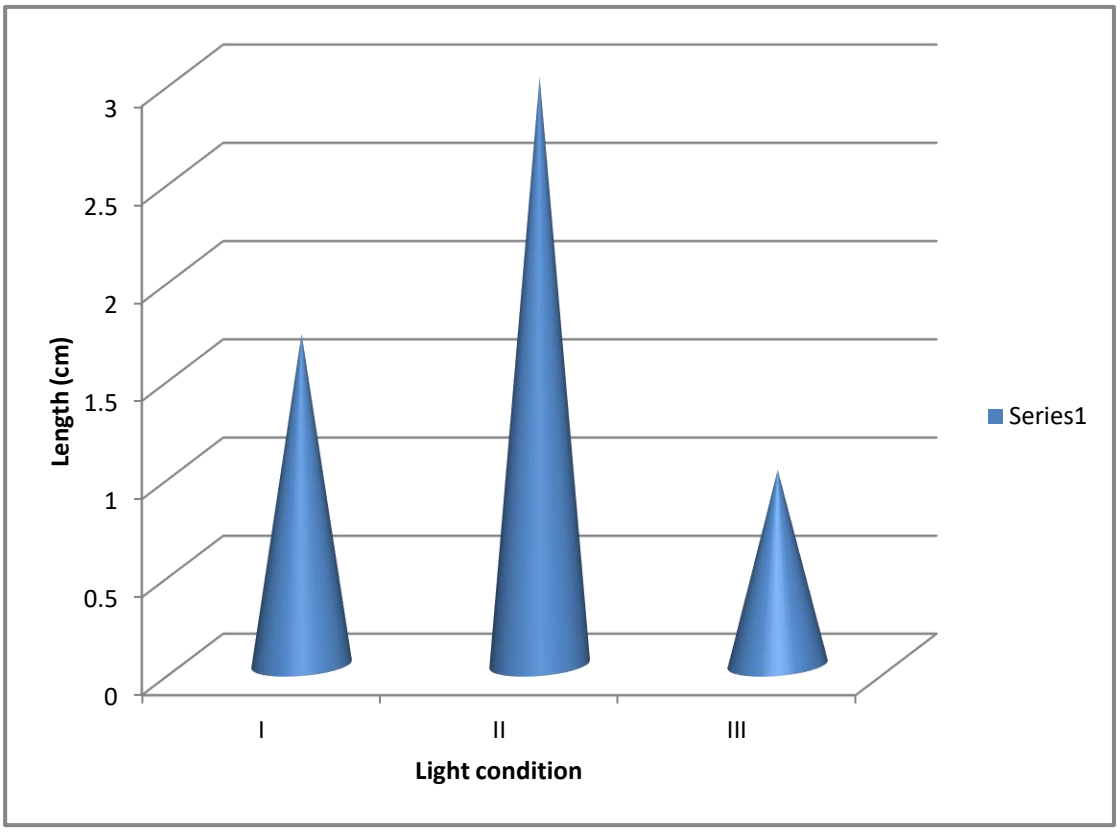
Table-4.17 Indicates the value of quality index (QI) and Sturbiness Quotient (SQ) of seedling of *Butea monosperma*grown in different light condition

Light condition	QI	SQ
Full sunlight	0.119	7.742
Semi-shady	0.245	6.785
Shady	0.095	3.862

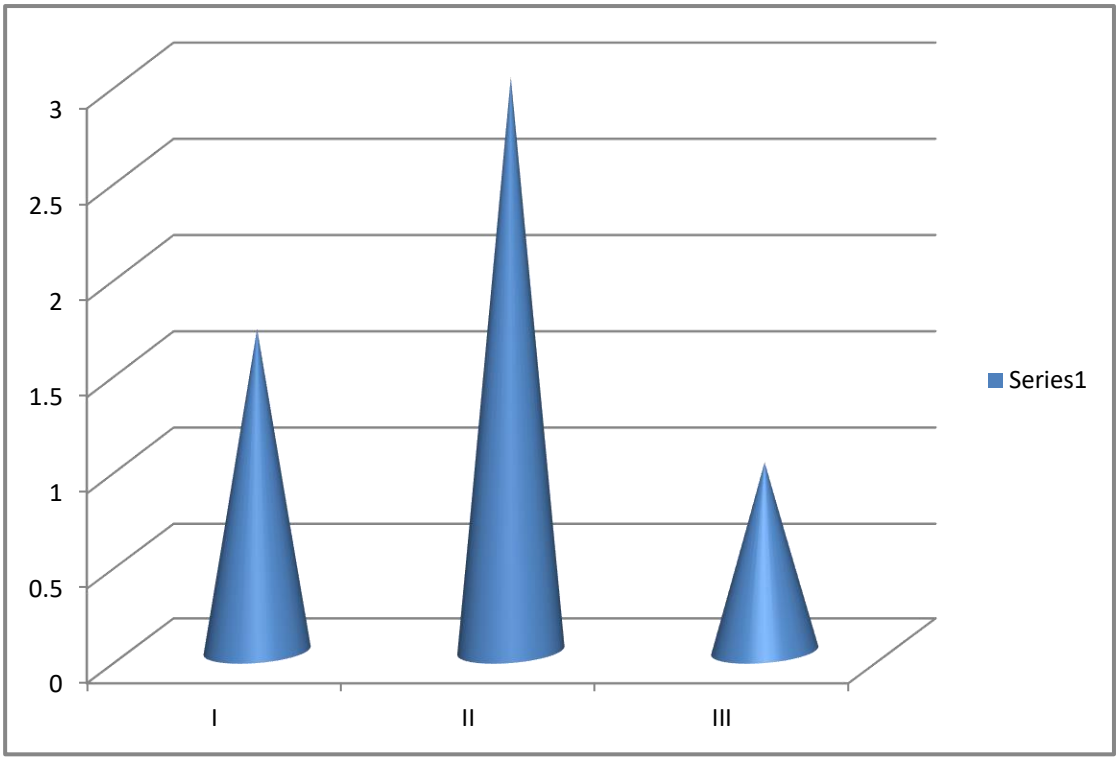
Graph-4.8: Effect of different light condition on Shoot length.



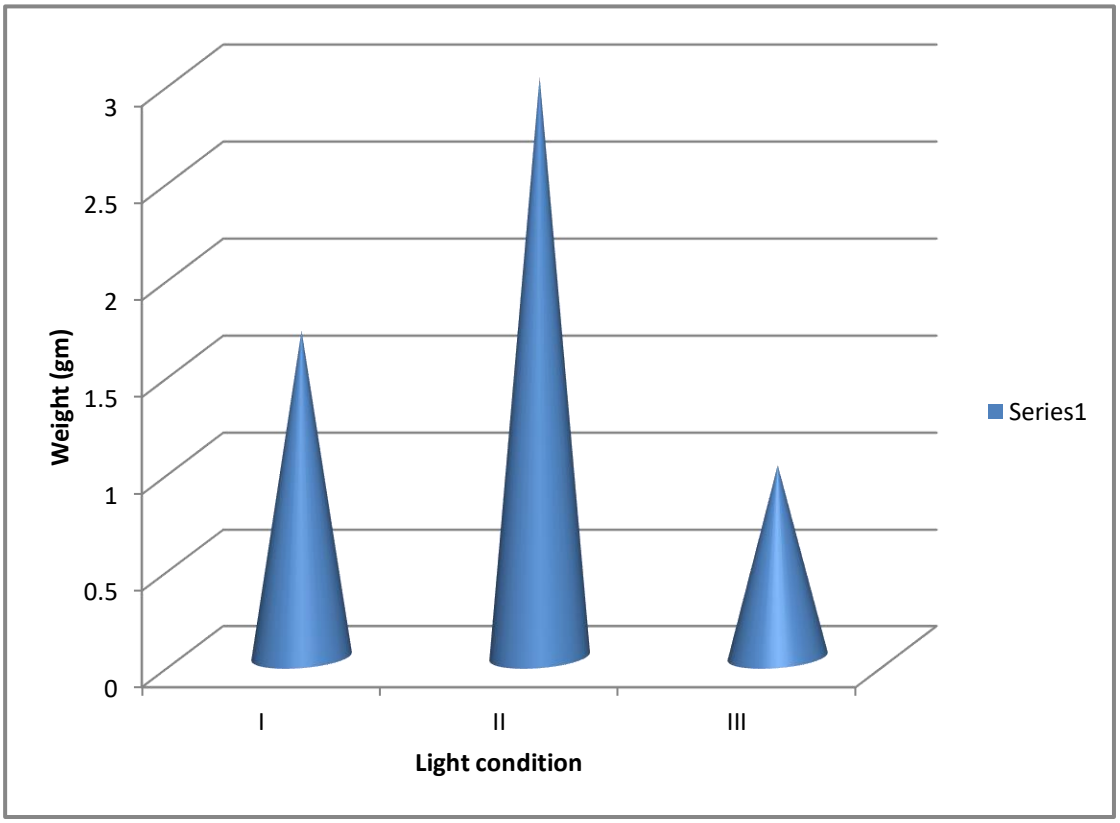
Graph-4.9: Effect of different light condition on root length.



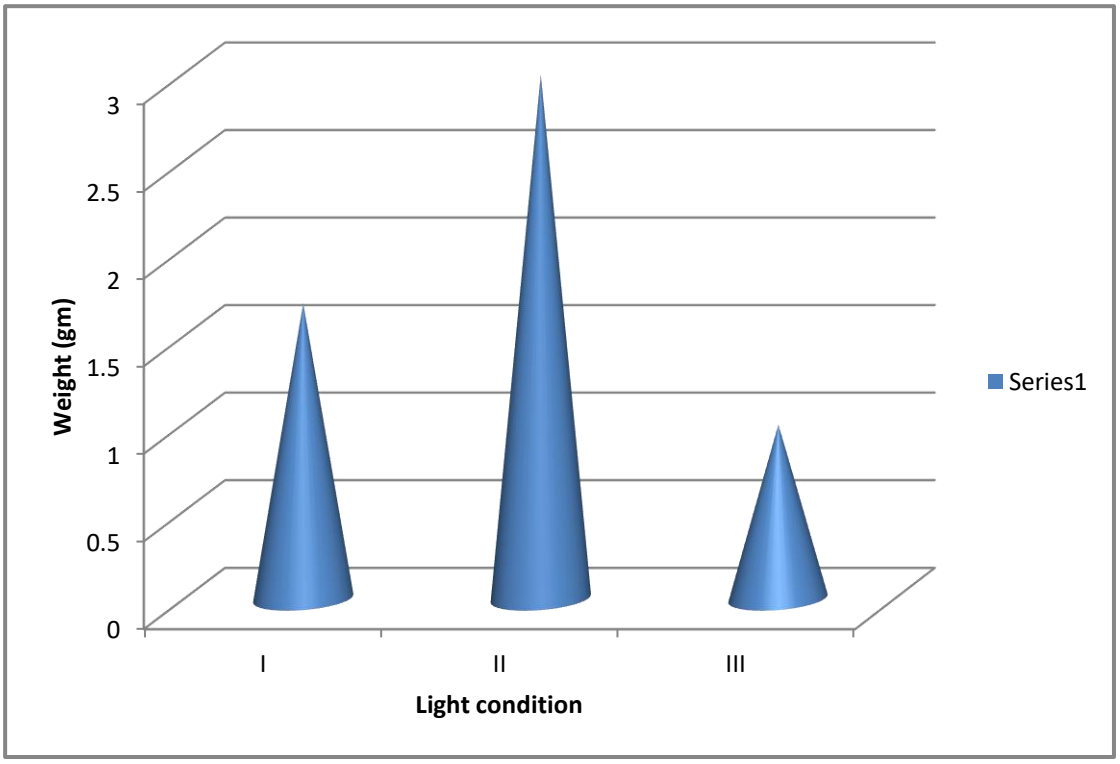
Graph-4.10: Effect of different light condition on Plant length.



Graph-4.11: Effect of different light condition on the biomass production of shoot.



Graph-4.12: Effect of different light condition on the biomass production of root.



The results obtained under different irrigation treatment are given in Table 4.18 & 4.19 and Graph-4.13 to 4.14. The results indicates that the maximum shoot length (47.5cm.) was recorded in the daily irrigation (I) followed by alternately (II) (31cm.) and twice/weekly (III) (21cm.). The maximum root length (49.48cm.) was observed in twice/weekly (III) category of irrigation, however, the minimum root length (40.50cm.) was found in daily irrigation (I). The maximum total length of seedlings was found in category of daily-I (110cm.) irrigation followed by alternately-II (81cm.) and twice/weekly-III (49.48cm.) irrigation regime. The ratio of shoot/root length ratio showed a different trend, as it was maximum (0.804) in I-category (Daily irrigation) and it was minimum (0.498) in category-III (twice/weekly irrigation). The better growth growth of seedlings in daily irrigation might be due to setting microenvironment of soil and proper aeration condition to the seedlings.

Percent moisture content in root was higher (89.38%) in II- category of alternate irrigation and a gradual decrease in it was observed through the I-category (78%) and III- category (51.190%) of irrigation. In shoot, percentage of moisture content followed the similar trend, the maximum (84.78%) moisture content were observed in alternate (II) irrigation followed by daily (I) (76.108%) and twice/weekly

(III) (58.07%) irrigation. The total number of leaves was higher (35) in daily irrigation (I) followed by alternately (II) (22) and twice/weekly (12.5) irrigation.

The maximum shoot dry weight was observed in category-I daily irrigation (2.36gm.) followed by category-II alternately (1.75gm.) and category-III twice/weekly (0.546gm.) irrigation. The dry weight of root was also follow the similar pattern it was also maximum in daily irrigation-I (2.731gm.) followed by alternately irrigation-II (1.95gm) and twice/weekly irrigation-III (2.731gm.) followed by alternately irrigation-II (1.95gm.) and twice/weekly irrigation-III (0.738gm.). The maximum average Collar diameter was recorded (15.59cm.) in daily irrigation-I, followed by alternately-II (12.90cm.) and twice/weekly-III (6.42cm.). The maximum dry weight (6.91gm.) of total seedling was found in daily irrigation followed by alternately (4.05gm.) and twice/weekly (2.276gm.).

The maximum and minimum photosynthetic area was 293.5 cm^2 and 148.38 cm^2 in twice/weekly and alternately irrigation condition respectively. The ratio of shoot/root dry weight shows a different trend, it was maximum in category-III (twice/weekly irrigation) (0.976) and minimum category-I (daily irrigation) (0.449). Chaturvedi, (1992) has also reported the same results in *Lagerstroemia parviflora*.

Therefore, on the basis of above observation it can be concluded that an average growth of seedling was found better in daily irrigation than others. The length of root was found better in the seedlings III category of irrigation but as regards the total dry weight of the seedlings, the maximum production was recorded under the influence of I-category (daily irrigation). In any phase of plant life the production of dry weight as compared tolength, number of secondary roots, leaves etc. is more meaningful and an important aspect in the establishment of plant life in the natural condition. The strength and vigour of a plant is represented by the weight and more appropriately to say by dry weight. Therefore, on the above observation it can be concluded that the average growth of seedlings of *Butea monosperma* at initial stages was found better in I-category of irrigation. The twice/weekly irrigated seedlings would have suffered with low moisture availability, which has checked the proper growth of seedling through the lack of turgidity and cell extension. Alternate irrigation made soil poorly aerated, thereby reducing water absorption in seedlings. The growth of seedling

in category-II (alternately irrigation) was less than compare to category-I (dairy irrigation.).

Table- 4.18(A) Effect of different irrigation condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements.)

Various measurement of seedlings	Irrigation condition {Daily (I)}		
	Max.	Min.	AV±S.E.
Total no. leaves of Seedlings	41	23	35±6.756
SL(cm.)	61.75	45	47.5±4.650
RL(cm.)	59	47	40.50±4.650
PL(cm.)	130.75	92	110±4.405
S/R L ratio	0.792	0.829	0.804±0.268
SDW (gm.)	3.04	0.925	2.36±0.026
RDW (gm.)	4.826	1.606	2.731±0.920
PDW (gm.)	8.862	5.513	6.91±1.277
S/R DW ratio	0729	0.575	0.449±0.313
Collar Diameter	23	7.5	15.60±4.146
%M.C. in Shoot	81.50	71	76.108±2.924
%M.C. in Root	91.3	73.186	78±3.294
PSA (cm^2)	342.5	148	245.5±19.684

Table- 4.16(B) Effect of different irrigation condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements.)

Various measurement of seedlings	Irrigation condition {Alternately (II)}		
	Max.	Min.	AV±S.E.
Total no. leaves of Seedlings	38	15	22±4.809
SL(cm.)	51.25	41.75	31±3.614
RL(cm.)	51	25.60	41.84±6.863
PL(cm.)	102.25	67.35	81±5.450
S/R L ratio	0.854	1.867	0.632±0.284
SDW (gm.)	2.147	0.892	1.75±0.456
RDW (gm.)	3.462	2.613	1.95±0.313
PDW (gm.)	6.906	4.729	4.005±1.25
S/R DW ratio	0.629	0.359	0.553±0.011
Collar Diameter	17	7.5	12.90±5.164
%M.C. in Shoot	91.766	75.81	84.78±3.92
%M.C. in Root	93.352	78.186	89.38±4.28
PSA (cm^2)	198.5	51.5	148.308±22.525

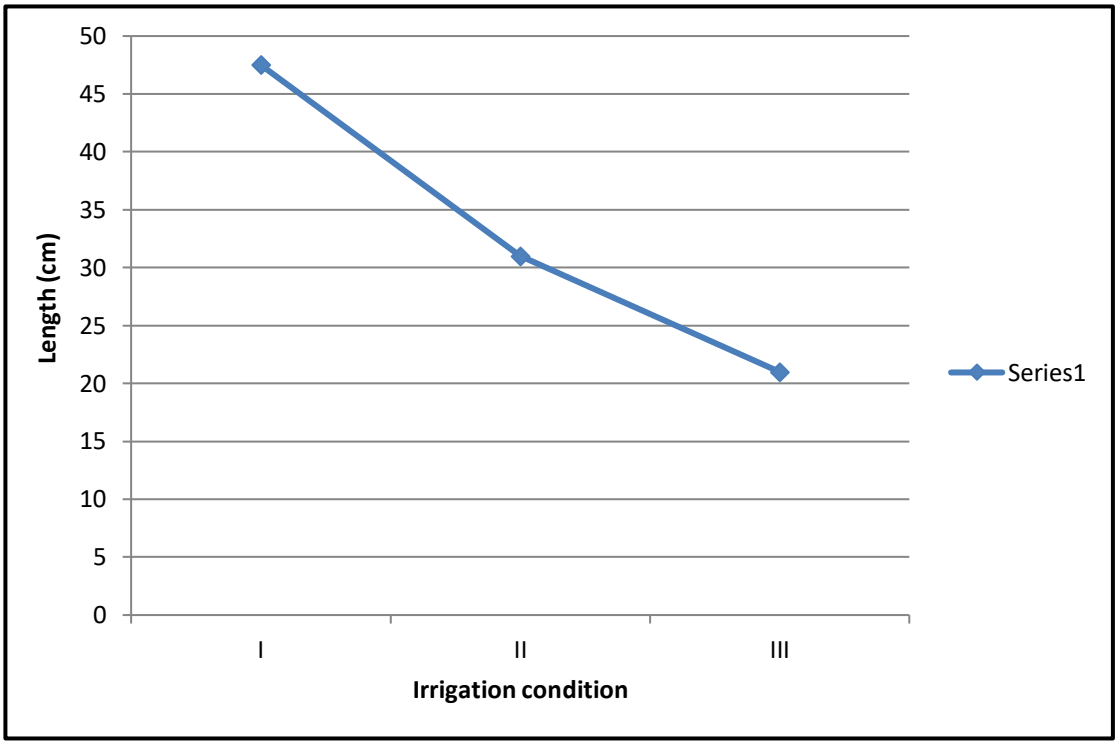
Table-4.16(C) Effect of different irrigation condition on various parameters of one year old seedling of *Butea monosperma* (Average value of 5 measurements.)

Various measurement of seedlings	Irrigation condition Twice/weekly (III)		
	Max.	Min.	AV±S.E.
Total no. leaves of Seedlings	16	4	12.5±2.018
SL(cm.)	30	17.25	21±4.197
RL(cm.)	60	42.30	49.48±4.172
PL(cm.)	90	59.55	51±5.450
S/R L ratio	0.689	0.286	0.498±0.124
SDW (gm.)	0.94	0.45	0.546±0.100
RDW (gm.)	1.38	0.24	0.738±0.230
PDW (gm.)	2.36	1.52	2.276±0.240
S/R DW ratio	0.662	1.25	0.976±0.868
Collar Diameter	9	2.5	6.42±1.905
%M.C. in Shoot	76.50	67	58.07±4.924
%M.C. in Root	76	51.230	61.190±6.537
PSA (cm^2)	361.450	148.30	293.5±14.898

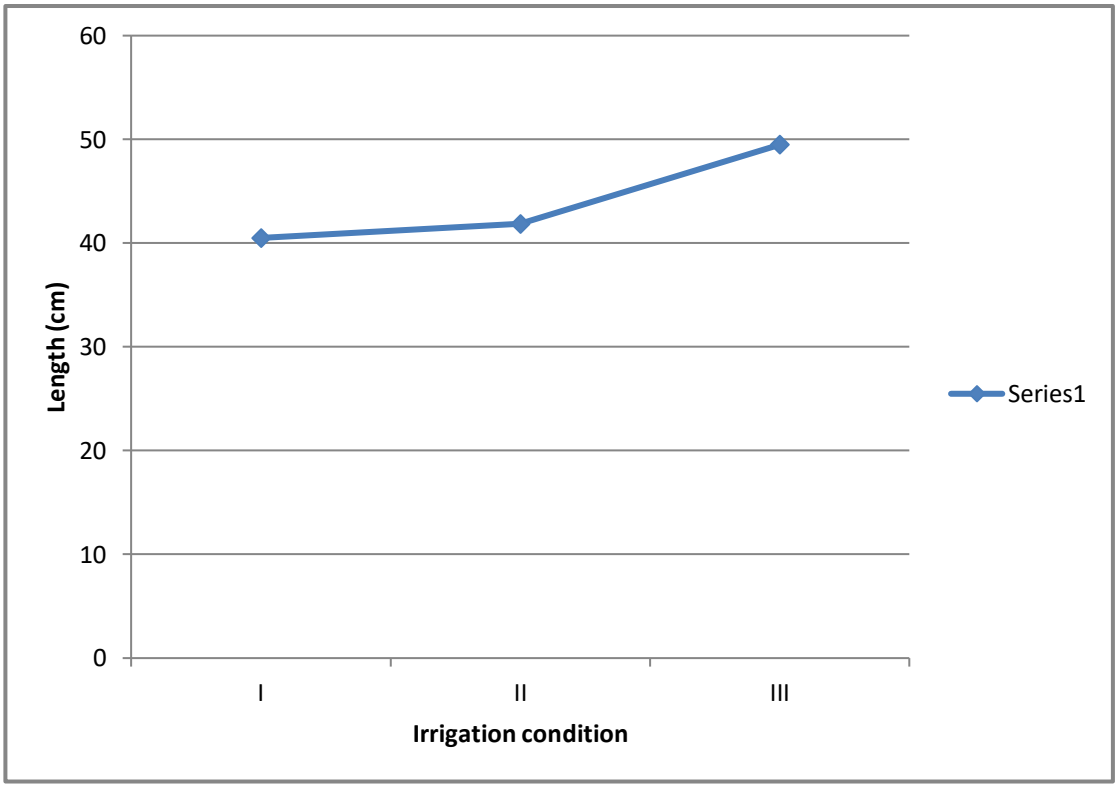
Table-4.19 Indicates the value of quality index (QI) and Sturbiness Quotient (SQ) of seedling of *Butea monosperma*grown in different water regime

Different irrigation treatment	QI	SQ
Daily (I)	0.873	7.055
Alternately (II)	0.558	6.279
Twice/weekly (III)	0.262	7.943

Graph-4.13: Effect of different irrigation on Shoot length.



Graph-4.14: Effect of different irrigation on Root length.



The data of seedling growth in relation to different to hormonal concentration are given in Table- 4.20 (A to G) & 4.21 and Graph- 4.15 to 4.18.

The growth and the biomass production of the roots and shoot under hormonal treatments were as under. The average maximum length of roots 76 cm were recorded in the seedling treated with 100 ppm/IAA and the minimum length 21.51 cm in the 250 ppm/GA_3. In control it was greater (29.1cm.) than minimum. The increase in number, length and diameter of roots may be probably due to hormonal effects, accumulation of synthesized food material and their downward translocation (Ling rajappa, 1982). The maximum 86 cm. and minimum shoot length 20.75 cm. were witnessed in the seedling sprayed with 25 ppm/IAA and 250 ppm/GA_3 respectively. In control it was 15.235 cm. The average maximum dry weight of root 3.73 gm. was found in 250 ppm/IAA, followed by 3.005 gm. in 50 ppm/GA_3 and it was minimum 0.336 gm under 250 ppm/GA_3 treatment. In control it was greater (0.496gm.) than minimum. The average maximum dry weight of shoot 2.56 gm. was found in 25 ppm/IAA followed by 2.51gm in seedling treated with 150 ppm/IAA while in control it was 0.415gm.

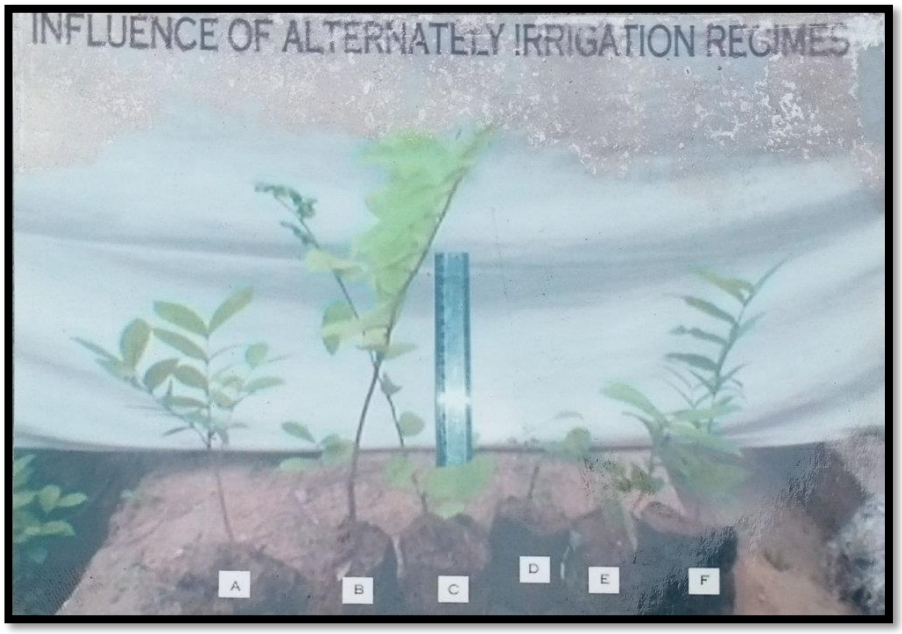


Figure No 4.9: Effect of alternately irrigation regimes of one year old seedling of *Butea monosperma.*

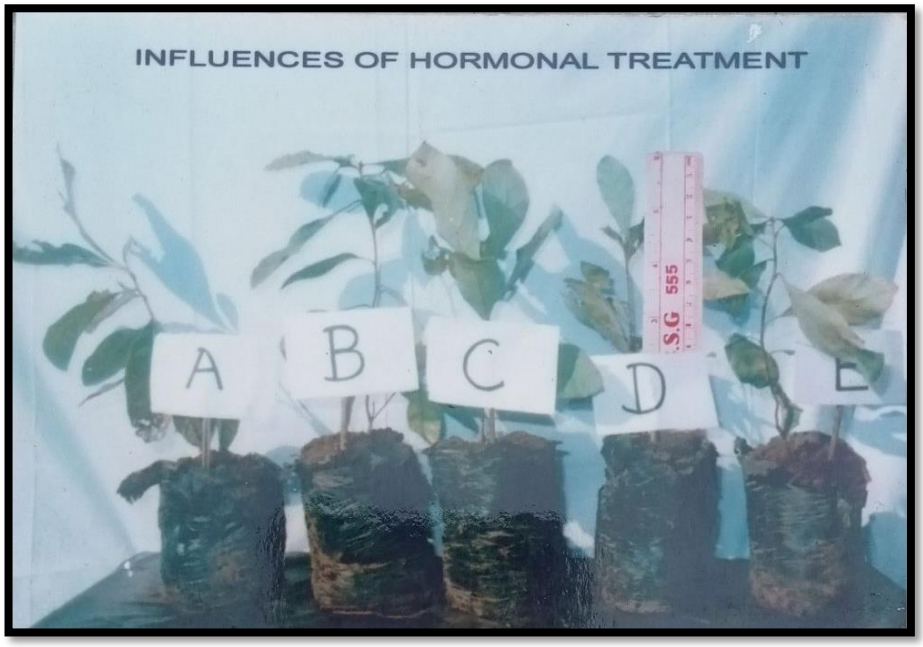


Figure No 4.10: Effect of 25ppm/IAA concentration on six months old seedling of *Butea monosperma*.

The maximum S/R length ratio (2.810 cm) was observed in 50 ppm/IAA while it is minimum (0.475cm) in 250 ppm/GA_3. In control it is 0.434cm. The number of leaves was observed higher (35) in 25ppm/IAA followed by 32 and 31 in 50 ppm/GA_3 and 25 ppm/IBA respectively while lower number of leaves (11.5) was recorded in 250 ppm/IAA. The average numbers of leaves in seedlings were show good performance in GA_3 hormone treatment, it is due to hastening of the process of leaf differentiation. Kroshmoorthy (1981) has reported that GA_3 enhances differentiation of leaves and leaf unfolding in plants. The maximum seedling length 152 cm was obtained under 25 ppm/IAA followed by 149 cm in 50 ppm/IBA and 31.8 cm. in control while it is minimum in 36.29cm. in 250 ppm/GA_3. Since application in IAA to a growing plant rarely stimulates stem elongation, though, it stimulate the growth of stem segments, it may be assumed that the stem tip normally supplies sufficient auxin to the elongation internode to maintain an optimum auxin concentration in these tissues (Wareing and Phillips, 1970). Thus with the increase in concentration of IAA, the decrease in the height may be due to inhibitory action of its supra optimal concentration.

The average total production of biomass was obtained maximum (6.730gm) in the seedling treated with 25 ppm/IAA followed by 6.634gm in 100 ppm/IBA and it is minimum in 0.637 gm in 150 ppm/IAA solution, against 1.002 gm in control. The

maximum shoot/root dry weight ratio 0.997 was recorded in 200 ppm/IBA while it is minimum (0.238) in 250 ppm/IAA.

The average moisture percentage of root was maximum 71.5% with 50ppm/GA_3 and minimum 45.01% with 250 ppm/GA_3, in control the percentage of moisture of root is 61.5%. The average moisture percentage in the shoot was maximum 79% with 50 ppm/GA_3, minimum 57% with 250 ppm/GA_3 and 67.005 in control.

Photosynthetic area of leaves was noted in the seedling treated with maximum 281 cm^2 with 150 ppm/IAA treatment and a minimum 41.55 cm^2 was obtained in 200 ppm/GA_3 treatment. The maximum average collar diameter (16.59cm.) was occurring in 25 ppm/IAA followed by 15.5 cm in 50 ppm/GA_3 and it is minimum 4.5 cm in 200 ppm/GA_3.

The pattern of shoot and root growth in different concentration of IBA did not follow any sequence. On the basis of above results with IBA treated seedling on definite conclusion could be made as the results were very much fluctuating and not show any clear cut pattern. But on the whole the average finding of growth and biomass production were comparatively better in 50 ppm.

Table-4.20 Effect of different concentrations of various growth hormone on seedlings of*Butea monosperma*

(A)

Various seedling measurement	25 ppm/IAA(H_1)			50 ppm/IAA (H_2)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	41	21	35±6.757	38	16	21±4.801
SL(cm.)	91	57	86±4.36	86	51	78±10.63
RL(cm.)	90.5	59.2	68±6	71	65	61.48± 3.863
PL(cm.)	181.5	116.2	15.2±10.17	157	116	129.48±5.493
S/R L ratio	1.504	0.884	1.816±0.394	1.686	0.836	2.810±0.751
SDW (gm.)	4.14	1.225	2.56±0.465	3.147	0.892	1.75±0.654
RDW (gm.)	5.862	2.607	3.731±1.920	4.462	2.613	1.95±0.313
PDW (gm.)	10.002	3.831	6.73±2.358	8.609	3.815	4.15±1.967
S/R DW ratio	0.706	0.471	0.696±0.342	0.705	3.41	0.898± 1.08
Collar Diameter	25	8.5	16.59±4.146	20	7.5	13.90±5.364
%M.C. in Shoot	89.507	61.180	77.07±3.924	93.676	65.81	78.08±2.92
%M.C. in Root	91.341	39.186	59±3.294	81.523	47.168	61±2.820
PSA (cm^2)	345.50	149	255.5±19.684	314.2	138	225±21.898

(B)

Various seedling measurement	100 ppm/IAA (H_3)			150 ppm/IAA(H_4)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	41`	17	19±4.018	23	20	21.5±1.540
SL(cm.)	81	47	62±2.63	83	51	66±3.7
RL(cm.)	68	61	63±2.67	85	59	61±8.2
PL(cm.)	146	108	117±6.414	168	110	137±15.25
S/R L ratio	1.245	1.90	1.940±0.284	0.976	0.864	1.013±0.817
SDW (gm.)	2.94	1.45	0.547±0.100	0.471	0.171	0.247±0.019
RDW (gm.)	1.33	1.28	0.738±0.314	0.566	0.190	0.375±0.267
PDW (gm.)	5.27	3.73	1.385±0.33	1.037	0.361	0.367±0.346
S/R DW ratio	2.210	1.132	0.794±0.317	0.832	0.90	0.696±0.449
Collar Diameter	16	4.5	8.42±3.905	15	5.5	9±3.47
%M.C. in Shoot	91.5	53	78.25±1.414	81.50	51	69±3.481
%M.C. in Root	84.51	43.230	63.519±1.573	87.73	49	61±2.483
PSA (cm^2)	357.51	147	26.5±17.678	301.51	275	28.1±4.310

(C)

Various seedling measurement	200 ppm/IAA(H_5)			250 ppm/IAA (H_6)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	15	11	1 3.44±3.135	14	10	11.5±1.05
SL(cm.)	73.50	30	63±6.00	66.45	33	51±3.5
RL(cm.)	81.50	44.5	66±16.2	71	49.5	61± 9.67
PL(cm.)	155	74-5	107±8.596	137.45	82.5	101±11.308
S/R L ratio	0.901	0.674	0.876±0.477	0.935	0.667	0.863±0.795
SDW (gm.)	0.382	0.113	0.263±0.451	0.490	0.305	0.442±0.170
RDW (gm.)	0.960	0.601	0.582±0.518	0.546	0.465	0.341±0.261
PDW (gm.)	1.342	0.714	0.854±0.699	1.036	0.770	0.908±0.331
S/R DW ratio	0.397	0.188	0.389±0.376	0.897	0.655	0.238± 0.674
Collar Diameter	9	7	6±2.01	11	5	8.09±2.727
%M.C. in Shoot	73	44.567	59±2.182	71	46.576	55±1.128
%M.C. in Root	79.582	40.715	54.01±1.03	71.325	39.168	51.38±1.28
PSA (cm^2)	153.54	123.710	132.66±5.31	151.67	121.10	141.42±5.571

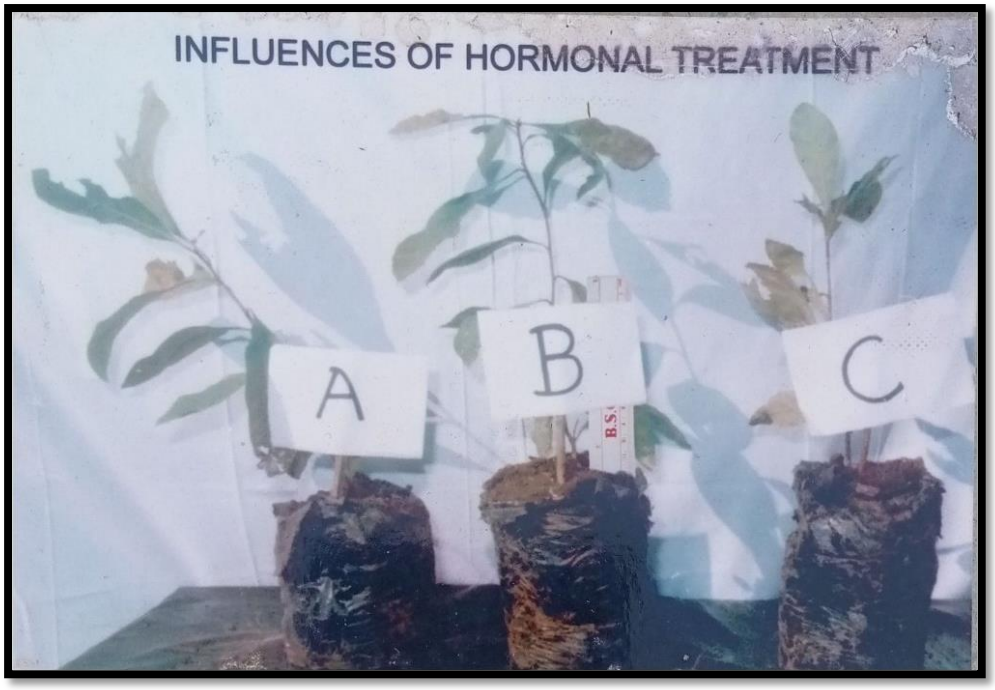


Figure No 4.11: The seedling performance of *Butea monosperma* in hormonal concentration at 50ppm/GA_3.



Figure No 4.12 : Effect of 150ppm/IAA concentration on six months old seedling of *Butea monosperma.*

(D)

Various seedling measurement	25 ppm/IBA (H_7)			50 ppm/IBA(H_8)		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	40`	22	31±7.576	38	24	29.4±3.057
SL(cm.)	94	59.25	83.4±2.6	98	61.52	66.6±2.4
RL(cm.)	90.5	53	61±7.051	92.5	59.90	69±5.02
PL(cm.)	184.5	112.25	142±11.173	190.5	121.420	149±12.65
S/R L ratio	1.038	1.118	1.749±0.987	1.059	1.027	1.25±2.305
SDW (gm.)	4.741	2.252	2.04±0.011	5.007	3.175	2.51±1.568
RDW (gm.)	5.628	3.516	2.115±0.987	4.829	2.120	1.225±1.979
PDW (gm.)	10.369	4.768	5.662±1.745	10.836	5.295	6.008±2.745
S/R DW ratio	0.842	0.895	0.689±0.549	0.733	0.697	0.747±0.647
Collar Diameter	19	6.5	11.57±3.146	21	7.5	14.62±4.898
%M.C. in Shoot	89.705	52.150	71.08±2.92	93.51	59	75.810±31.317
%M.C. in Root	89.341	69.168	51±1.249	86.314	61.25	46±2.205
PSA (cm^2)	315.512	148	255.65±19.608	309	169	256±17.816

(E)

Various seedling measurement	100 ppm/IBA(H_9)			150 ppm/IAA (H_{10})		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	30	19	21±4.5	32	14	18.5±4.750
SL(cm.)	95.52	51.25	78.8.±3.8	92.25	60.65	71.5±4.5
RL(cm.)	91.65	59.65	66.4±5.21	97	49.75	50.75±10.75
PL(cm.)	187.1	112.90	146±13.66	189.5	110.4	142.65±5.667
S/R L ratio	1.042	0.831	1.304±1.75	0.951	0.922	1.452±0.697
SDW (gm.)	4.956	2.956	2.001±1.689	4.713	2.569	2.340±0.969
RDW (gm.)	4.639	2.006	1.522±1.947	6.971	4.002	2.913±1.927
PDW (gm.)	10.595	5.962	6.634±1.547	11.684	5.571	6.01±1.648
S/R DW ratio	0.878	0.983	0.698±0.648	0.676	0.641	0.373±0.654
Collar Diameter	19.5	6	6±2.01	17	8.7	10.54±3.54
%M.C. in Shoot	91.043	54.051	72±1.371	81.951	49.65	68±1.950
%M.C. in Root	79.314	31.895	52±2.294	69	29.175	49±2.402
PSA (cm^2)	297	168.590	197±21.245	259	119.75	205±23.64

(F)

Various seedling measurement	200 ppm/IBA (H_{11})			250 ppm/IBA(H_{12})		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	29	16	31.75±3.809	19	11	13.25±2.05
SL(cm.)	69.75	45.25	60±7.56	60.5	34	41.75±4.560
RL(cm.)	89	63.75	72.2±12	66	44.75	35±3.640
PL(cm.)	158.5	109	129±14.56	126.5	78.75	97±4.572
S/R L ratio	0.783	0.648	0.775±0.630	0.916	0.759	1.151±1.742
SDW (gm.)	3.001	1.951	2.106±0.956	2.889	1.625	0.997±0.245
RDW (gm.)	3.971	1.957	2.309±0.998	3.421	1.997	2.109±1.978
PDW (gm.)	6.972	3.908	4.445±1.955	6.31	3.622	4.106±2.424
S/R DW ratio	0.755	0.996	0.997±0.718	0.844	0.813	0.553±0.128
Collar Diameter	18	6.25	8.75±2.01	10	5	8.09±2.727
%M.C. in Shoot	83	43.71	63.51±2.28	79	44.75	59.08±2.318
%M.C. in Root	71.25	39	45±2.987	65.25	31	41.197±1.833
PSA (cm^2)	205	179	191.75±11.245	198.5	67.50	89±23.025

(G)

Various seedling measurement	25 ppm/GA_3(H_{13})			50 ppm/GA_3(H_{14})		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	36	19	23±3.757	39	23	32±2.434
SL(cm.)	93	58	76.±3.370	97	68.25	81±2.630
RL(cm.)	88.25	51	71.25±5.171	91	53.75	69±7.81
PL(cm.)	181.25	109	137.25±20.451	188	122	147.75±19.44
S/R L ratio	1.053	1.137	1.67±0.997	1.065	1.269	1.319±1.574
SDW (gm.)	3.147	1.892	2.06±0.947	4.140	1.752	2.15±0.965
RDW (gm.)	3.862	1.907	2.992±1.117	5.816	2.776	3.005±1.525
PDW (gm.)	6.829	3.799	5.225±2.065	9.956	4.528	5.515±2.391
S/R DW ratio	0.854	0.992	0.849±0.680	0.712	0.631	0.747±0.676
Collar Diameter	19	7.5	12.90±3.923	23	10.5	15.52±4.364
%M.C. in Shoot	87.570	51.181	71.59±3.891	93	56.509	79±3.294
%M.C. in Root	91.314	51.571	69±3.305	89.341	46.186	71.5±2.740
PSA (cm^2)	342.5	147	219±20.625	297	191.75	227±21.848

(H)

Various seedling measurement	100 ppm/ GA_3 (H_{15})			150 ppm/ GA_3 (H_{16})		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	29	15	14.75±3.908	19	11	13.5±3.425
SL(cm.)	69	35	61±5.65	62	30.5	48±4.65
RL(cm.)	88.75	61.25	71.35±8.51	74	40.75	53±9.12
PL(cm.)	157.75	121.25	136±9.180	136	71.25	98.5±16.827
S/R L ratio	0.787	0.806	0.752±0.570	0.837	0.748	0.559±0.785
SDW (gm.)	1.121	0.957	0.556±0.124	0.997	0.787	0.659±0.125
RDW (gm.)	2.007	1.743	0.959±0.254	1.875	0.978	0.843±0.605
PDW (gm.)	1.898	1.763	1.218±0.387	2.872	0.765	1.521±0.733
S/R DW ratio	0.558	0.549	0.475±0.889	0.531	0.804	0.793±0.520
Collar Diameter	17	8.25	11.254±3.45	15	9.75	11.25±1.94
%M.C. in Shoot	81	59	174.51±1.280	90	51.5	68.5±2.251
%M.C. in Root	81.25	56	68.9±3.833	79.25	41	63±1.249
PSA (cm^2)	198.5	179	151±20.950	1387.5	91	121±24.674

(I)

Various seedling measurement	200 ppm/GA_3(H_{17})			50 ppm/ GA_3 (H_{18})		
	Max.	Min.	AV±SE	Max.	Min.	AV±SE
Total no. leaves of Seedlings	21	14	17.25±2.01	15	10	13.24±2.153
SL(cm.)	47	23.75	39±4.289	32	15.25	20.75±3.182
RL(cm.)	62	33.75	43±6.025	46	25	31.51±3.250
PL(cm.)	109	57.50	76.75±10.367	78	40.25	56.29±3.432
S/R L ratio	0.758	0.703	0.976±0.734	0.695	0.610	0.475±0.769
SDW (gm.)	0.520	0.142	0.352±0.068	0.380	0.131	0.261±0.535
RDW (gm.)	0.814	0.413	0.596±0.173	0.508	0.160	0.366±0.162
PDW (gm.)	1.334	0.556	0.976±0.242	0.888	0.321	0.628±0.28
S/R DW ratio	0.638	0.343	0.564±0.365	0.748	0.689	0.919±0.781
Collar Diameter	11	6.5	5.5±0.055	9	5	7±1.02
%M.C. in Shoot	87.383	54.425	61.114±1.64	81.864	35.576	57.070±1.182
%M.C. in Root	74.548	43.548	57.190±1.130	69.538	41.715	45.01±2.03
PSA (cm^2)	71.52	21.75	41.55±4.824	64.54	33.701	45.66±6.33

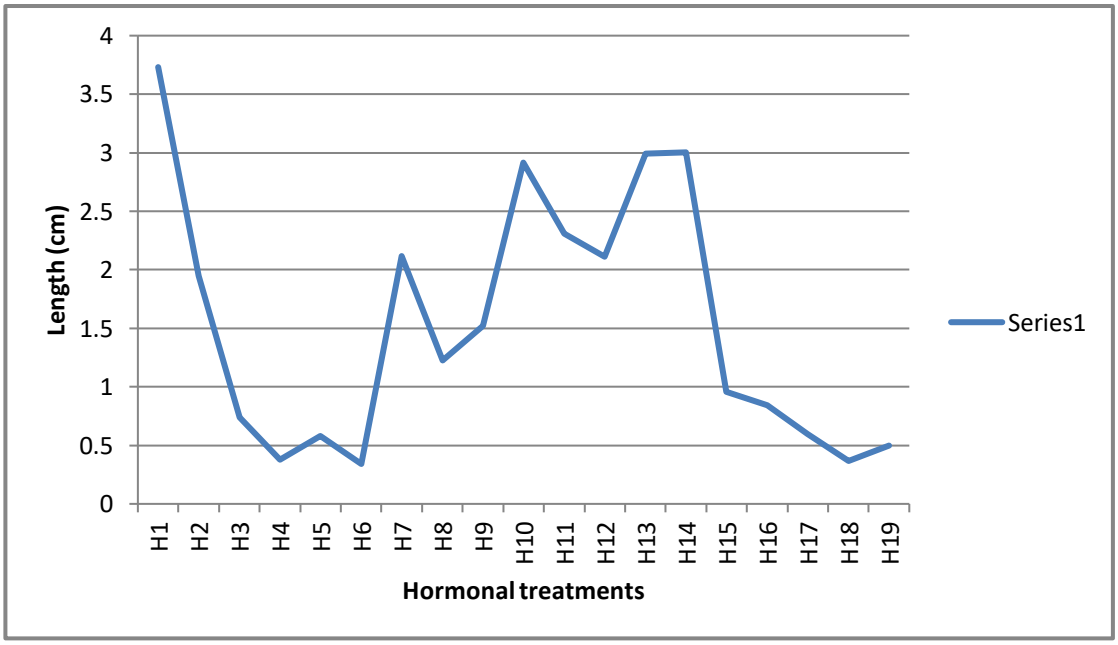
(J)

Various seedling measurement	Control condition (H_{19})		
	Max.	Min.	AV±SE
Total no. leaves of Seedlings	19	12	15.7±2.047
SL(cm.)	29.7	7.5	15.235±2.517
RL(cm.)	39.5	11	29.1±4.205
PL(cm.)	69.2	18.5	31.8±10.13
S/R L ratio	0.448	0.832	0.434±0.152
SDW (gm.)	0.520	0.180	0.415±0.168
RDW (gm.)	0.941	0.122	0.496±0.171
PDW (gm.)	1.461	0.302	1.002±0.981
S/R DW ratio	0.558	1.47	0.653±0.151
Collar Diameter	12	4.25	7.59±2.146
%M.C. in Shoot	87.833	51.548	67.005±1.64
%M.C. in Root	80.176	35.548	61.5±2.021
PSA (cm^2)	73.25	24.75	43.56±5.842

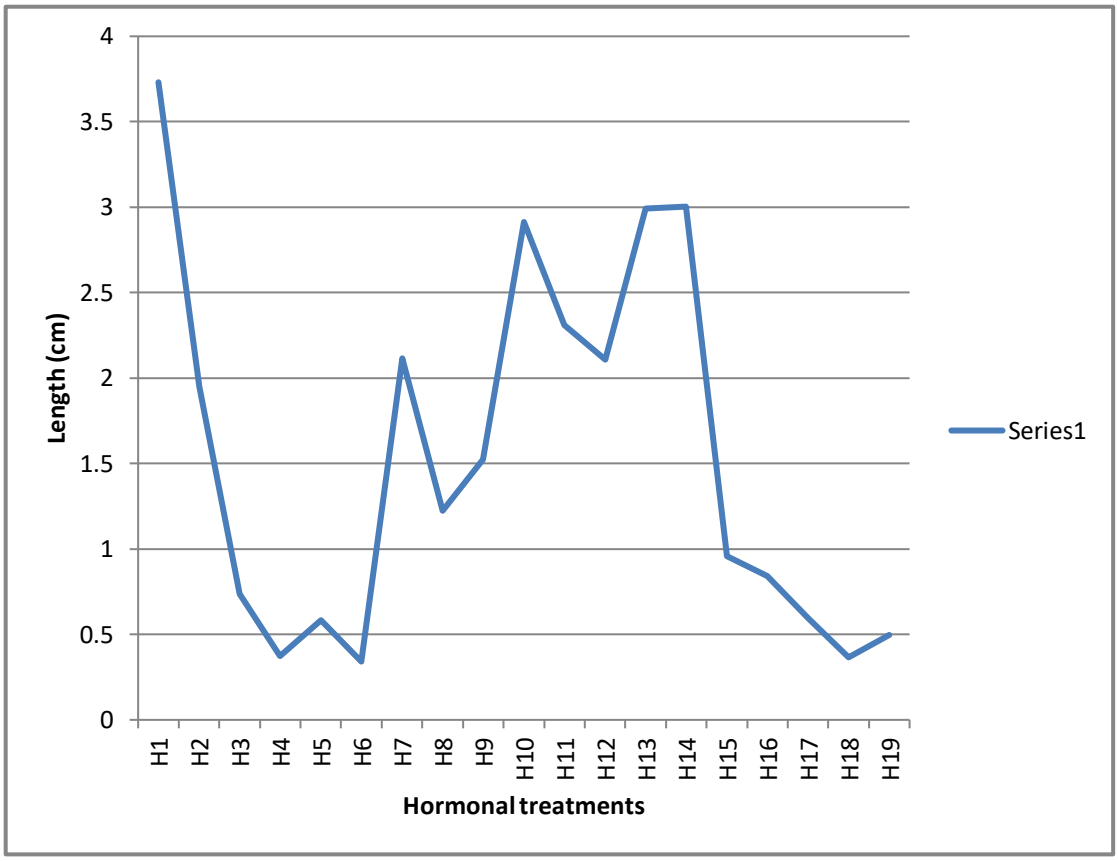
Table-4.21 Showing the value of Quality index and Sturdiness Quotient in different hormonal treatments

Treatment	QI	SQ
H_1	0.683	9.162
H_2	0.407	9.280
H_3	0.094	13.890
H_4	0.049	12.333
H_5	0.046	17.833
H_6	0.103	12.484
H_7	0.427	12.27
H_8	0.490	10.191
H_9	0.512	11.642
H_{10}	0.421	13.472
H_{11}	0.283	14.765
H_{12}	0.329	11.990
H_{13}	0.461	10.639
H_{14}	0.538	9.519
H_{15}	0.096	12.088
H_{16}	0.083	18.76
H_{17}	0.067	13.954
H_{18}	0.106	5.184
H_{19}	0.199	4.189

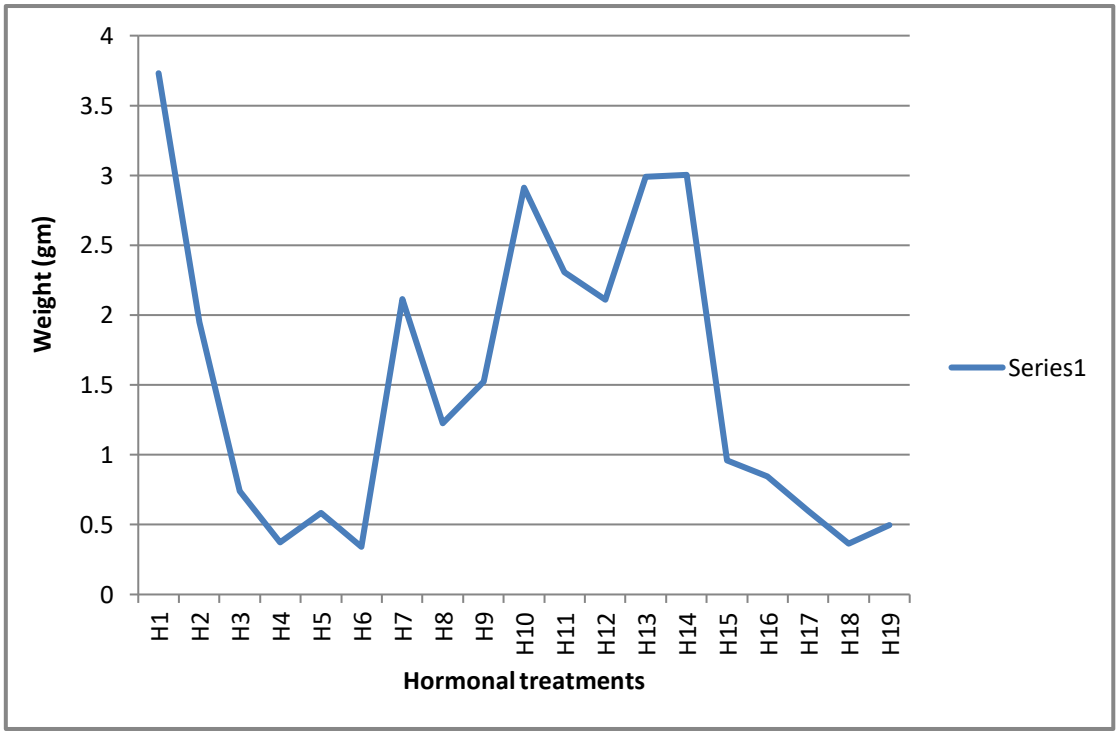
Graph-4.15: Effect of hormonal treatment on the Shoot length.



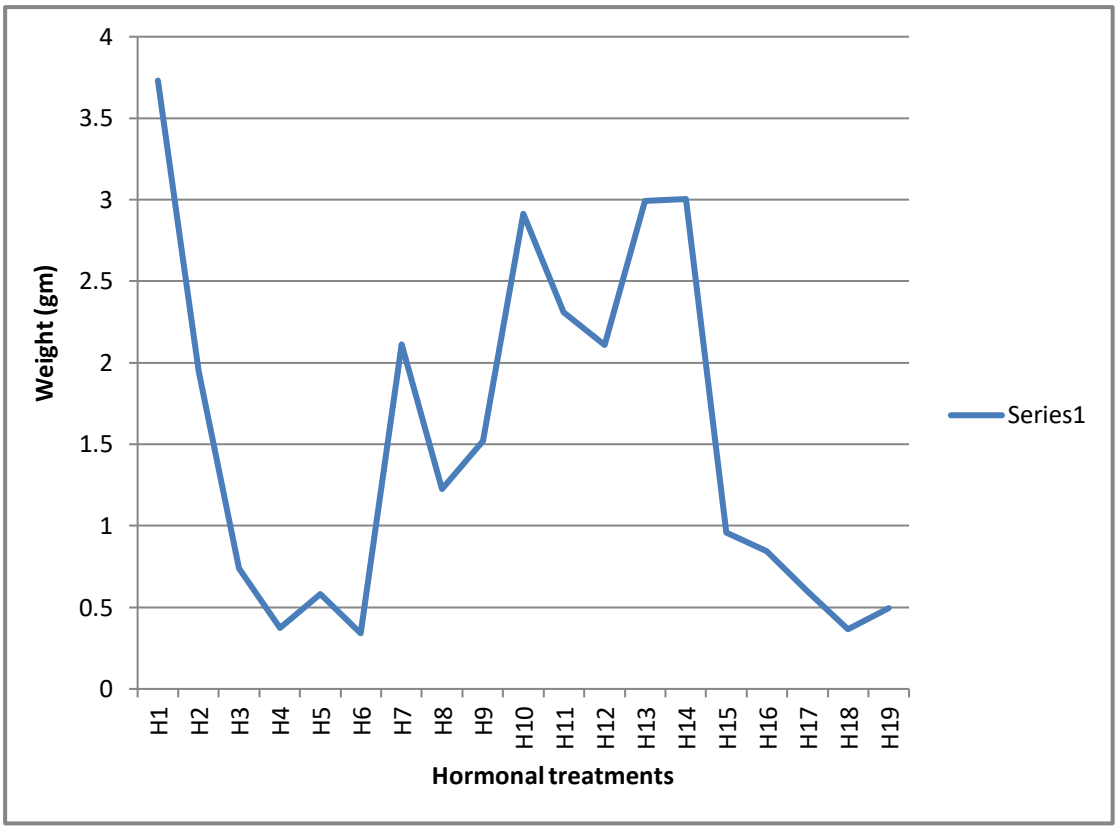
Graph-4.16: Effect of hormonal treatment on the Root length.



Graph-4.17: Effect of hormonal treatment on the Biomass production of Shoot.



Graph-4.18: Effect of hormonal treatment on the Biomass production of Root.



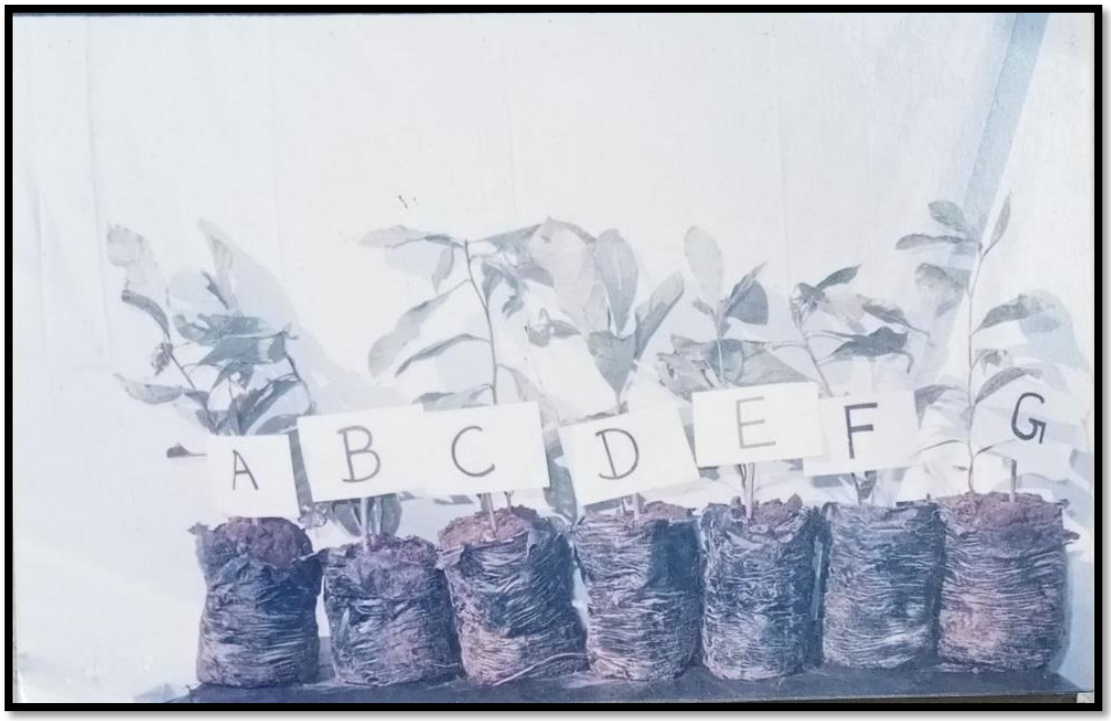


Figure No 4.13: The seedling performance of *Butea monosperma* in hormonal concentration at 100ppm/IBA.

Table- 4.22 Growth of regenerated shoots (one year old) in different lopping treatment (value based on 5 plants each) (value are Mean ±S.E.)

Growth parameter	Various number of Coppice					
	C_1	C_2	C_3	C_4	C_5	C_6
Stump C. B. H. (cm)	14.56±2.83	16.66±2.47	17.35±3.12	18.92±4.69	19.25±3.59	20.78±4.51
Coppice length (cm)	75.08±7.45	75.89±5.69	67±7.92	59±7.69	49±11.4	34.28±8.31
Base Breadth (cm)	8.24±1.30	7.91±1.70	7.34±2.63	6.27±1.04	5.96±1.59	5.55±1.29
No. of Branch	5.80±1.51	5±1.00	4.83±1.04	4.73±1.57	4.14±1.23	3.83±1.28
No. of Leaves	17.50±2.047	18.4±1.94	16.05±3.06	16.75±4.135	15.95±3.074	17±3.29
Photosynthetic area (cm^2)	119.65±21.6	115±12.31	119.78±20.82	105±14.182	96.65±12.75	89.176±11.83
Dry weight of Branch (gm)	156.00±22.02	134.62±19.96	114.69±30.56	107.46±27.73	106.66±21.38	96.46±23.35
Dry weight of Leaves (gm)	76.75±12.733	72.84±13.621	84.69±14.521	78.52±13.63	69.64±12.42	65.25±10.31
Moisture content of Branch	69.42±11.13	64.59±10.04	59.070±10.18	56.62±9.631	53.25±10.578	61.968±9.52
Moisture content of Leaves	62.98±4.29	64.89±1.70	65.65±3.31	66.31±2.837	66.24±3.154	68.29±3.121

The observation recorded for comparing the growth performance of plants raised through stem cutting after 12 months revealed that out of a total 50 branch cutting, sprouting of leaves takes place in 21, and nearly 58 percent of the cuttings were not able to sprout in semi light condition while only 5 cutting were sprout in full sun light treatment. Thus in the branch cutting sprouting behavior of leaves was better under semi-light condition (about 20 percent) as compared to open light.

This may be an influence of some environmental factors such as temperature and soil moisture that is modified to some extent in semi-shady condition. However, observation on root potential of the branch cutting was not positive. Thus, propagation of *Butea monosperma* tree by stem cutting was not suitable. Perhaps, the reasons of the experiment failed to propagate the species are that the biochemical status of the stem cuttings during different stages of rooting plays an important role in the success rate for that species.

The total sugar reduced with the rooting as it was utilized as a source of energy during root initiation. Thus, vegetative propagation through stem cutting cannot be used effectively in this species for raising orchard.

Similarly the results of root cutting were dissatisfied, since they were neither sprouted nor rooted in any observation. This may be due to the suppression of juvenile part of root cutting, which would not be able to make their way through the hard soil layer. Absence of sufficient aeration due to comparatively more water logged condition.

The data recorded on the coppice regeneration are presented in Table 4.22. A perusal of Table indicates that an average maximum length of coppice (75.08cm) was recorded in category C_1 while the minimum length 34.28cm was recorded in C_6 category. The base breadth also followed similar pattern it is maximum (8.24cm) in categoryC_1 and minimum (5.55cm) in category C_6. Total number of branch also more in C_1category. The maximum (20.78cm) cbh was recorded in C_6 category. This may be due to the more activation of starch percentage towards the C_6 category, which was higher initiation at the time of coppice cutting. The maximum dry weight (156.94gm.) of branch was recorded in C_1 category while it is minimum (96.46) in C_6 category.

The increase moisture content was observed with increase in number of coppice. The present investigation revealed that the poor performance of *Butea monosperma* was

observed when no thinning was applied. According to Ojha, *et. al.* (2008) the coppice regeneration in single individual was found better growth and biomass in *Butea monosperma*, this may be due to the devoid of struggle The observation recorded for comparing the growth performance of plants raised through stem cutting after 12 months revealed that out of a total 50 branch cutting, sprouting of leaves takes place in 21, and nearly 58 percent of the cuttings were not able to sprout in semi light condition while only 5 cutting were sprout in full sun light treatment. Thus in the branch cutting sprouting behavior of leaves was better under semi-light condition (about 20 percent) as compared to open light. This may be an influence of some environmental factors such as temperature and soil moisture that is modified to some extent in semi-shady condition. However, observation on root potential of the branch cutting was not positive. Thus, propagation of *Butea monosperma* tree by stem cutting was not suitable. Perhaps, the reasons of the experiment failed to propagate the species are that the biochemical status of the stem cuttings during different stages of rooting plays an important role in the success rate for that species. The total sugar reduced with the rooting as it was utilized as a source of energy during root initiation. Thus, vegetative propagation through stem cutting cannot be used effectively in this species for raising orchard.

Similarly the results of root cutting were dissatisfied, since they were neither sprouted nor rooted in any observation. This may be due to the suppression of juvenile part of root cutting, which would not be able to make their way through the hard soil layer. Absence of sufficient aeration due to comparatively more water logged condition.

The data recorded on the coppice regeneration are presented in Table 4.22. A perusal of Table indicates that an average maximum length of coppice (75.08cm) was recorded in category C_1 while the minimum length 34.28cm was recorded in C_6 category. The base breadth also followed similar pattern it is maximum (8.24cm) in categoryC_1 and minimum (5.55cm) in category C_6. Total number of branch also more in C_1category. The maximum (20.78cm) cbh was recorded in C_6 category. This may be due to the more activation of starch percentage towards the C_6 category, which was higher initiation at the time of coppice cutting. The maximum dry weight (156.94gm.) of branch was recorded in C_1 category while it is minimum (96.46) in C_6 category.

The increase moisture content was observed with increase in number of coppice. The present investigation revealed that the poor performance of *Butea monosperma* was

observed when no thinning was applied. According to Ojha, *et. al.* (2008) the coppice regeneration in single individual was found better growth and biomass in *Butea monosperma*, this may be due to the devoid of struggle and competition among themselves for ventilated need like, food, water, mineral and aeration etc.

Chapter- 5

CONCLUSIONS AND RECOMMENDATIONS AND FUTURE SCOPE OF RESEARH

1.1 CONCLUSION:-

In the present investigation an attempt has been made to study the Autecology and regeneration behavior of *Butea monosperma*. Which is considered to be one of the most important forest tree species of India. There is urgent need of establishment of the economically, medicinally, ornamentally important and high yielding forest product plant in possible nude areas. One of such tree is *Butea monosperma*, which is locally known as "Dhak". It is the most dominated tree luxuriantly growing on the dry eroded areas of Bundelkhand region. Its pulp is useable in halmicthic and skin cancer treatment. It is supposed to be a miscellaneous tree of various mixed forests all over India. Blending together various facts as discovered and described in the present work can draw an integral ecological picture of the species.

Bundelkhand lies at 23º 8' - 26° 30' N latitude and 78º 11' - 81° 30' E longitudes in between the Indo-Gangetic plain. Dhasan, Betwa, Chambal and Ken are the main rivers flowing within the tract.

Forest vegetation of Jhansi and Tikamgarh district and its adjoining area is the transitional between the south tropical dry deciduous type and north tropical dry deciduous type. There are three types of soil such as Mar soil, Padua soil and kabar soil. The most part of land is rocky and soil is characterized by low fertility. Surface rocks are predominantly granite of the lower pre-cambrian period. Sand stone, shales and limestone of high quality along with sills and the famous pink Archaean gneiss rocks are also found in this region.

The annual rainfall was 800.5mm and mean temperature mixture 44.2°C (May) and minimum 4.5°C (January) of the habitat of present study.

Forest is a grandest biological association of the nature predominated by the trees and other plant species. The present study deals with investigation and characterization the floristic composition and vegetation diversity of the two mixed

deciduous forests (Banguon and Orchha) of Bundelkhand region. The climate of the two forests was almost similar and can be said as semi-arid with undulating topography. The 19 trees species were found in Orchha forest while 15 trees species occur in Banguan forest. *Alangiumlamarkii* was most frequent in Banguan forest whereas in Orchha forest *Tectona grandis* appeared to most frequent. Only 8 species were found common in both forests. *Alangiumlamarkii* had the highest density (7.6 individual/hec.) on Banguan forest while highest density (18.05 individual/hec.) tree of Orchha forest was *Tectona grandis*. The community coefficient value of these forests was 53.537%, which indicates less similarity.

The Phenological behavior of 11 tree species of the stand was observed. In *Butea monosperma* the initiation of new leaves starts in the beginning of May. The initiation periods continues till the end of June after which the leaves attain their full size. The leaf-fall of the species started in winter season in the beginning of December and by the end of January about 60% leaves were shed. The tree becomes leaf less in second week of March. The flowering of the species was initiation in the month of May and completed till the end of July. The fruit initiation starts in early August and continues till October. The process of fruit maturation were started November and completed till last week of December. The fruit fall were started in January and completed till the end of March.

The most suitable time for Pod/seed collection was in March to April. Seeds were embedded in a dark brown sweet pulp. Numerous septa occur in Pod and a seed lies in between two septa. The average periphery of Pods is 7.34cm. The average area of Pods is 336cm^2. The length, breadth and weight of seed were 13.01±0.62mm, 5.56±0.23mm and 0.181 respectively.

Tetrazolium chloride was used to test the viability of seeds of *Butea monosperma*. Chemically scarified seeds were soaked in water, decoated and kept in TTC solution for 20 hours at 35ºC in dark. Very low (0.1%) concentration of TTC was used in this study. After staining, the seeds were evaluated for viability according to the staining patterns. Attempt has also been made to identify viable and non- viable categories of seeds and on the basis of staining pattern.

The effect of Pre-sowing treatment on seed germination of *Butea monosperma* was studied. The effect of mechanical scarification, sulphuric acid treatment (5, 10 and

15 minutes) and dry heat treatments at 60, 80 and 100^0C (15, 30 and 60 minutes) have also been worked out. The percentage germination of seeds was found to differ at different treatments. Seeds treated with sulphuric acid for 10 minutes show better germination (100%). Germination was higher at 60^0C dry heat incubation compared to 80^0C and 100^0C.

Seeds of *Butea monosperma*, a medicinally important ornamental tree were sown at various depths for determination of suitable depth. The Seeds were sown at six depths 1, 2, 3, 4, 5, and 10cm. The soil depth at 2cm is most suitable for germination. In 2cm higher germination were recorded (80%), however, further increase in depth beyond D_2 to D_6 a decrease in percentage germination was found.

The concentration of Leaf-leachate and leaching hours seem to harmful effect for germination of *Butea monosperma* seed. Negative allelopathic were occurring. The maximum germination percentage (65%) was found in 25gm leachate dissolve 500ml solution for 24hr.

Different duration of Imbibition effect the germinative capacity of seeds, which can be attributed to be increased hydration initiating metabolic activities in embryos of seeds. The average maximum imbibition was observed in forty-eight hours. The duration of imbibitions also increased the percent germination.

Growth performance of six month old seedling of *Butea monosperma* observed in different potting media. It was found better in Sand + Black (1:1 ratio by volume) followed by Red +Black (1:1 ratio by volume) than any other mixture. In the mixture Red + Padua +Sand (1:2:1) no seedlings could grown.

The average growth seedling remained higher under 45 percent light condition followed by 100 percent and 20 percent light. This behavior may be due to the moderate humidity and favourable microclimatic conditions under 45% light, it appears that this tree species is shade loving during early phase of growth.

The regime of daily irrigation was found to be most suitable for the growth of seedlings, while the other irrigation do not show the appreciable results, hence the species can grow well on soil with moderate moisture.

The lower concentration of IAA shows best height of the seedling whereas the maximum dry matter production was found in 25ppm/IAA, followed by 50ppm/GA_3. The pattern of shoot and root growth in different concentration of IBA did not follow any sequence.

Silviculture treatment following silviculture experiment was as follows.

1- Branch cutting.
2- Root cutting
3- Coppice regeneration study

In silviculture treatment it has been concluded that none of the branch cutting were able to initiate rooting. Sprouting of leaves nearly 42% in semi-shady (about 20 percent light) condition and while in full sunlight only 5 cutting were sprout. In root cutting treatment they were sprouted nor the root initiated. Hence the experiment with root cutting was found to be negative.

The silviculture methods of coppice regeneration seems to be the most economical and of much practical utility. It is important to note the cattle do not eat it and hance havily grazed areas coppice shoots of *Butea monosperma* remain untouched. The best growth and biomass of coppice was observed when a single coppice is left per stump.

It shows the decreased trend with increasing number of left coppice. In the absence of thinning it shows the poor performance. Hence, to obtain the maximum yield of this species the thinning may be recommended particularly with coppice regeneration.

5.2 RECOMMENDATION:-

5.2. 1 Large-Scale Forest Restoration & Reforestation

The autecological insights can be applied for reforestation of degraded lands and dryopical forests using Butea monosperma Development of site-specific plantation models based on soil type, moisture regime, and light requirements of the species.

5.2.2. Optimization of Nursery Techniques

Standardization of seed germination protocols, pretreatments, and sapling management for mass propagation.Establishment of high-survival plantation packages for forest departments and nurseries.

5.2.3. Conservation of Genetic Resources

Scope to develop ex-situ conservation strategies such as seed banks, clonal banks, and tissue culture storage.Identification and conservation of elite, high-yielding germplasm of Butea monosperma.

5.2.4. Enhancement of Medicinal & Economic Uses

Possibility to study how ecological conditions influence phytochemical properties and resin (lac) production.Development of commercial cultivation models for pharmaceutical, ayurvedic, and dye industries.

5.2.5. Understanding Climate Change Impacts

Long-term ecological monitoring for assessing climate tolerance, drought resistance, and adaptability of the species.Predictive climate suitability mapping for future habitat distribution.

5.2.6. Support for Sustainable Livelihoods

Promotion of Butea monosperma-based agroforestry systems to enhance income of local communities.Training and entrepreneurship in lac cultivation, seed oil extraction, and plant-based products.

5.2.7. Soil Fertility & Ecosystem Services

Further studies on nitrogen-fixing potential and soil-restoring ability of the species.Application for erosion control, carbon sequestration, and biodiversity support.

5.2.8. Scope for Biotechnological Interventions:Genetic improvement studies on:

High-growth genotypes, Disease-resistant types, High-resin producing variants, Application of tissue culture and micropropagation for large-scale multiplication.

5.2.9. Policy & Management Recommendations

Data can assist in developing:Conservation action plans for Butea-dominated forests, Forest and agroforestry policies for semi-arid regions,Nursery and plantation guidelines for government & NGOs

The present research on the autecological exploration of Butea monosperma, with special reference to nursery growth and regeneration behaviour, provides a strong scientific basis for several future ecological, silvicultural, and socio-economic applications. The findings of this study can be effectively utilized in forest restoration and rehabilitation programs, particularly in degraded, dry, and semi-arid tropical regions where Butea monosperma exhibits high adaptability. Species-specific ecological requirements identified in the study can guide site selection, plantation planning, and long-term management of restored forest ecosystems.

The standardized nursery techniques developed through this research offer significant scope for large-scale plantation and afforestation initiatives. Further refinement of seed pretreatment, germination enhancement, and seedling management practices can improve survival rates and growth performance in field conditions. These protocols may be adopted by forest departments, social forestry units, and private nurseries to ensure quality planting material for restoration projects.

The study also opens avenues for conservation of genetic resources. Identification of ecologically superior and fast-growing genotypes can support ex-situ conservation strategies such as seed banks, clonal repositories, and future breeding programs. Long-term monitoring of natural populations may help in understanding population dynamics and sustaining genetic diversity under changing environmental conditions.

In the context of climate change, the autecological data generated can be extended to assess drought tolerance, temperature resilience, and adaptive potential of Butea monosperma. This will aid predictive modeling of species distribution and suitability under future climatic scenarios, strengthening climate-resilient forestry planning.

The research further holds promise for enhancing the medicinal, economic, and industrial value of Butea monosperma. Studies linking ecological conditions with

phytochemical variability can support sustainable exploitation for pharmaceutical, dye, lac, and non-timber forest product industries. Cultivation-based production systems may reduce pressure on natural populations.

Additionally, the species shows immense potential in agroforestry and rural livelihood enhancement. Integration of Butea monosperma into farming systems can improve soil fertility, support lac cultivation, and generate alternative income sources for local communities, contributing to sustainable development goals.

Future investigations may also involve biotechnological approaches, including tissue culture, micropropagation, and molecular characterization, to facilitate mass multiplication and genetic improvement. Overall, the present study serves as a foundational framework for sustainable forest restoration, biodiversity conservation, ecosystem service enhancement, and policy-oriented forest management involving Butea monosperma.

5.3 FUTURE SCOPE OF RESEARCH:-

5.3.1 Physiological and Ecophysiological Studies:-

Detailed analysis of photosynthesis, transpiration, and water-use efficiency under varying environmental conditions. Study of plant response to abiotic stresses such as drought and temperature extremes.

5.3.2 Soil Microbial Interactions

Investigation of the role of mycorrhizal associations and rhizosphere microbes in nutrient uptake and seedling establishment (Verma et al., 2021).

5.3.3 Climate Change Studies

Long-term monitoring to assess the impact of climate variability on phenology, germination, and regeneration patterns.

5.3.4 Genetic Improvement

Studies on genetic diversity using molecular markers for identification of superior genotypes. Development of improved varieties with higher adaptability and growth performance.

5.3.5 Advanced Propagation Techniques

Standardization of tissue culture and micropropagation protocols for large-scale multiplication. Use of plant growth regulators (PGRs) to enhance germination and seedling growth.

5.3.6 Landscape Ecology and GIS Applications

Use of remote sensing and GIS tools for mapping species distribution and habitat suitability.

5.3.7 Role in Ecosystem Restoration

Evaluation of its potential in carbon sequestration and ecological restoration of degraded ecosystems.

Traditional plant knowledge and cultural understanding are the focus of ethnobotany. Plant linguistics is an interdisciplinary field that studies the many facets of human plant interaction, including language, literacy, medicine, nutrition, archaeology, economivs and more. Therefore, ethnobotany may be used as an entry point to other fields of study. Given everything were covered so far, it should come as nbo surprise that ethnobotany is a branch of study that draws other disciplines and has many varied application. Thus, there is a vast opportunity to examine the relevance of ethnobotany in the face of contemporary prigress and to provide them a specific task, which should involve.

The current research has the potential to play a pivotal role in the future for the protection of biological variety and long term economic growth. In this way, knowledge about regional flora may be preserved, restored and disseminated. Floristic innovations and assessments of conservation circumstances for different plant species benefit from this.

BIBLIOGRAPHY

Aahfaq Nazir, Riffat Naseem Malik and Muhamamd Ajaib (2012). Phytosociological studies of thje vegetation of sarsawa Hills District Kotli, Azad Jammu and Kashmir. *Biologia, Pakistan*, 58 (1 &2): 123-133.

Abu-a sab, Peterson Pm, Shelter ASG and Orli S. S. (2001). Earlier plant flowering in spring as a response to global warming in the Washington. DC. Area. *Biodoversity and conservation.* 10: 597-612.

Ademire, M. O. and Oladede, R. N. (1991). Effect of IBA on the growth of *Leucaena leucophala* seedlings. *Nigerian J. For*., 21(1-2): 22-24.

Agarwal, P. K and Kaur, S. (1975). Standardization of the tetrazolium test for Ragi (*Elusinecorocana*) seeds. *Seed Sci. and Technol*., 3: 556-568.

Agarwal, R. L. (1995). Seed techonology. Oxford and IBH Publishing Co. New Delhi.

Agarwal, R. P., Bajpai, S. P. and Tiwari, Pradeep (1996). Effect of depth of sowing on growth and survival of ten species of forest tees. *J. Trop. For*., 12(III): 151-155.

Agboola, D. A. (1995). The effect of storage condition and soil depth on the longevity and germination of seeds of *Prosopis africana* (Guill and Perr.) Toub. *J. Trop. For*. 11(II): 115-120.

Agboola, D. A. and Adedire, M. O. (1998). Response of treated dormant seeds of three tropical tree species to germination promoters. *Nigerian J. Bot.*, 11: 103-110.

Ahlgren, C. E. (1981). Some effects of different forest litters on seed germination and growth. *Can. J. For. Res*., 11(3): 710-714.

Ahmad, I., Ahmad, M.S.A., Hussain, M., Ashraf, M., Ashraf, M. Y., and Hameed M., (2010). Spatiotemporal aspects of plant community structure in open

scrub range lands of submountainous Himalayan plateaus. *Pakistan J. Bot.*,2 (5): 3431-3440.

Ahuja, M. R. (1986). Perspectives in Plant bio-techonology. *Curr. Sci.*, 55(5): 217-224.

Ajaib, M., Khan, Z. and Siddiqui, F. M. (2012). Ethnobotanical studies on useful climbers of District Kotli, Azad Jammu and Kashmir, *Int. J. Biol, and Biotech*., 9(4): 421-427.

Ajaib, M., Khan, Z., N. and wahab, M., (2010). Ehanobotanical studies on useful shrubs of Districkotli, Azad Jammu and Kashmir, Pakistan. *Pak. J. Bot*., 42(30: 1407-1415.

Ali, M., Akhter, S. and Kamaluddin, M. (1997). Study on the bearing of Hot water treatment on seed treatment and seedling growth of *Albizia procera* (Benth). *Indian For*., 123(8): 764-768.

Allen, M. B. and Arnon, D. J. (1955). Studies of nitrogen fixing blue green algae-II. The sodium requirement of *Anabaena cylindrical*. *Physiol. Plant*, 8: 653-660.

Annapurna, D., rathore, T.S. and Joshi, G. (2007). Effect of Potting media ingredients and sieve size on the growth of seedlings of Sandalwood (*Santalum album* L.) in root trainers. *Indian For*., 133(2): 171-188.

Ansari, A. A. and Bhadola, G. N. (1989). Phenological observation of some woody angiosperms of Pouri Garhwal, *Indian J. For*., 12: 21-24.

Anthony, J. and Cheyeom, F. (1969). Observation on the growth and development of *Pinus cribaea* Mor. Seedling grown in various potting mixtures, *Matay Forester*, 32(3): 303-328.

Arjunan, M. C. and Ponnammal, N. R. (1993). Studies on Phenology and nursery technology of certain tree species. *Indian Bot. Contract*, 10: 147-150.

Arjunan, M. C., Tamil Selvi, M. and Lakshmanan, K. K. (1995). Phenology of some woody angiosperms of Coimbatore district. *Ann. For*., 3(1): 45-52.

Arya, S., Tomar, R. and Toky, O.P. (1994). Effect of plant age and auxin treatment on rooting responses in stem cutting of *Prosopis cineraria. J. Arid Environ*., 27 (!): 99-103.

Aswathanarayana, S.C., Mahadevappa, M., Raddy, Y.A.N. and Kurdikeri, M.B. (1993). Effect of shade on germination and seedling growth in few tropical tree species. *J. Tro. For*., 9(IV): 315-322.

Athaya, C. D. and Mishra, G. P, (1981). Notes on the forest flora of central India III. *Bull. Bot. Soc.*, Univ. Saugar, 28: 66-70.

Attri, P. K., Kumari, D. and Kumar, Aman (2022). Evaluation of Phenological variation in response to climate change: with special references to *Rhododendron arboreum* and *Quercus leucotrichophora*, Shimla, Himachal Pradesh, India. *International Journal of Environmental Sciences.* 11(4): 103-109.

Awang,K. and Hamzah, Mohd. Basri (1986). Effect of potting mixture and fertilizers on the growth of *Acacia mangium*wold seedlings, *Malaya appl. Biol*. 15(1):31-42.

Babeley, G. S. and kandya, A. K. (1986). Use of TTC for rapid testing of the viability of *Lagerstroemia parviflora* (Roxb.) seeds. *J. Tro. For*., 2(III): 226-231.

Babeley, G. S. and kandya, A. K. (1990). Use of Tetrazolium chloride for testing the viability of some tropical forest tree seeds-II., *J. To. For*., 6(IV): 341-349.

Badeck, F. W., Bondean, A., Bottchger, K., Doktor, D., Lucht, W., Schaber J and Sitch, S. (2004). Responses of Spring Phenology to climate change. *New Phytologist* 162: 295-309.

Badola, K. C., Pal, Mohinder and Bhandari, H. C. S. (1993). Vegetative propagation of Rangaigan (*Solanum torvum* SW.) by rooting branch cuttings. *Indian For*., 119(2): 1027-1028.

Bagchi, S. K., Joshi, D. N. and Rawat, D. S. (1990). Variation in seed size of *Acacia* sp., *Silva Ganet*., 39: 107-110.

Bahar, Nawa and Naithani, K. C. (2006). Effect of Pre-sowing treatment on germination of *Acacia concina* DC. Seeds. *Ann. For*., 14(2): 222-225.

Bahar, Nawa and Singh, V.R.R. (2007). Influence of media on germination and vigour of *Mesua ferrea* (Linn.). *Indian For*., 133(11): 1475-1480.

Bahuguna, V. K. and Lal, Pyare (1990). To study the effect of environment and different soil mixture on germination of *Acacia nilotica* seeds at nursery stage. *Indian For*., 116(2): 474-478.

Bahuguna, V. K. and Lal, Pyare (1991). Effect of shade and mulch on germination of *Toona ciliate. Indian For.,* 116(7): 942-945.

Bahuguna, V. K. and Lal, Pyare (1992). Standarisation of nursery technique (sowing method, optimum irrigation schedule and effect of shade and Mulch) of *Celtis australis* Linn. Under Dehradun climate condition. *Indian J. For.,* 15(4): 313-316.

Bakshi, T. S. (1952). The effect of preliminary period of darkness on the percentage of seed germination of *Anthoshiluscriocephalus* Benth. *Curr. Sci*., 21: 108.

Bakshi, M., Thakur, K. S. and Kumar, S. (2007). Clonal variation in regeneration of shoots after hedging in vegetative multiplication garden of *Dalbergia sissoo* (Shisham) Roxb. *Indian For*., 133 (1): 101-107.

Bakshi, M., Thakur, K. S. and Kumar, S. (2007). Clonal variation in regeneration of shoots after hedging in vegetative multiplication garden of *Dalbergia sissoo* (Shisham) Roxb. *Indian For*., 133(1): 101-107.

Balaji, B. and Nitant, H. C. (2002). Phytosociological studies of Yamuna ravines. *Range Mgmt. and Agro*., 23 (2): 110-114.

Balasubramaniam, P. and Bole, P. V. (19930. Fruiting phenology and seasonality in tropical evergreen forest in Pt. calimere wildlife Santuary. *J. Bambay Nat. Hist. Soc.,* 90: 163-177.

Bannerjii, U.K. (1998). Germination of *Melia azedarach* seeds with IAA, IBA, GA_3., *Indian For*., 124(3): 220-223.

Baruah, P. P. (2003). Phytosociological account of Macrophytes of a disturbed lentic habitat in Middle Assam. *Ann. For*., 11 (1): 27-36.

Beniwal, B. S. (1987). Phenological study of trees in Arunchal Pradesh. *Indian For*., 113: 779-*791*.

Beniwal, B. S. and Dhawan, V. K. (1991). Standardization of nursery techniques (Use of different germination media and watering method) of *Anthocephalus chinensis. Indian For.*, 117(1): 105-109.

Beniwal, B. S., and Singh, N. B. (1990). Observation on flowering fruiting and germination behavior of some useful plant of Arunchal Pradesh. *Indian For*., 116 (2): 216-227.

Bewley, J. D. and Black, M. (1978). Imbition, Germination and Growth. In: *Physiology andBiochemistry of seeds in relation*. Vol-I *springer verlin Heild Elberg*., New York.

Bhagat, Ranjana (1994). Effect of temperarure on the Acacia catechu seeds treated with Gibbellic acid (GA_3). Ad. Plant Sci., 7(1): 173-176.

Bhagat, S., Singh, O. and Singh, Virendra (1993). Effect of seed weight on germination, survival and initial growth of Horse chestnut (*Aesculus indica*, Colebr) in the nursery. *Indian For*., 119(8): 627-629.

Bhardwaj, D. R., Verma, Nitin and Bhardwaj, N. R. (2004). Effect of harvest time and Pre-sowing treatment on germination behavior of Axle wood (*Anogeissus latifolia* Wall.) seeds. *Indian J. For*., 27(1): 89-93.

Bhardwaj, S. D. and Chakraborty, A. K. (1994). Studies on time of seed collection, sowing and Pre-sowing seed treatment of *Terminalia bellirica*Roxb. and *Terminalia chebula* Retz., *Indian For*., 120(5): 430-439.

Bhardwaj, S. D., Chakraborty, A. K. and Joshi, N. K. (1993). Vegetative propagation of *Terminalia bellirica*Roxb. and *T. chabula* Retz. By stem cuttings. *Indian For*., 119(5): 360-366.

Bhargava, O. P. (1951). *Anogeissus pendula* in madhya Bharat. *Proc. VIII Silvi. Conif, Dehradun*.pp. 490-491.

Bhatnagar, H.P. (1965). Studies on growth behavior of Sal (*Shorea robusta*) seedlings in different Sal forest soils. *Trop. Ecol.*, 6: 141-151.

Bhatnagar, H.P. and Singh, U. (1981). Effect of growth regulators on growth development of *Acacia nilotica* seedlings. *Van Vigyan J. Soci.*, 19: 129-135.

Bhatnagar, H.P. and Talwar, K. K. (1978). Studies on the effect of growth regulators on growth and trachidescharcter of *Pinus caribea* seedlings. *Indian For.*, 104: 333-354.

Bhatnager, S. (1968). Ecological studies of forests of Sagar with special references to litter and ground flora. *Ph. D. Thesis*, SaugarUniversoty, Saugar.

Bheemaiah, G. (2004). Effect of irrigation and fertilizer application on growth of Teak (*Tectona grandis*) in semi-arid regions. *Indian For.*, 130(11): 1311-1315.

Bheemaiah, G., Subrahmanyam, M.V.R. and Ismail, Syed (1997). Performance of Teak under different irrigation and fertilizer management practices. *Indian For.*, 123(12): 1171-1175.

Bisht, P. S. and Kediyal, V. K. (1995). Effect of chemical treatment on germination and survival of the seedlings in *Atropa belldoma* (Linn.), *Indian J. For.*, 18(3): 208-210.

Bisla, S. S., Nandal, D. P. S. and Narwal, S. S. (1992). Influence of aqueous leaf extracts of *Eucalyptus* and *Popular* on the germination and seedling growth of winter crops. In: *Proceedings forst national Symposium on Allelopathy in Agro Ecosystem. (Eds. P. Tauro and S. S. Narwal). Indian Society of Allelophy, Haryana Agricultural University,* Hisar, India, pp. 95-97.

Boes, T. K. and Strauss, S. H. (1994). Floral Phenology and morphology of black cotton wood, *Populastrichocarpa* (Saliacaceae). *Amer. J. Bot.*, 81: 562-567.

Boojh, R. and Ramakrishan, P. S. (1981). Phenology of trees in a Sub-tropical evergreen Montana forest in North-East India. *Geo-Eco. Tro,* 5: 189-209.

Brahman, M. (1996). Effect pf Pre- sowing treatment for hasenening the germination of *Enterobiumcyclocarpum* (Jacq.) Griseb. And *Hymenaeacourbaril* (L.). *Indian For.*, 122(8): 740-745.

Bush, J.K. and Auken, O.W.V. (1987). Light requirement for growth of *Prosopis glandulosa* seedlings. *Southwestern Naturalist* 32: 469-473.

Chacko, K. C., John, S. K. and Asokan, S. M. (1997). Evolution of some pre-sowing treatment for germination of Teak (*Tectona grandis* Linn. F.) fruits, *Ann. For*., 5 (1): 55-61.

Chakrabarti, K., Zaidi, A. and Barari, S. (1998). Compost for container nursery- A west Bengal experience. *Indian For.*, 124 (1): 17-30.

Chakrawarti, A. K. and Verma, C. M. (1968). Germination of promising desert grass seeds under different depths of sowing in sandy soil. *Ann. Arid Zone*. 7: 75-81.

Champian, H. G. and Griffithe, S. L. (1948). Manual of General silvicultural for. India Oxford Univ. Press.

Champian, H. G. and Seth, S. K. (1968).General silvicultural of India *Gove. Ind. Publ. Br. Deptt. Print. Stationary*. Delhi-6.

Chandra, J. P. and Ram, A. (1980). Studies on depth of sowing Deodar (*Cedrus deodara*) seed. *Indian For*., 106: 852-855.

Chandra, J.P. and Chauhan. P. S. (1976). Note on germination of Spruce seeds with Gibberellic acid. *Indian For*., 102(90): 721-725.

Chatterji, U. N. and Mohnot, K. (1968). Ecophysiological investigations of seeds of *Prosopisjuliflora* Linn. In: R. Mishra and B. Gopal (Ed.) *Proc. Symp. Recent Adv. Trop. Ecol*., 261-268.

Chaturvedi, N. (1993). Ecophysiological study of *Lagerstroemia parviflira* (Roxb.), *Ph. D.Thesis, Bundelkhand Univ*., Jhansi (U.P.).

Chaturvedi, N., (1992). Ecophysiological study of *Lagerstroemia parviflora* (Roxb.), *Ph. D. Thesis*, Bundelkhand Univ., Jhansi (U. P.).

Chaturvedi, O. P. and das, D. K. (2004). Effect of seed drying, storage and Pre-treatment on the germination and growth of *Acacia auriculiformis* and *Acacia nilotica* seedlings. *Indian J. For*., 27(1): 75-81.

Chaturvedi, S. K. and Bajpai, S. P.(1999). Effect of light condition in Root, shoot and Plant length of selected forest tree species. *Indian For*., 125(7): 725-729.

Chhangani, A. K. (2004). Flowering and fruiting phenology of plant of a dry deciduous forest in the Aravalli Hills of Rajasthan, India. *Indian For*., 130 (7): 771-784.

Chhangani, A. K. (2004). Leaf Phenology of plants of a dry deciduous forest in the Aravalli Hills of Rajasthan, India. *Indian For*., 1301(10): 1095-1104.

Chhetri, R., Kumar, P. and Megha (2020). Phenological trends of tree species of forest Research Institute Dehradun, India. *Research J. of Agriculture and forestry Sciences*. 8(2): 1-8.

Chhilar, S., Hooda, M. S. and Chopra, D. (2002). Seed source variation in *Acacia nilotica* (L.) WillD, Es. DEL. *Indian J. For*., 25(2): 150-153.

Chien, C. T., Plao, L.T. and Lin, T. P. (1999). Effect of moisture content and temperature on the storage and germination of *Cinnamomum camphora* seeds. *Seed Sci. and Technol*., 27(1): 315-320.

Cilliers S. S., Bredenkamp G. J. (2000). Vegetation on road verges on an urbanization gradient in Potchefstroom, South Africa. Landsc. Urban Plan 46: 217-239.

Cole, D.W., Ford, E.D. and Turner, J. (1990). Nutrient, Moisture and productivity of establishment forest. *For. Ecol. Manage*., 30: 283-297.

Correia, M. J., Coehlo, D. and David, M. M. (2001). Response to seasonal drought in three cultivars of *Ceratonia siliqua*; Leaf growth and water relations. *Tree physiol.*, 21: 645-653.

Cromer, R. N., Tompkins, D. and Barr, N.J. (1984). Irrigation of *Pinus* radiate with waste water: Tree growth in response to treatments. *Australian For. Res*., 14: 57-65.

Curtis, J. T. and Cottam, G. (1956). Plant Ecology work book. Laboratory field references manual. *Burgess Publishing* Co., Minneapolis, Minn. U. S. A.

Curtis, J. T. and Cottam, G. (1962). Plant Ecology work book. Laboratory field references manual. *Burgess Publishing Co*., Minneapolis, Minn. U. S. A.

Curtis, J. T. and McIntosh, R. P. (1950). The intertelations of certain analytic and synthetic phytosociological characters. *Ecology*, 31: 434-455.

Dadhwal, K. S. and Singh, Bijendra (1992). Effect of normal soil mixture on *Leucaena leucocephala* (Lamk.) de Wit. In minespoil of outer Himalayas of Utter Pradesh. *Indian For*., 118(3): 234-236.

Dadhwal, K. S., Singh, Bijendra and Naraian, Pratap (1993). Studies on placing Mixing of a normal soil in Limestone mine spoil on the performance of two species. *Indian For.*, 119(12). 1011-1019.

Dani, H. P., Pati, D. P., Basu, S. and Behera, N. (1991). Phytosociological analysis of forest vegetation of Kantamal region, Orissa. *J. of Tropical For*., 7(II): 151-158.

Das, A. P. and lahiri, A. K. (1997). Phytosociological Studies of the ground Flora in different types of vegetation on Tiger hill, Darjeeling District, West bangal. *Indian For*., 123(12): 1176-1187.

Dash, M.C. (2001). Fundamental ecology. Tata MeGraw-Hill, New Delhi. Pp.195.

Daubenmire, R. (1947). Phenology and other characteristics of tropical semi-deciduous forest in north-western Costa Rice. *J. Ecol*., 60: 147-170.

Daubenmire, R. (1947). Plants and environment wiley eastern Pvt. Ltd., New York.

Dave, D. N. and Jain, B. K. (2009). Allelopathic effect of *Chenopodium album* L. on in vitro seed germination of *Triticum aestivum* L. *J. Indian Bot. Soc*., 88(1&2): 191-194.

Devi, S. P. and Singh, P. K. (2007). Floristic analysis and Distribution of Rattan in Manipur as a Sustainable bioresource. *Indian For*., 133 (6): 805-812.

Dhar, D.W., Singh, D.P., Meshram, S.U. and Wattal, P. N. (1992). Nursery practices for raising *Leucaena* seedlings. *Indian J. For*., 15(!): 71-72.

Dickson, A. A., Leaf, L. and Hosner, J.F. (1960). Quality appraisal of white spruce pine seedlings stock in nurseries. *Forestry Chronicle*., 36: 10-13.

Dube, P. (1991). Ecophysiology of some important tropical forest tree seeds *Ph.D. Thesis. Dr. H.S. Gour Univ*., Saugar.

Dutta, G. and Devi, A. (2015). Phenology and Population study of six tree species in tropical forest of Assam, Northeast India. *Tropical Ecology*, 56(3): 393-399.

Dwivedi, A. K., Singh, P. N. and Samuel, C. O. (2015). Phenological Attributes of Angiospermic Flora in a Riverine wetland of Gorakhpur. *J. of ecology*. 4(2): 1-11.

Eavis, B. M. and Payne, D. (1969). Soil Physical conditions and root growth. In root growth (Ed., W.J. Weittington) Buttrworths. London.

Edofin, A.O., Agboola, D. A..Aduradola, A. M. and Ayodela, M. S. (2004). Effect of some growth hormone on seed germination and seedling growth of some savanna tree Legumes. *Indian For*., 130(11): 1241-1249.

Fabian, P., Menzel, A., Karjalainen, T., Spiecker, H. and Laroussinie (1999). Changes in Phenology of trees in Europe. *Proc. Intl. Seminar*, Nancy, France, 27: 43-51.

Fasidi, I. O., Samani, E.R.T., Kadiri, M. and Afboola, D. A. (2000). Studies on growth inhibitors and promoters in dormant and germinating seeds of *Parkia biglobosa. Nigerian J. Bot*., 13: 89-95.

Fenner, M. (1998). The Phenology of growth and reproduction in Plants. Perspectives in Plant ecology, *Evolution and Systematics* 1: 78-91.

Funk V., Hollowell T., Berry P., Kelloff C. and Alexander S. N. (2007). Chechlist of the plants of the Guiana shield, *Contributions from the United States National Herbarium*, 55: 1-84.

Furguson, J. M. and Turner (1971). Influence of unfilled cotton seed on emergence and vigour. *Crop Sci*., 11: 713-715.

Galav, P. K., Katewa, S. S., Chaudhary, B. L. and Jain, Anita (2005). Phytosociological studies on the grassland community of Southern aravalli Hills of Rajasthan. *Indian For*., 131 (7): 943-952.

Gargya, G. R., Sharma, A. K. and Vasistha, H. B. (1998). Phytosociological analysis of some sub-alpine and region of garhwal in relation to Nardostschys Jatamansi DC. *Ann. For*., 6 (2): 213-220.

Gaur, R. D. (1982). Dynamics of vegetation pp. 12-15. The vegetational wealth of the Himalayas (ed. G. S. Paliwal) Delhi.

Gaur, R.D. and Sharma, C. M. (1985). Morphology, viability and effect of growth regulators on the germination and Tude growth of *Prunus cerasoides* D. Don. *J. Tree Sci*.,4(1): 30-33.

Gautam, J. and Bhardwaj, S. D. (2001). Effect of seed size anr Pre-sowing treatment of Ban Oak (*Quercus leucotrichophora*). *Indian J. For*., 124(3): 311-315.

Gera, Neelu., Gera, Mohit amd Purohit, mamta (1998). Tetrazolium test for the seeds of *Acacianilotica* Willd. Ex. Del. *Indian For*., 124(2): 1039-1042.

Ghildiyal, S. K. and Sharma, C. M. (2005). Effect of seed size and temperature treatment on germnation of various seed sources of *Pinus wallichiana* and *Pinus roxburghii* from garhwal Himalaya. *Indian For*., 131(1): 56-65.

Ghosh, R. C., Singh, R. P. and Sharma, K. K. (1974). Standardisation of nursery technique of tropical pines, Hostening germination of *Pinus caribaea* (Var. Hondurensis) and *Pinus patula* seeds. *Indian For*., 100: 407-421.

Ghyare. B. P. (2005). Effect of Gibberellic acid on germination of five timber tree species. *Indian For*., 131(6): 844-846.

Ghyre, B.P. (2005). Effect of Gibberellic acid on germination of five timber tree species. *Indian For.*, 131(6): 844-846.

Ginwal, H.S., Rawat, P. S., Bhandari, A. S., Krishan, C. and Shukla, P.K. (2001). Selection of proper potting mixture for raising *Acacia nillotica* seedlings under root trainer seedling production system. *Indian For*., 127(11): 1239-1249.

Ginwal, H.S., Rawat, P. S., Bhandari, A. S., Krishan, C. and Shukla, P.K. (2002). Evaluation of potting mixture for raising *Dalbergia sissoo* seedling under Root trainer system. *Indian For*., 128(5): 523-533.

Goal, V. L. (1989). Performance of some five wood species in nursery of alkali wasteland.., 113(12): 792-797.

Gonzalez, J. F. (1993). Effect of seed size on germination and seedling vigour of *Virola koshni* Ward., *For. Ecol. Mgmt*., 57: 275-281.

Gopal. M. and Thapaliyal, R. C. (1969). Topographical TZ test of Indian tree seeds. *Van Vigyan*, 7: 37-45.

Gopikumar, K. (2002). Seed germination studies in selected farm forestry tree species. *Indian J.For.,* 25(3): 334-346.

Grazesik, M. (1995). Effect of growth regulators on plant growth and seed yield of *Mathiolaincane*, Brillient Barbara. *Seed Sci. and Tech.*, 23(3): 801-806.

Grunwald, C. and karschon, R. (1974). Effect of seed origin on Coppice regeneration of *Eucalyptus camaldulensis. SilvaeGenetica*. 23 (5): 140-144.

Gularia, V., Nayital, R. K. and Gupta, B. (1999). Phytosociological variation in three *Pinus*r*oxburghii*sergent stands in mid Hill of Mimachal Pradesh. *Range Mgmt. and Agri*., 20(1): 47-54.

Gunaga, R. and Vasudeva, R. (2002). Variation in flowering Phenology in a clonal seed orchard of Teak (*Tectona grandis* L. f.). *J. Tree Sci*., 21 (1&2): 1-10.

Gupta, B. B., Kumar, A. and Negi, D. S. (1993). Vegetative propagation through branch cuttings in *Dalbergia sissoo*Roxb. *Indian For*., 119(5): 381-387.

Gupta, B. N. and Kumar, A. (1977). Interrelated effects of temperature and moisture on seed germination of *Dendrocalamusstrictus* Nees. *Ind. For*., 103(3): 212-219.

Gupta, B. N. and Raturi, A. S. (1975). Tetrazolium staining of seeds for interpretation of viability of six Indian tree species. *Indian For*., 101(11): 659-673.

Gupta, R. and Basu, P. K. (1980). Influence of light and shade on *Solanum khasianum* Clarke. *Indian For.,* 106(20: 872-874.

Gupta, S. K., Pathak, P. S. and Debrey, R. (1983). Seedling growth of *Laucaena leucocephala*. II- Effect of seed size. *Ind. J. forestry*, 5(3): 202-204.

Gutterman, Y. (1985). Seed germination of desert Plants. Springer- Verlag. Barlin, 253 pp.

Halos, S. C. (1983). Casurina in philippine forest development management and utilization Proc. Of an international workship. Canberra-Australia, pp. 88-98.

Handa, A. K., Khare, N. and Chauhan, S. P. S. (2005). Vegetative propagation of *Albizia lebbeck*through stem cuttings. *Indian For.,* 131(1): 66-70.

Harper, J. L. and Obeid, M. (1967). Influence of seed size and depth of sowing on the establishment and growth of varieties of fiber and oil seed flax. *Crop Sci*., 7: 527-532.

Hedegart, T. (1975). Seed collection of Teak. In report on RAO/DANIDA training course on forest seed collection and Handing. Vol.2, FAO, Rome.

Husain, Karam, Dubey, S. D. and Srivastave, R. L. (2000). Impact of irrigation and nutrient on Linseed *(Linum usitatissimum). Ad. Plant Sci*., 13(II): 387-391.

Idu, M. and Omanhinmin, A. C. (1997). Effect of acid pre-treatment on germination and seedling development of *Dichrostachys cinerea* (L.) wright and arn., *Ann. For*., 5(2): 136-139.

Indira, E. O., basha Chand S. and Chacko, K. C. (2000). Effect of seed siz grading on germination and growth of Teak (*Tectona grandis*) seedlings. *J. Trop. For. Sci*., 12 (1): 21-27.

ISTA (1983). Biochemical test for viability (The tetrazolium test). 20th ISTA Congress, Ottawa June 17-25: 46-52.

Jadeja, B. A. and Nakar, R. N. (2010). Phenological studies forest, Gujrat, India. *Plant Arechives* 10(210: 825-828.

Jain, R. K. (1981). Ecophysiological studies of forest trees with special references to Teak (*Tectona grandis*). *Ph. D. Thesis,* sagar Univ., Sagar.

Jealum, J. K. (1979). Effect of some seed bed types and watering frequencies on germination and growth of Black spruce. A green house study. *Rept. Can. For. Serv.*, Rep. O-X-292: 1-33.

Jerlin, R. and Vadivelu, K. K. (1994). Standardization of Pre-sowing treatment for *Acacia mellifera* (Vahl.) Benth. Seeds. *Indian J. For*., 17(4): 284-287.

Jha, K, Kumar (2004). Vegetation structure in artificially raised young forests of *Tectona grandis* in moist deciduous region. *Indian For*., 130(3): 253-266.

Jin, Q. L., duan, J. L. I., Dong, X., Tina, X., Wang, B. and Li, Z. (2006). Scarification damages by H_2SO_4 and their effect on vigour, germination and emergence of *Glycyrrhiza uralensis* Fisch seeds. *Seed Sci. and Technol*., 32: 227-231.

Johnson, T. (1987). Development of Stump suckers by *Betula pubescence* at different light intensities. *Scandinavian J. of forest research*, 2(1): 77-83.

Joseph, A. and Freezaillah, Blnche Yeom (1969). Observation on the growth and development of *Pinus caribaea* seedlings in potting mixture of different composition. *Malayan Forester*, 32(3): 303-327.

Joseph, Lucyamma, Satish, K. V. and Mehta, P.M. (1996). Effect of growth regulators and chemical treatment on Post- harvest life of *Ixora cocconia* and *Vinca rosea,Ad. Plant Sci.*, 9(2): 187-193.

Joshi, A. P. (1984). *Anogeissus latifolia,* An ecological study. *Indian J. of Ecol*. 11(1): 27-31.

Joshi, A. P. and Gupta, S. K. (1982). The structure of the vegetation and community coefficient of certain sub-tropical forest of Western Himalaya, *Indian J. For.*, 5(4): 277-281.

Joshi, M. and Dhar, U. (2003). Effect of various pre-sowing treatment on seed germination of *Heracleum candicans* Wall. Ex. DC: A high value medicinal plant. *Seed Sci. and Techol*., 31: 737-743.

Joshi, N.K. and Tewari, S.C. (1990). Phytosociological analysis of woody vegetation along an altitudinal gradient in Garhwal Himalaya. *Ind. J. For*., 13 (4): 322-328.

Joshi, S. A., Sreepathy, Kumar, B. and Venugopal (1994). Structural, floristic and edaphic attributes of the grassland- Shola forest of Eravikulam in Peninsular India. *For. Eco. Management*, 65 (2-3): 279-291.

Josiah, S.J., and Jones, Norman (1992). Root trainers for seedlings production system for tropical forestry and Agroforestry. *Land Resource service*-4. Work Bank.

Kailash, S. Gaira, ranbeer S. Rawal, Balwant rawat and Indra D. Bhatt (2014). Impact of climate change on the flowering of *Rhododendronarboreum* in central Himalaya, India. *Current Sciences*, 106 (12& 25).

Kaletha, M. S., Bhatt, B. P. and Todaria, N. P. (1996). Allelopathic effects of some agroforestry tree crops of garhwal Himalaya. *Range Mgmt. and Agrofor*., 17(2): 193-196.

Kanak, Sahai (1999). Effect of storage on seed viability in some leguminous taxa. *Indian For*., 125(6): 609-612.

Kandya, A. K. and Babeley, G. S. (1984). Tetrazolium colouring: An Index for tests of viability and Vigour of some tropical forest seeds. In Proc. IUFRO Int. Symp. On methods of production and quality control of forest seeds. Guritiba, Brazil, pp. 495-501.

Kandya, S. (1989). Pre germination treatment: an essential in *Peltophorumferrugineum* seeds. *Vanikisandesh*, 13 : 24-27.

Kandya, S. (1990). Enchancing germination in *Cassia siamea* seeds. *J. Tropical For*., 6(1): 28-35.

Kanodia, K. C. (1981). Studies on the ecology of grasses and grass land in Jhansi district (U. P.). *Ph. D. Thesis*, Jiwaji Univ., Gwalior.

Kanwar, Himani and Sharma, Sandeep (2023). Phenology and Global climate change: A Comprehensive Review. *J. of applied forest ecology*, 11 (1): 20-30.

Karma, S. K. (1976). Use of X- ray radiography for studing seed quality in tropical forestry. *Studia ForesteliaSuecia* No.11, pp.33.

Katewa, S.S. (1990). Phytosociological studies on three main grassland communities in Udaipur district (Rajasthan). *Botanical Researches in India (N. C. Aery and B. L. Chaudhary, eds.) Udaipur.* Pp. 398-403.

Kathiravan, M., Ponnuswamy, A. S. and Navistha, C. (2009). Determination of suitable cutting size for vegetative propagation and comparison of propagules to evaluate the seed quality altibutes in *Jatropha curcas* Linn. *Natural Product radiance*, 8(2): 162-166.

Kattimani, K. N., Reddy, Y. N. and Rao, R. B. (1999). Effect of Pre-sowing seed treatment on germination, seedling emergence, seedling vijour and root yield of Ashwagandha (*Withaniasominifera*Daunal). *Seed Sci. and Techonol*, 23: 157-163.

Kaur, G., Singh, B. P. and Nagpal, A. K. (2013). Phenology of some Phanerogams (tree and shrubs) of Northwestern Punjab, India. *Jou. Of Botany*. 1-10.

Keim, F. R., Chambers, J. L. and day, W. (2006). Long term success of stump sprouts in height graded baldcypress water tupelo swamps on the Mississippi delta. *Forest eco and Mag*., 234(1-3): 24-33.

Keith D. A. (1988). Floristic lists of New South Wales, Cunninghamia, 2 (1): 39-73.

Khan, J. A. (1999). Periodicity of Major Phenophases in woody species in dry deciduous forest of Gir, India. *Tropical ecology*, 40(2): 299-303.

Khan, M. L. amd Tripathi, (1986). Tree regeneration in a distributed sub-tropical wet hill forest of north-east India. Effect of stump diameter and height of Sprouting of four tree species. *Agroforestry*, 17(2-3): 199-299.

Khan, M. L. and Tripathi, (1986). Tree regeneration in a disturbed sub-tropical wet hill forest of north-east India. Effect of stump diameter and height of Sprouting of four tree species. *Agroforestry*, 17 (2-3): 199-299.

Khan, M.L., Bhuyan, P., Singh, N.D. and Todaria, N.P. (2002). Fruit set, seed germination and seedling growth of *Mesua ferrea* (Clusiaceae) in relation to light intensity. *J. Tro. For. Sci.*, 14(1): 35-48.

Khan, P. A., Mughal, A. H. and Khan, M. A. (2001). Allelopathic effect of leaf extract of *Populus deltoids* M. on germination and seedling growth of some vegetables. *Range Mgmt. andAgroforestry*, 22(2): 231-236.

Khare, Ambica, Ray, A. K., Malaviya, D. R. and Kaushal, P. (2007). Phenology variation among different species of genus *Trifolium*. *Range Mgmt. and Agroforestry*. 28 (2): 394-397.

Khare, P.K. and Mishra, G.P. (1981). Relative growth performance of seedlings of *Butea monosperma* (Lamk.) Taub. In three artificial soil types. *Bull. Bot. Soc., Univ. of Saugar,* 28: 56-59.

Kharkwal, G., (2009). Qualitative analysis of tree species in evergreen forests of kumaun Himalaya, Uttarakhand, India, *Indian African of Plant Science* 3 (3): 049-052.

Khere, Neeraj and Saxena, A. K. (2003). Effect of Pre-sowing treatment o seed germination and seedling growth of *Acacia nilotica* Willd. *Range mgmt. and Agrofor*, 24(2): 104-113.

Khurana, Poonam and Kalpana (2008). Phytosociological study in Natural forest of hastinapur. *Indian For.*, 134 (4): 554-562.

Kiran, D.J.S., Rao, P.S., Venkaish, K., and Saibabu, A. (2001). Effect of Gibberellic acid (GA_3) on germination of *Givotiarottleriformis. Indian For.*, 127(8): 944-946.

Konatowska, M. and Rutkowski, P. (**2019).** Phytosociology, A useful tool for the assessment of Past and Future Human impacts on Plants and forest Ecosystem. *J. of Biosciences andMedicines*, 7: 154-163.

Kozlowaki, T. T. (1971). Seed germination and seedling development. In: *growth anddevelopment of Trees*-I (ed.) Academic Press, New York.

Krishan, B. and Toky, O. P. (1996). Provenance variation in seed germination and seedling growth of *Acacia nilotica* Sub spp. Indica in India, *Genetic resourese and crop evolution*, 43 (1): 97-101.

Krishna, A., Verma, R. K. and Gupta, S. R. (2000). Floristic composition and life form of a mixes dry deciduous forest of central India. *Flora and Fauna*, 6 (2): 79-81.

Krishnan, R. M. (2000). Flowering Phenology and Floral succession in monocarpic Barleria involucrate var. Elata. *Ind. J. For*., 23 (2): 178-185.

Kruse, M. (1996). Embryo exicision versus longitudinal cut in tetrazolium viability determination of cereal seeds. *Seed Sci. and Technol*., 24: 171-183.

Kulezynski, S. (1937). The study of plant communites W. H. Freeman and Cosan Fransico.

Kulkarni, H. D. (1986). The vegetative propagation of important forest tree species of M. P. by rooting of stem Cutting. *J. Trop. For*., 2(IV): 268-269.

Kumar, Devendra (2007). Effect of seed size on germination and seedling performance during storage of Neem (*Azadirachta indica* A. Juss) seeds. *Indian For*., 133 (9): 1198-1204.

Kumar, Devendra and Mishra, D. (2007). Effect of seed orientation and sowing depth on germination and seedling performance of Neem (*Azadirachta indica* A. Juss) Seeds. *Ann. For.*, 15(2): 311-321.

Kumar, Devendra, Mishra, D.K. and Singh, Balbir (2007). Effect of temperature, media and light on germination of Neem (A*zadirachta indica* A. JUSS.) seeds. *Indian For*., 133(12): 1636-1642.

Kumar, Manisha, Bhardwaj, S. D. and Panwar, Pankaj (2001). Effect of Pod and seed size on germination parameters of *Albizia lebbeck*. *Indian J. For*., 24(4): 496-499.

Kuo, W. H. J., yan, A. C. and Leist, N. (1996). Tetrazolium test for the seeds of *Salvia splendens* and *Salvia farinacea. Seed Sci. and Tech*., 24: 17-21.

Kushwaha, C. P. and Singh, K. P. (2005). Diversity of Leaf Phenology in a tropical deciduous forest in India. *J. of tropical ecology*. 21: 47-56.

Lakon, G. (1942). TopographischerNachweis der keimfahigkeit der Getredefruchtedurch Tetrazolium salze. *Ber. Dt. Bot. Ges*., 60: 299-305.

Lall, J, (1988). Hirachical community classification of Bandha Vagarh national park Tala forest range. *Trop. Ecol*., 298 (1).

Lall, Pyare, Bisht, N. S. and Agarwal, S. K. (1997). Determination of Proper depth of seed sowing in *Michelia champaca* in nursery. *Indian For*., 123(2): 118-122.

Larson, L. A. and Lwanga, K. (1969). The effect of prolonged seed soaking on seedling growth of *Pisum sativum. Can. J. Botany*, 47: 707-709.

Lasmarias, Vitoria, T. (1979). Survival and growth of akle (*Albizia acle*) and Supa (*Sindora supa*) in various pottong media. *Sylva trop*., 4(3): 161-166.

Lata, Sneh and Verma, K. R. (1993). Pre-sowing treatment of Bhimal (*Grewia optiva* DRUMMOND) seeds. *Indian For*., 119(2): 135-138.

Lavania, S. K., and Singh, Virendra (2004). Effect of seed source on germination and early seedling growth in Himalayan Poplar (*Populus ciliata* Wall. Ex. Royle.). *Indian J. For*., 27(1): 15-18.

Lavania,S. K., Singh, R. P. and Singh, Virendra (2006). Effect of Gibberellic acid and pH on Seed germination in Blue Pine (*Pinus Wallichiana,*A..B. Jacks).*Indian For*., 132(8): 1024-1028.

Linkosalo, T. (2000). Mutual regularity of spring phenology of sone boreal tree species: Predicting with other species and phenological models. *Can. J. For. Res*., 30(4): 667-673.

Loach, K. (1957). Shade tolerance on tree seedlings. *New Phytol*, 66: 607-621.

Longman, K. A. and Jenik, J. (1974). Tropical forest and its environment. Longman, London.

Lopushinsky, W. (1990). Seedling moisture status. Target seedlings symposium (Rose, R., Carupbell, S. J. and Landis, Ta. D. eds) USDA forest survey. Rocky mountain forest and Range experiment station, fort Collins Colorado. General technical report pp. 123-138.

Lowell, E. K., garrett, H. E. and Mitchell, R. J. (1989). Potential long term growth gains from early clump thining of Coppice regeneration of Oak stands. New forests, 3: 11-19.

Luna, R.K. and Naresh, Chamoli (2008). Evaluation of quality of seedling raised under agro-net shade and direct sunlight. *Indian For*., 134(1): 17-25.

M. C. Donough, W. T, (1977). Seed physiology. In Rangeland plant physiology (Ed. R. S. Sosebie), SOC, *Range mange. Range SCI, Ser*, 4: 156-184.

M.C. Donough, W.T. (1979).*Quaking aspen*, seed germination and early seedling growth U.S.D.A. *For. Ser. Res. Pap.,* 134:1.13.

Mahadevan, N. P. (1991). Phenological observation of some forest tree species as an aid to seed collection. *J. tropical For*., 7(3): 243-247.

Mahajan,S. K. and Paliwal, P. R. (1985). Biological spectrum of the flora of sirwel Medhya Pradesh. *Geobios*, 12 (5): 212-214.

Maithani, G. P., Bahuguna and Singh, H. P. (1988). Effect of size of container and different soil media on the germination behavior and growth of seedlings of *Acacia nilotica, Albizia procera* and*Derbergia sissoo. Indian J. For.*, 11 (1): 56-59.

Malik, N. Z., Arshad, M. and Mirza, S. N. (2007). Phytosociological Attributesof Different Plant communites of the Pre-Chinasi Hills of Azad Jammu and Kasmir. *Int. J. Agri. Biol*., 9 (4): 569-574.

Mamanteo, B. P. and Veracion, V.P. (1984). Coppicing of Oak trees, *Sylva trop*. 10(2): 181-185.

Manga, V. K. and Sen, D. N. (1995). Influence of seed traits on seed germination in *Prosopis cineraria* (L) MacBride. *J. Arid Environ*, 31: 371-375.

Manga, V. K. and Sen, D. N. (19956). Genetic parameters for traits in *Prosopis cineraria* (L), *Ind. J. For*., 19: 148-151.

Marca, O. L., Marziliano, P. A. and Moretti, N. (1998). Experiment research in ageing holm Oak (*Quercus ilex L*.) Coppices: Preliminary results, *Ann. For. Sci*., 55: 461-476.

Marunda, C. T. (1990). Effect of seed Pre-treatment on development of *Acacia auriculiformis* and *Acacia holosericea* seedlings. In: Turnbull, J. W. (ed), *Tropical Tree Seed Research*. *ACIARProceedings* No. 28, Canberraa, Australia, pp. 33-36.

Masilamani, P. and Annadurai, K. (2003). Influence of seed treatment on germination and initial seedling vigour of irrigated Teak (*Tectona grandis* Linn. F.). *Indian J. For*., 26(1): 48-52.

Masilamani, P. and Dharmalingam, C. (1999). Influence of seed treatment with Potassium nitrate on germination and seedling vigour of Teak (*Tectona grandis*Linn.F.). *Indian J, For*., 22(1): 1-6.

Masilamani, P. and dharmalingam, C. (2002). Emhancement of germination and sedling growth in Silver Oak (Grivillea robusta A. Cunn.) seeds. Indian Ji. For., 25(1): 30-33.

Masilamani, P. and Vadivelu, K. K. (1997). Effect of growth regulator and Nutrient on viability and vigour of Preconditioned seeds of Arjan (*Hardwickiabinnata*). *Indian J. For*., 20(3): 223-226.

Masilamani, P. and Vadivelu, K.K. (1997). Effect of growth regulator and Nutrient on viability and vigour of preconditioned seeds of Anjan (*Hardwickiabinnata)*. *Indian J. For*., 20(3): 223-226.

Masilamani, P., Singh, B. G., Chinnusamy, C. and Annadurai, K. (1999). Influence of seed orientation and depth of sowing on germination of vigour of Anjan (*Hardwickiabinnata*Roxb.). *Trop. Agri. Res. and Extension*, 2: 76-78.

Masilamani, P., Singh, B.G., Chinnusamy, C. and Annadurai, K.(1999). Influence of seed orientation and depth of sowing on germination of vigour of Anjan (*Hardwickiabinnata*Roxb.). *Trop. Agri. Res. and Extension*. : 76-78.

Mathur, C. M. (1956).*Anogeissus pendula* forests in Rajasthan. Their silviculture and management. *Proc. IX Silvi. Conf. Dehradun* pp. 186-191.

Mathur, C. M. (1961). Artificial regeneration of *Anogeissus pendula* (Edgew.) in Rajasthan. *Proc. 10th Silvi. Conf*., Dehradun.

Mathur, R. and Bhatnagar, P. S. (1992). Phenology of Major Plant species at ambagarhResearve forest, Jaipur. *Indian J. For.,* 15 (3): 224-228.

Mayer, A. M. and Poijakoff-Mayber, A. (1963). The germination of seeds. *Pergamon Press,* London.

Mayer, A. M. and Shain, Y. (1974). Control of seed germination. *Ann. Rev. Plant Physiol*, 25: 167-193.

Menburge, G. DELA (1996). La germination et les plantules des essences arbores da la cote d'Tvoire: Nogent Sur Marne. CTFT. 1996,p.389.

Menon, A. R. R. and Shah, G. L. (1982). Phytosociological studies of the Saurashtra (Gujrat) Mutual species correlation studies in the area *Indian J. For*., (1): 55-63.

Miller, J.H. and Jones, N. (1995). In organic and compost based growing media for tree seedling nurseries. World Bank Technical paper No. 264. Forestry service, The world Bank Washington DC. Pp.-75.

Milton, Suzanne J. (1982). Effect of shading on nursery grown *Acacia* seedlings. *J. S. afri. Bot*. 48(2): 245-272.

Mishra, K.K. and Jaiswal, H. R. (1993). Effect os size of polythene bags and potting mixture on the survival and growth of Silver Oak (*Grevillea robusta* Parker) seedlings. *Indian For*., 119(11): 941-943.

Mittal, R. K. and Sharma, M. R. (1981). Seed mycoflora of *Cassia fistula* L., *Indian J. For*., 125(6): 609-612.

Mohariya, A. D., patil, B. N., Wankhede, S. G., band, P.E., Bokey, S.P. and Dorkar, A.R. (2003). Response of different varieties of *Chrysanthemum* to growth regulators. *Ad. Plant Sci*., 16(1): 93-96.

Moza, M. K. and Bhatnagar (2005). Phenology and Climate change. *Current Sciences*. 9: 243-244.

Mughal, A. H. (2000). Allolepahic effect of leaf extract of *Morus alba* L. on germination and seedling growth of some pulses. *Range Mgmt. and Agroforestry*, 21(2): 164-169.

Mulik, N. G. and Bhosale, L. J. (1989). Flowering phenology of the mangroves from the west coast of Maharashtra. *J. Bom. Nat, Hist. Soc*.: 86 (3).

Murthy, A. V. and Krishna, R. G. (1973). Problems of Teak seed. Flower and fruit studies, in seed Processing Proc. Symposium IUFRO Wkg. Group on seed problem, Bergen Vol.II paper 20.

Mutha, N., Bohar, M. D., Burman, Uday and Harsh, L. N. (2004). Effect of seed size and Pretreatmentr on germination of *Albizizlebbeck* (L.) Benth., *Indian J. For*., 27(1): 11-14.

Mutha, N., Burman, U., Harsh, L. N. and Tiwari, J. C. (1994). Effect of seed weight on germination and seedling quality of *Prospisjuliflora* (SW.) DC., *Ann. Arid Zone*, 33:253-254.

Mutha, N., Burman, U., Tiwari, J. C. and Harsh, L. N. (1995). Effect of sowing depth on germination and seedling quality of *Prosposisjulifera. J. Tree Sci*., 14: 41-43.

Nagabhushnam, P. and Reddy, S. M. (1999). Impact of Bionoculants on the growth of Pongamia (*Pongamia pinnata*). *J. Ind. Bot. Soc*., 78: 171-172.

Nagaraja, N. G. (1998). Mineral composition of *Cassia fistula* (Linn.) leaves infected with *Sarcinella cassiae*. *Ad. Plant Sciences*, II (1): 291-294.

Nagaranjan, M. and Mertia, R. S. (2006). Effect of seed size and sowing depth on germination and seedling growth of *Colophospermum mopane* (Kirk ex Benth.0 Kirk Ex J. LE ON. *Indian For.*, 132(8): 1007-1012.

Nagaveni H. C. and Ananthapadmanabha, H. S. (1989). Retention of viability in Sandal (*Santalum album*) seeds. *J. Tree Sci*., 8(1): 40-41.

Nageswara, Y. Rao and Balasubramanian, P. (1993). Phytosociological analysis of Wetland vegetation in point calimere wildlife sanctuary, Tamilnadu. *Indian J. For*., 6 (2): 144-150.

Naidu, C. V., rajendrudu, G. and Swany, P. M. (2000). Effect of plant growth regulators on seed germination of *Sapindustrifoilotus* Vahl. *Seed Sci. and Techn*., 28: 249-252.

Naidu, C.V., Chandra, M. and Swamy, P. M. (1998). Influence of shade on growth and biomass production in five tropical deciduous tree species. *J. Tro. For*., 14(IV): 204-206.

Naithani, H. B., pal, R. C. and Srivastava, R. K. (2006). Vegetation analysis of the Tirumali Hills, Andhra Pradesh. *Indian For*., 132 (9): 1110-1130.

Nanda, K. K. (1969). Effect of gibberellin on forest plant II. Internodal growth in seedlings of *Salmaliamalabarica*Schett. And Endl. Indian J. Plant Physiol., 7(1) 57.

Natarajan, N. and Rai, R. S. V. (1998). Studies on maximization of germination in *Acacia auriculiformis*. *Indian J. For*., 11(4): 304-306.

Nath, T. K., Hossain, M. K. and Alam, M. K. (1998). Diversity and composition of trees in Sitapahar forest reserve of Chittagong Hill Tracts (South) forest Division, Bangladesh. Ann. For., 6(1): 1-9.

Nautiyal, S., Tooley, N.G., Singh, A.K. and Bhomik, A.K. (1987). Forest vegetation survey of south Raipur Division M.P. *A Quadrate analysis*. 10(1): 16-18.

Navchoo, I. A. and Kachroo, P. (1986). Phenology of Vegetation of Pulwama (Kasmir, India). *Indian For*., 112 (9): 833-839.

Nayital*, et. al,* (1995). Effect of growing media on the growth of *Bauhinia variegate* Linn. Seedlings. *Range Mgmt. and Agro*., 16: 105-108.

Nayital, R. K. and Mehta, Richa, (2003). Effect of storage condition on the germinability of *Albizia chinansis* seed. *Indian J. For*., 26(1): 35-40.

Negi, A. K. ndTodaria, N. P. (1997). Effect of seed size and weight on germination pattern and seedling development of some multipurpose tree species of Garhwal Himalaya. *Indian For.*, 123(1): 32-36.

Negi, C. S. and Nautiyal, S. (2005). Phytosociological studies of a traditional reserve forest Thal ke Dhar, Pithoragarh, Central Himalayas (India). *Indian For*., 131 (4): 519-534.

Negi, G. C. S. (1989). Phenology and nutrient dynamics of tree leaves in KumaunHimalayan forest. *Ph. D. Thesis, Kumaun Univ*., Nainital.

Newstron, L. E. and Frankia, G. W. (1994). A new classification for plant Phenoligy based on flowering pattern in lowland tropical rain forest at La Selva, Costa Rice. *Biotropica*, 26 (2): 141-159.

Newton, P. N. (1988). The structure and phenoligy of a moist deciduous forest in the Central Indian Highlands. *Vegetatio.*, 75: 3-16.

Niensteedt, H. F. C., Cech, F. C., Mergen, F., Wang, C. W. and Zak, B. (1958). Vegetative propagation in forest genetic research and practices. *J. For*., 56: 826-839.

Nizam, M. Z. U. and Hossain, M. K. (1999). Effect of seed weight on germination and initial seedling growth in *Albizia saman* (Jacq.) F.MUELL., Indian For., 125(6): 613-617.

Ojha, S. K., Acharya, K. P., Acharya, B. and Ragni, R. (2008). Simple coppice management options for the Sal (*Shorea robusta*) forests in the Terai of Nepal. *Banko Janakari*, 18(1): 32-41.

Ojha, S., Chauhan, H. S., Singh, P. P., Kumar, D. and Singh, K. (2000). Irrigation and nitrogen requirement of Spearmint on a Sandy Loam soil under Sub-tropical conditions. In: *National Seminar on the Frontiers of Research and Development in medicinal plant CIMAP*, Lucknow, Abst. P. 86.

Okti, D.U.U. (1972). Growth rates of some West African forest tree seedlings in shade. *Ann. Bot*., 32: 953-959.

Osborne, D. J. (1973). Panel discussion on Pre-sowing seed treatment IN: *Seed Ecology* (ed.) W. Heydecker, Penn. State. Univ. Press Park.

Ossting, H. J. (1956). The study of Plant communities. W. H. freeman and Co London: 440.

Oudhia, P. and Tripathi, R. S. (1998). Allelopathic effect of *Parthenium hysterophorus* L. on kodo, mustard and problematic weeds P. 139-139.In: Proc. First. Int. Conferences on *Parthenium management*, (Vol-II). UAS, Dharwad.

Padhay, B., Khan, P. A., Acharya, B. and Buxipatra, N. (1992). Allopathic effect of *Eucalyptus* leaves on seed germination and seedling growth of Finger Millet. Alloelopathy in Agroforestry (Eds. P. Tauro and S. S. narwal). *Indian Society of Allelopathy. Haryana Agriculture University*, Hissar, India, pp, 102-104.

Pal, Mohinder, Gupta, B. B. and Raturi, D. P. (1991). Effect of Gibberellin and fertilizers on growth of nursery stock of *Dalbergia sissoo. Indian J. for*., 14(3): 190-195.

Palani, M. dasthagir, M. G., Kumaran, K. and Jerlin, R. (1996). Effect of Pre-sowing treatment on growth attributes of *Albizia lebbeck* (L.) Benth, *Ann. For*., 4 (1): 85-88.

Pandey, A. K. and Khatoon, Sayeeda (1999). Effect of orientation of seed placement and depth of sowing on seedling emergence in *Sterculia urens* (RoxB.). *Indian For*., 125(7): 720-724.

Pandey, A. K., Solamki, K. R. and Gupta, V. K. (2002). Periodical growth and phenology of 4 Year old Neem in Semi-arid region. *Range Mgmt. and agroforestry*. 23 (2): 122-125.

Pandey, P. K., Singh, J., Meshram, P. B., Banerjee, S. K. and Pal, Mohinder (2004). Phenological studoes on *Azadirachta indica* A. Juss. (Neem) of Satpura and Adjacent Agro-climate zones of Madhya Pradesh (India). *Indian For*., 130(3): 273-282.

Pandey, Savita and Kandya, A. K. (1993). Relationship between various seed parameters and Germination capacity of some forestry seed. *J. Tro. For.*, 9(4): 337-341.

Pandey. P. K. and Sharma, S. C. (1986). Seasonality and pattern in leaf fall and Litter accretion on the forest floor in plantation of demonstration area. Forest Research Institute and College. Dehradun (India). *Indian For.*, 112: 328-341.

Pandit, B. R., Gopikumar, S. and Paresh, Piyush (1997). Vegetation studies in Valavadar national park in relation to wild life management. *Flora and Fauna*, 3 (2): 103-106.

Panwar, P. and Bhardwaj. S.D. (2000). Effect of soil amendment and mulch on establishment of trees in sandstone mine spoils in mid hill zone of Himachal Pradesh. *Ann. For.*, 8(2): 214-219.

Pasha, M. K. and Das, R. K. (1982). Quick viability test of Soyabean seeds by using tetrazolium chloride. *Seed Sci and Technol.*, 10: 651-655.

Pathak, P.S., Rai, M.P. and Roy, R.D. (1983). Seedling growth of *Laucaenaleucophala* (Lam.) de wit. I. Effect of shading. *Indian J. For.*, 6: 28-31.

Patra, A. K., Pande, P. K. and Sahu, T. R. (2007). Vegetation analysis of open and closed canopy sal and miscellaneous Forests of satpura plateau, India. *Indian For.*, 133 (5): 611-627.

Paulsamy, S., Arumugasamy, K., Rangarajan, R. N. and Monorama, S. (1996). Evaluationn of Calcareous mine spoils for tree seedling growth. *Ann. For.*, 4(2): 159-161.

Pelton, J. (1953). Ecological life cycle of seed plants. *Ecol.*,34: 619-628.

Pereira, A. R., Anrrade, D. C., Decosta, R. L. and Fonseca, A. G. (1984). Influence of shoot position and height of cut on the survival of *Eucalytus grandis* Coppice. *BuletineTechnicoinstitute Brasileriro de DoeasenvolVimento Florestal*, : 59-62.

Piussi, P. (1970). Research on the ecological requirement of *Picea abies* seedlings. *G. Bot. Ital.*, 104: 193-214.

Ponnammal, N. R., Arjunan, M. C. and Anthony, K. A. (1993). Seedling growth and biomass production of *Hardwickiabinata*Roxb. as affected by seed size, *Indian For*., 119 (1): 59-62.

Popler, Paul A. Gordon, W. F. and Hertbert, G. B. (1980). Comparetive phenological studies of treelet and shrub species in tropical wet and dry forest in the low land of Costarica. *J. Ecol*., 68: 167-188.

Purohit, M., Mishra, G. P. and jamaluddin (1996). Tetazolium staining of seeds for testing of viability of some topical tree species. *J. Trop. For*., 12(3): 166-170.

Purohit, M., Pant, N. C. and Lal, R. B. (1997). Preliminary observation of storage of *Albiziaprocera* (Roxb.) Benth seeds. *Aust. J. For*., 2(4): 9-12.

Purohit, Mamta and bisht, Smita (1999). Use of TTC for interpretation of viability of seeds of Albizizprocera (Roxb.) Benth. *Indian For*., 125(8): 828-834.

Pyare, lal and Karnataka, D. C. (1993). Effect of orientation, seed sowing and soil mixture on germination behavior of *Quercus leucotrichophora. Indian For.*, 119 (2): 122-125.

Quraishi, A., Biswas, J. and Mishra, S. K. (1996). Seed weight related germination capacity in *Cleistanthuscollinus* Benth, *Indian J. For*., 9(1): 79-82.

Qureshi, Huma, Muhammed Gulbaz Arshad and Yamin Bibi (2014). Invasive flora of Pakistan: a critical analysis, International J. of Bioscience, 4 (1): 407-424.

Raemakers, j. J., Aldrich-Blake, F. P. G. and Payne, J. B. (1980). The forest Malayan Forest Primates (D. J. Chivers, ed.) Plenum Press, New York, pp. 29-61.

Rajput, A., (1992). Seed biology of some selected tree species of central India. *Ph. D. Thesis. Dr.H.S. Gour Univ*., Saugar.

Ralhan, P. K., Khanna, P. K., Singh, S. P. and Singh, J. S. (1985). Phenological characteristics of the tree layer of Kumaun Himalayan forests. *Vegetatio*, 60: 91-101.

Ramachandran V. S. and nair V. J. (1998). Flora of cannanore, *Botanical Survey of India, Calcutta.* 599.

Rao, M.R.K.V. and Rajagopal, V. (1972). Influence of seed coat and leaching on germination on dormant seeds of ground nut TMV-3 and early seedling growth. *J. Indian Bot. Soc*., 10(IV): 278-286.

Rao, S. V. S. and Mishra, R. M. (1994). Phytosociological analysis of two tropical deciduous forest of Central India. *J. Tro. For*., 10(IV): 278-286.

Rastogi, Nidhi and Rastogi, Alind (2007). Phytosociological analysis of forest vegetation of Sipahijala wildlife Sanctury, Tripura. *Ann. For*., 15 (2): 227-244.

Rathore, T.S., Annapurna, D., Joshi, G. and Srivastava, A. (2004). Studies on potting mixture and size of container on the quality of seedling production in *Casuarina equisetifolia*forest. *Indian For.*, 130(3): 323-332.

Ravichandran, V. K., Balasubramanian, T. N. and rajasekaran, S. (1994). Vegetative propagation of *Casuarina junghuhniana* by rooted springs. *Indian J. For*., 17(4): 361-362.

Rawat, R. S. and Nautiyal, S. (2007). Inter-clonal variation in *Dalbergia sissoo*Roxb. With respect to growth performance survival and Phenological characteristics in different climate zones. *Indian For*., 132 (2): 215-228.

Ray J. G. and George Jojo (2019). Phytosociology of roadside communities to identify ecological potentials of tolerant species. *African J. Of Ecology and Ecosystems* 6(4): 001-007.

Reddy, Ch. Sudhakar., Pattanaik, Chiranjibi, Dhal, N. K. and Biswal, A. K. (2006). Vegetation and floristic diversity of Bhitarkanika National Park, Orissa, India. *Indian For*., 132 (60: 664-680.

Reich, P. B. (1995). Phenology of Tropical forest patterns: causes and consequences. *Canadian J.of Botany*. 73: 164-174.

Reich, P. B. and Borchert, R. (1984). Water tree and tree phenology in a tropical dry forest in the lowlands of Costa rice. *J. Ecol*., 72: 61-74.

Roller, K.J. (1977). Suggested minimum standards for containerized seedlings in *Nova scotia. Canadian forestry serv. Dept. of the environment Info*. Rep. M.X., p-69.

Rose, R., Glesson, F. G. and Atkinson, M. (1993). Morphological and water stress characteristics of three *Douglas fir* stock types in relation to seedling performance under different soil moisture condition. *New Forests*, 7: 1-17.

Roy, M. M. (1986). Seedling growth of *Albizia amara* (Roxb.) Boiv. On different soil types. *Indian J. of Range Mgmt*., 7: 63-70.

Roy, M. M. (1992). Effect of seed pretreatment with Potassium nitrate and Thiourea on germination of *Albizia lebbeck* (L.) Benth. *Indian J. For*., 15(4): 356-357.

Roy, S. B. and Tiwari, R. (1970). Triphenyl Terazolium Bromide for seeds viability test. *Madras Agri. J*., 97: 185-187.

Rutter A. J. (1956). The relation between dry weight increase and linear measure of growth in young conifers. *Forestry*, 28: 128-135.

Sadhu, R. N. and Kaul, V. (1990). Studies on seed viability and germination of *Populus ciliate* growing in Kashmir. *J. Tro. For*., 6(1): 146-149.

Sahai, kanak and Tendon, S. (1993). Studies on flowering and seed quality of some trees of *Tectona grandis* L. f., *Indian J. For*., 16 (2): 127-131.

Saina S., dasti A. A. Hussain F., Wazir S. M. and Malik S. A., (2009). Floristic composition along an 18km long transect in Ayubia national park, District Abbottabad, Pakistan. *Pak, J. Bot.*, 41(5): 2115-2127.

Saini, B. C., Mishra, K. K. and Singh, R. N. (1999). Effect of Pre-sowing seed treatment on germination of Teak (*Tectona grandis*)Seed in sand beds. Indian J. *For*., 22 (3): 245-247.

Saju, P.U., Gopikumar, K., Asokan, P.K. and Anil, J.R. (2000). Effect of shade on seedling growth of *Grevillea robusta, Tectona grandis* and *Allianthustriphysa*in the nursery. *Indian For.*, 126(1): 57-61.

Sasithorn, Karaboon, Ripona, S., Thanapornpoonpong, Sa-nguansak., Pawelzik, E. and Vearasilp, Suchada (2005). Breaking dormancy and optimum storage temperature of Golden Shower (*Cassia fistula*) seeds. Conference on international Agricultural research for development Trooentag (2005). Stuttgart Hohenheim, October.

Savio, M. D., Bachpai, V. K. W., Nautriyal, R.S.C. (1999). Potting medium trials in *Casuarina equisetifolia. Sylva plus*, 6(1): 18-20.

Saxena, A. K. and Shah, J. S. (1982). A phytosociological analysis of woody species in forest communities of apart of kumanon Himalaya. *Vegetatio*, 50:3-32.

Saxena, A. K., Rao, O.P. and Singh, B. P. (1995). Effect of shade on seedlings growth of *Delbergia sissoo, Acacia catechu* and *Casuarina equisetifoilia. Ann. For*., 3(2): 152-157.

Saxena, R.K. (1990). Species diversity in tropical dry deciduous forest with particular reference to some forests of Central India. *J. Trop. For*., 6(3): 222-232.

Saxena, S. K, (1989). An ecological study of *Anogeissus pendula* (Edgew.) with special reference to seed germination and silvicultural treatment, *Ph. D. Thesis, Bundelkhand Univ*., Jhansi.

Saxena, S. K. (1989). An ecological study of *Anogeissus pendula* (Edgew.) with special reference to seed germination and silvicultural treatment, *Ph.D. Thesis, Bundelkhand Univ*., Jhansi.

Saxena, S. K. and Tripathi, J. P. (1989). Archietectural studies of root sucker in *Anogeissuspendula*Edgewand their relation with topography. Proc.76th Session, *Indian Science congress*, Part-III.

Saxena, S. K., Dhakarey, R. P. S., Dwivedi, R. K. and Jethi, D. K. (1992). Vegetational analysis of selected forest stands in Kaymore plateau. *J. Tro. For*., 8(4): 323-328.

Schmidt, Lars (2000). Planning and preparation of seed collections. *Guide to handing and subtropical forest seed* (Kirsten Olesen, ed.) Danida forest seed Centre, Humleback, Denmark pp. 292-293.

Sehgal, R. N. and Singh, baltas (1990). Effect of Pre-treatment of seed germination of *Pistacia*integerrina. *Indian J. For*., 13(1): 57-60.

Sehgal, Vinay, Kumar, Jain, S., Aggarwal, P. K. and Jha, S. (2011). Deriving crop Phenology Metrics and Their Trands using Times Series NOAA-AVHRR NDVI Dat. *J. Indian Soc*. *Remote Sens*. 39 (3): 373-381.

Seiler, J. R. and Cazell, B. N. (1990). Influence of water stress on the physiology of Red Spruce seedlings. *Tree physiol*.,6: 69-77.

Semalty, R. K. and Sharma, C. M. (1996). Phenology and Floral biology of *Acer caesium* Wall. *Indian For*., 122 (2): 170-176.

Semwal, R. L., Nautiyal, K. S., Rao, Maikhuri, R. K. and Bhandari, B. S. (1999). Structure of forests under community conservation: A Preliminary study of Jardhar village initiative in Garhwal Himalaya, ENVIS bulletin- Himalayan Ecology and Development, 7(2): 16-27.

Seth, S.K. and Srivastava, P.B.L. (1972). Effect of profile morphology on root development of Sal (*Shorea robusta*) seedlings. *Indian For.*, 98(2): 156-167.

Shah, G. L. and Bhatt, R. G. (1980). Phytosociology of the forests of Panchmahals district in Eaastern Gujarat. *Indian J. For.*, 3 (1): 47-53.

Shaheen, H. and Shinwari, Z. K., (2012). Phytodiversity and Endemic richness of karambar lake vegetation from Chitral, Hindukush- Himalayas. Pak. J. Botany 44 (1): 15-20.

Shamet, G. S. and khosla, P. K. (1996). Vegetative propagation of Deodar (*Cedrus deodara*) in North-West Himalaya. *Ann. For*., 4(1): 21-24.

Shamet, G. S. and Kumar, S. (1998). Rooting studies of *Punica granatum* and *Delbergia sissoo* cutting under controlled Phytoenvironment condition. *Indian For*., 114(6): 331-334.

Shanker, V. (1970). Growth of *Trichodesma amplexicaul* Roth. in relation to certain edaphic factors. *Trop. Ecol*., 11: 80-89.

Sharma, A., Tiwari, K. P., Tiwari, H. C. and koshare, M. (2002). Pre-sowing seed treatment in *Pterocarpus marsupium*Roxb. to enhance seed germination and seedling growth. *J. Tro. Fro.*, 16(1): 23-30.

Sharma, B. K. and Jain, P. P. (1981). Studies on the effect of Period of collection and storage of Sal (*Shorea robusta*) seeds, kernel and its oils. *Indian For.*, 107: 336-350.

Sharma, D. K., Pandey, C. B. and singh, A. Kumar (2001). Seed polymorphism in *Acacia nilotica* and their effect on growth of seedling in nursery condition. *Range Mgmt. and Agrofor*, 22(2): 225-230.

Sharma, L.K. and Pandey, O.N. (1999). Effect of plant growth regulators on rooting behavior of cutting of *Dalbergia latifolia*Roxb. and *Delbergia sissoo*Roxb. *Indian For.*, 125(4): 421-426.

Sharma, M. P. and gaur, R. D. (1983). A contribution of the Flora of Pokharrn block (Chamoli Garhwal) western Himalaya. *Indian J. For.*, 6(2):149-157.

Sharma, Niranjan (2002). The flora of rajasthan. Avishkar Publishers, Distributers, Jaipur (Raj.) p-77.

Sharma, P. D. (2004). A text Book, Ecology and environment. *Rastogi publication*, Gangotri, Meerut. P-137.

Sharma, P., Thakur, V. and Panwar, P. (2002). Effect of seed size and storage temperature on germination of *Toona ciliate* seeds. *Indian J. For.*, 25(4): 420-423.

Sharma, Ritu, S., Kothari, R. M. and Ramamurthy (2004). The role of potting media in raising *Acacia auriculiformis* Plantlets in nursery. *In. J. For.*, 27(1): 51-55.

Sharma, S. (1996). Studies on seed qulity parameters of important social forestry tree species. *Ph. D.Thesis. Dr. Y. S. Parmar Univ. of Horticulture and Forestry. Solan*. India.

Sharma, S. K. (1990). Floristic composition and Phytosociological studies of a herbaceous community at Dibrugarh. *Indian J. For.*, 13 (4): 273-280.

Sharma, S. K., Gorge, M., Prasad, K. G. and Krishnamurthy, T. (1986). Ecology of the tropical savannah vegetation of Nilgiris. *Indian J. For*., 100-103.

Sharma, V. and Natwat, G. S. (1987). Allelopathic effect of *Argemone maxicana* L. on species of Triticum, Brassica, raphanus and Pennisetum, *Curr. Sci*., 56(9): 427-428.

Sharma, Yogender and Sharma, J. C. (2004). Effect of irrigation and nutrient regions on moisture distribution pattern and available nutrient under young Chirepine (*Pinus roxburghii*) plantation in Mid Hill conditions of Himachal Pradesh. *Indian For*., 130 (8): 911-920.

Shaukat, S.S., Siddiqui, Z. S. and Seemi, Aziz (1999). Seed size variation and its effect on germination, growth and seedling in *Acacia nilotica* Sub sp. Indica (Benth.) Bernan. *Pak. J. Bot*., 31(21): 253-263.

Sheelavanta, M. N., Bhat, R. S. and Halepyati, A. S. (1993). Breaking dormancy in *Sesbania rostrata* by acid and boiling water treatment. *Seed Res*. (Spl. Vol.) : 484-489.

Shiley, H.L. (1929). The influence of light intensity and light quality upon the growth of plant. *Am. J. Bot*., 16: 354-390.

Shukla, Jitendra, K, and Kasera, Pawan, K. (2004). Response of irrigation and spacing levels on growth parameters of Khejiri (*Prosopis cineraria). Indian J, For*., 27(4): 335-338.

Siddiqi, N. A., Shahidullah, M. and Shahjalal, M. A. H. (1991). Studies on the size viability and germination of seeds of Sundri *(Heritiera fomes* Buch. Ham.) *Indian J. For*., 14(2): 119-124.

Singh, A. and Verma, M. M. (1970). TZ derivatives for seed viability tests. *Indian J. Agri. Sci.,* 40: 867-872.

Singh, Balbir and Nayyar, Harsh (2000). Response of aged Bamboo (*Dendrocalamushamiltonii* L.) seeds to application of Gibberellic acid and Indole -3-Butyric acid. Indian For., 126(8): 874-878.

Singh, E. J., Yadav, P. S. and Singh, T. B. (1998). Ecological study of Shiroy Hills Manipur. *Flora and Fauna*, 4(1): 7-8.

Singh, J. S. and Singh, V. K. (1992). Phenology of seasonally dry tropical forest. *Curr. Sci*., 63 : 684-689.

Singh, J., Rama, D.S., Taneja, K.D. and Malik, B. S. (1989). Effect of irrigation on green and dry matter production in summer forages. *Forage Res.*, 15(1): 25-28.

Singh, Jarnail and Mahajan, A. G. (1998). Natural regeneration status in Melghat forests. An overview. *Indian For.*, 124 (4): 186-196.

Singh, K. and Nanda, K. K. (1981). Effect of gibberallic acid on extension growth, bud dormancy and flowering of Juvenile seedlings of *Callistemon viminalis L. Indian J. Exp. Biol.*, 19: 661-663.

Singh, K. P. and Kushwaha, C.P. (2005). Emerging paradigms of tree Phenology in dry tropics. *Current Sciences* 89: 964-975.

Singh, K. P. and Kushwaha, C.P. (2006). Diversity of flowering and fruiting Phenology of Trees in a Tropical Deciduous forest in India. *Annals of Botany*. 97: 265-276.

Singh, K. P., Dhakre, Gunjan and Chauhan, S. V. S. (2005). Effect of Mechanical and Chemical treatment on seed germination in Pongamia*glabra*L. ,*Seed Res*., 33(2): 169-171.

Singh, Mahabir, Sharma, B.K. and Yadav, H. S. (1995). Response of plant growth regulatgors and Layering dares on air layering of Jack fruit (*Artocarpus heterophyllus* Lam.) . *Ad. Plant Sci*., 8(1): 130-133.

Singh, N. B. (1985). Biochemical test for viability of two Indian trees, *NationalSeminar onforest tree seeds*, Hyderabad, June.

Singh, N. B. (1992). Tetrazolium staining test for seed viability of two Indian tree species. *J. Tro.For.*, 8(IV): 303-307.

Singh, N. D. and Arunachalam, A. (2002). Effect of Pre-sowing treatment and seed size on germination in five Leguminous tree species. *Range Mgmt. and Agrofor*., 23(2): 139-143.

Singh, P., Balbir., Sharma, Shivesh and Atul (2006). Effect of microsite variation on the Phenological studies of Himalayan shrubs Wood fordia, *Carissa prinsepia* and *Debregeasia*. *Indian For*., 132(2): 211-220.

Singh, R. R. and Chander, Harish (2001). Effect of auxins on rooting behavior of Neem (*Azadirachta indica*) Branch cuttings. *Indian For.*, 127(9): 1019-1024.

Singh, R. V. and Gupta, K. C. (1979). Preliminary stuies on germnation of *Populus ciliate* seed. In Proc. Symposium on silvipasture. *Management and Utilization of Peplars*, F. R. I., Dehradun.

Singh, R. V. and Singh, Virendra (1984). Germination of Silver fir as affected by depth of sowing. *Indian J. For*., 7(4): 328-329.

Singh, R. V., Chandra, J. P. and Sharma, S. N. (1973). Effect of depth of sowing on germination of Kail (*Pinus wallichiana*) seed. *Indian For*., 99(6): 367-371.

Singh, R. V., Chandra, J. P. and Sharma, S. N. (1975). Effect of depth of sowing on germination of Spruce (*Picea smythiana*) seed. *Indian For.*, 101(3).: 170-175.

Singh, R., Sood, V. K., Bhatia, Monika and Thakur, G. C. (1991). Phytososiological studies on tree vegetation around Shimla, Himachal Pradesh. *Indian J. for*., 14 (3): 169-180.

Singh, R.R., Kaushik, J. C. and Singh, jagir (2000). Effect on soil media on germination, shoot and root length and number of nodules of three nitrogen fixing tree species seedlings. *Indian J. For*., 23(2): 157-159.

Singh, S. L. and sahoo, U. K. (2019). Shift in Phenology of Some Dominant tree species due to climate change in Mizoram, North East India. *Indian J. of Ecology*. 46(1): 132-136.

Singh, S. L. and Yadav, R. N. (1988). Regeneration through Coppice in some tree species. *Vansansadhan: A Botanical J. of state forest Research laboratory*, Kanpur 5(2).

Singh, Sachin and Tripathi, J. P. (2008). Use of TTC for interpretation of viability of seeds of *Cassia fistula* (Linn.). *Flora and fauna*, 14(1): 47-56.

Singh, Sarjan., Singh, Ombir and Singh, Virender (1993). Effect of seed weight on germination. Survival and initial growth *of Aeseulus indica., Indian For.*, 119(8): 627-629.

Singh, V. and Sah, V. K. (1992). Effect of seed weight on germination and seedling growth in Silver fir (*Abies pindrow* Spach). *Van Vigyan*, 30: 104-106.

Smith, A. M. (1961).*Practice of Silviculture* (11th ED.), John wiley sons Inc., New York.

Smith, F. G. (1952). The mechanism of the Tetarzolium reaction in Corn embryos. *Plant physiol*., 27: 445-456.

Smith, P., martino D., Cai Z, Gwary D. Janzen H., Kumar P, Mecarl B, Ogles. Omara F, Rice C, Scholes B and Sirotenko O (2007). Agriculture In: Metz B, Davidson OR, Basch PR. Dave R and Meyer LA (eds). *Climate change 2007: Mitigation. Contribution of working Group III to the fourth Assessment report of the Intergovernmental Panel on Climate change.* Cambridge University Press, Cambridge United Kingdom and New York, NY, USA.

Sood, Rachita and Thakur, P. S. (2006). Response of multipurpose tree species to two successive summer droughts after transplanting. *Indian For.*, 137(7): 841: 849.

Sparks, T. H. and Menzel, A. (2002). Observed changes in seasons: An overview. *International* J. of climatology 22: 1715-1725.

Srimathi, P., Vinay, Rai P. S. and Surendran, C. (1991). Studies on the effect of seed coat and seed size on seed germination in *Acacia mellifera. Indian J. For.*, 14: 5-7.

Srinivasan, K. and Saxena, S. (2007). Effect of dormancy breaking treatment on seed quality during storage of four *Acacia* species. *Ind. J. For*., 30(2): 233-240.

Srivastava, H. S. (2003). A text book of Plant Physiology and Biochemistry, *Rastogi publication, Meerut*. pp.-303.

Srivastava, P. and Singh, S. (2013). Phenology and Biodiversity of Riparian plant species of Ganga River Bank at Bharwari (Kaushambi), U. P., India. *Indian J. Sci. Res.*4 (1): 117-123.

Srivastave, H. S. (2003). A text book of plant physiology and Biochemistry. *Rastogi publication,* Meerut. Pp.303.

Srivastave, R., Nanhorya, P. and Upadhyaya, J. K. (1998). Selection of proper potting mixture for root trainers of *Eucalyptus* hybrid. *Indian Fo*r., 124(7): 502-510.

Stein, W. I., Slabangh, P. E. and Plummer, A. P. (1974). Harvesting processing and storage of fruits and seeds in seeds of woody plants in the United States. Agricultural Handbook No. 450, *For. Service, USDA* Washington, D. C.

Stirnemann R., Pletsers A., Proctor H., Cooney T., Caffarra A, O Halloran J., Jones M and Donnelly A (2008). Climate change impacts on Phenology: Implication for terrestrial ecosystem. Presented at the climate change and Systematics conferences at Trinity College, Dublin, Ireland.

Strasberg, D. (1996). Diversity, size composition and spatial aggregation among trees on a 1 ha rain forest plot at La Reunion. *Biodiversity and Conservation*, 5: 825-840.

Subhi, M. N. and Shakya, P. R. (1993). Structural and floristic compositrion of Oak (Quercus semecarpifolia sm.) forest at Domjechauki, rasuwa District, Central Nepal. *Indian For*., 199(6): 466-471.

Sudhakar, K., and jijeesh, C. M. (2008). Effect of germination, grading and storage of Teak (*Tectona grandis* Linn. F.) drupes on the germination parameters. *Indian For*., 134(2): 241-249.

Sudhakar, K., mammen, W., Santosh kumar, A. V. and Ashokan, P. K. (1996). Effect of seed size, Rooting medium and fertilizers on containerized seedling *Ceiba pentandra*. *Indian For*., 121(12): 1135-1142.

Sudheendra, Kumar, V. V., Nair, K. S. S. and Chacko, K. C. (1993). Phenology and seasonal growth at Nilambur (Kerala) India. *Ann. For*., 1: 42-46.

Sujit, R., Sudhakara, K., Santoshkumar, A. V. and Asshokan, P. K. (1994). Effect of different pretreatments on germination of *Ceiba pendandra* (Linn.) Gaertn. *Seeds. J. Trop. For*., 10: 199-206.

Sulladnath, U.V. and Kologi, S. D. (1960). Synergustion influence of IBA and NAA on the rooting of air layering in Chiku var. Kalipatti. *Indian Hort*., 17: 9-17.

Sunderraju, R. and Bharanthi, R. K. (1989). Silviculture and management practices of *Casuarina* in Tamilnadu. Proc. *Nat. Sem. On Casuarina*, 18-19 Dec., Neyveli.

Suparna, M. R., Farooqi, A. A. and Prasad, T. G. (1993). Influence of various pre-sowing treatments in *Gloriosa superbe* L., *Indian J. For*., 16(2): 123-126.

Swarupanandam, K., sasidharan, N., Chacko, K. C. and Basha, S. Chand (1996). Studies on the Shola forests of Kerala. *KFRI Research Report*. 158.

Tekatay, D. D. (1994). Germination ecology of two endemic multipurpose species of Erythrina from Ethiuopia. *Forest Ecology and Mangement*, 65: 81-87.

Thakur, A. S. and Khare, P. K. (2008). Species diversity and Composition of forest vegetation of Sagar District in Central India. *Indian For*., 134 (6): 801-813.

Thakur, I. K., Gupta, A. and Thakur, vidya (2002). Germination of scarified seed of *Grewiaoptiva*. *Indian J. For*., 25 (2): 158-160.

Thakur, P. S., Butt, V. and Thakur, A. (2008). Impact of inter annual climate variability on the Phenology of elaven multipurpose tree species. *Curent Sciences* 94(8): 1053-1058.

Thakur, P. S., Chauhan, S., Thakur, A. and Dhall, S. P. (2000). Influence of Paclobutrazol and moisture stress conditioning on drought suspectibility in *Robinia psedoacacia* seedlings. *J. Trop. For. Sci.*, 12: 493-502.

Thakur, P. S., Kashyap, T., Thakur, A. and Dhall, S. P. (1998). Effect of moisture stress conditioning on the performance and water relationship of *Grewia optiva* seedlings during water deficit. *Indian J. Plant physiol*., 3: 152-155.

Thakur, V., and Chauhan, J. C. (1997). Phytosociological analysis of woody vegetation along habitat Gradiation in the Mid-Hills of Himachal Pradesh. *Indian For*., 13 (1): 49-54.

Theertha, P. C., Dr. Sincy Josesh, Drishya N. S., Atheena K. and Anusree N. (2021). Floristic Diversity and Phytosociological studies of selected area in kanayannur, kannur District, Kerala, *International J. of Creative Resarch Thoughts (IJCRT)*, 9 : 4048-4057.

Tiwari, Pankaj and Saxena, A. K. (2003). Effect of different soil mixtures and fertilizers on the growth of *Dalbergia sissoo* (Roxb.) seedlings. *Indian J. For*., 26(3): 254-259.

Tiwari, Pradeep K., Bajpai, S. P., Agarwal, Ravi and Kiran, Savita (2000). Studies in the effect of different light conditions on seedling growth of some Leguminous foret tree species. *J. Trop. For.*, 16(III): 63-69.

Tripathi, J. P. (1984). Ecophysiological study of *Anogeissus pendula* (Edgew.). *Ph. D. Thesis*, *Sagour Univ*, Sagour.

Tripathi, J. P. and Bajpai, S. P. (1982). Phytosociological study of *Anogeissus pendula* Type forests of Bundelkhand region-I. Bulletin of the Botanical society, *University of Sagar*, 29: 37-44.

Tripathi, J. P. and Saxena, S. K. (1986). Growth performance of *Anogeissus pendula* seedlings under nursery conditions relation to different irrigation conditions. *Indian J. Range Mgmt*., 7(2): 79-82.

Tripathi, J. P., Yadav, A. S. and Bajpai, S. P. (1983). Phytosociological study of *Anogeissus pendula* Type forests of Bundelkhand region-II. *J. Tree Sci*., 2 (172): 58-62.

Tripathi, K. P., Mahrotra, Shanta and Pushpangadan, P. (2006). Vegetation characteristics of tropical forests of Andaman Islands. *Indian For.*, 132 (2): 165-180.

Tripthi, J. P. and Saxena, S. K. (1987). A note on natural regeneration of *Anogeissus pendula*Edgew., *Geobios*. 14: 102-103.

Tuteja, S, C. and Singh, V. (1980). The botany of Sheopur Forest division of Madhya Pradesh. I. Geology and Forest types. *Indian J. For*., 3: 9-14.

Upreti, K. K., Murti, G. S.R. and Bhatt, R. M. (1999). Response of French bean cultivars to water deficit: Changes in Endagenous hormone. Preline and chlorophyll. *Biologia plantarum*, 40: 381-388.

Vaish, C.P. (1965). Effect of NAA and IBA on the germination of Onion (*Allium cepa* L.) Allahabad farm. 39: 80-84.

Vanangamudi, K. C., Umarani, R., Bharathi, A. and Venketesh, A. (1998). Effect of seed source on physical and physiological qualities of *Acacia nilotica* seed. *Seed Res*., 26(2): 114-116.

Vazquez-Yanes, C. and Orozco-Segovia, A. (1993). Patterns of seed longevity and germination in the tropical rainforest. *Annual Review of Ecology and Systenaties*, 24: 69-87.

Verma, D. C. and Haider, M. M. (1998). Allelopathic potential of Leaf extracts of some forest trees on seed germination in *Leucaena leucocephala*. *Range Mgmt. amd Agroforestry*, 19(1): 83-85.

Verma, R. and Das, R. R. (1981). Ecological studies on the forest Kolaras range. *Indian J. For.,* 5: 123-128.

Verma, R. C. and Puri, Sunil. (1996). Vegetative propagationof*Acacia catechu* (Willd.) using mature softwood and hardwood cuttings. *J. Tree Sci*., 11(2): 95-100.

Verma, R. K., Anand, Krishna and Gupta, S. R. (1999). A review on Bundelkhand forest communities. *Flora and Fauna*, 5 (1): 37-39.

Verma, R.K., Kapoor, K.S., Rawat, P.S. and Kumar, Surinder (2006). Effect of Lime stone mine spoil and forest soil based potting media on growth performance of different tree species under nursery. *Indian For.*, 132(8): 1001-1006.

Verma, R.K., Totey, N. G. and Gupta, B. N. (1997). Analysis of forest vegetation in the permanent preservation plot of Tamna in Orissa, *Indian For.*, 123(11): 1007-1016.

Verma, S. K., Sharma, V. K. and Bagchi, S. K. (1999). The Phenology of flowering of reciprocal F1 Hybrids *Eucalyptus citriodora* Hook *Eucalyptus torelliana* F.V. Muell., F2 and F3 segragates and parent species at New forest, Dehradun, *Ann. For.*, 7(1): 120-124.

Vidyasagaran, K., Gopikumar, K and Ajithkumar (2004). Phytosociological analysis of selected Shola forest of the Nilgiri hills of Western ghats. *Indian For.*, 130 (3): 283-290.

Vidyasagaran, K., Pramod, G. K. and Gopikumar, K. (2000). Ecological studies in a high land riverine island forest ecosystem, Kuruva, Wynaad. Proc Intl. Symp. On Tropical Research, Kerala forest research Institute, Peechi Kerala 2-4 Augest 2000.

Vijayalalitha, S. J. and Lada, R. Rajasekaran (1997). Germination inhibitors in Pink Cassia (*Cassia grandis*). A possible role in Dormancy. *Ad. Plant Sci.*, 10(1): 227-228.

Vinaya, Ghat, S. and Kumbhojkar, M. S. (1991). Phenology of deciduous Ornamental trees from western Maharashtra. *Indian J. For.*, 14(3): 181-189.

Vyakaranahal, B. S., Shashidhara, S. D., Merwade, M. N. and Havaldar, Y. N. (1992). Effect of grading on seed quality in *Termarindus indica* (L.). *My Forest*, 28 (4): 325-328.

Vyas, S.P. and Nein, Saroj (1999). Effect of shade on the growth of *Cassia ungistifolia. Indian For.*, 125(4): 407-410.

Watva, Aparna, Gandhe, R. V. and Gandhe, K. R. (2003). Vegetation structure and composition of semi-evergreen forest Fragments in mulshi area of Northern Western Ghats. *Ann. For.*, 11 (2): 155-165.

Wedd, L. J., Dale, M. B., Tracey, J. G. and Kikkawa, J. (1977). Structural classification as a method to predict site potential in the development and conservation of tropical humid forest lands. In Trasaction of the international MAB IUFRO work shop on tropical rain forest Ecosystem Research (Ed. R.F. Bruing) Homburg Reinbek, chair of world forestry special report No.1: 32-148.

Weigh, M. (2001). Evidence for increased sensitivity to nutrient and water stress in a fast growing hybrid willow compared with a natural willow clone. *Tree physiol.*, 21: 1141-1148.

White, Lee. J. T., (1994). Patterns of fruit fall phenology in the lope reserve gabon**.** *J. of Trop. Ecol.*, 10: 289-312.

Whitwford, P. B. (1949). Distribution of woodlwnd plant in relation to successive and colonial growth. *Ecol.* 30: 199-208.

Woods, P. V., Peseta, O. and Webb, M. J. (1998). Effectiveness of Organic potting media for raising Mahagony (*Sweiteniamacrophhlla*) seedlings in Western Samoa. *J. Trop. For.*, 10(4): 555-560.

Yadav, A. S. and Mishra, G. P. (1982). Effect of imbibitions on gernative capacity in seeds of some tropical dry deciduous forest trees. *Bulletin of the Botanical society, Univ. of sagour*, 29 (1&2): 1-4.

Yadav, A. S., Khare, P.K. and Mishra, G.P. (1982). Growth performance of *Tectona grandis* Linn. F. Seedlings in different pot culture media. *Indian J. For.*, 5: 86-89.

Yadav, R. K. and Yadav, A. S. (2008). Phenology of selected woody species in a tropical dry deciduous forest in Rajasthan, India. *Tropical Ecology*, 49: 25-34.

Yadav, S. S. and Shah, G. L. (1984). Phytosociological studies of the vegetation of Duhanu forest division in Maharashtra II correlation of the species. *Ind. J. Ecol.*, (1): 15-18.

Yadav, S. S., Hooda, M. S. and bangarwa, K. S. (1998). Effect of seed size on physiological seed quality in Shisham (*Dalbergia sissoo*). *Ind. J. For*., 21(1): 13-15.

Yadav, V. K., Kjhare, P. K. and Mishra, G. P. (1986). Quick test for viability and vigour of seeds of *Chloroxylon sweifenia, J. Trop. For*., 2: 213-216.

Ye, M. F. (1984). Effect of plant growth regulation on rooting of cutting several tree species. *Plant Physiol. Communication*, 28-29.

Yeboah, J., Lower, S. T. and Amoh, F. M. (2009). The rooting performance of Shea (*Vitellaria paradoxa*) stem cutting as influence by wood types sucrose and rooting hormone. *ScientificResearch and Essay*, 4(5): 521-525.

Zhang, G., Q. Song and D. Yang (2006). Phenology of *Ficus racemosa* in Xishuangbanna, Southwest China. *Biotropica*, 378: 334-341.

Zodape, S. T. (1991). The improvement of germination of some forest species by acid scarification. *Indian For*., 117(1): 65-67.

Bundelkhand Research Journal | December, 2024 | Volume 2, Issue 2 ISSN: 2584-0533

Effect of Pre-Sowing Treatment and Seed Size on Germination in *Butea monosperma* (Roxb.)

Manoj Kushwaha and Sachin Singh
Department of Botany, P. K. University Shivpuri (M. P.)
Corresponding Author: manojkushwaha271990@gmail.com
Received 27 June 2024; Revised 08 November 2024; Accepted 22 December 2024

ABSTRACT

The effect of pre-sowing treatment on seed germination of *Butea monosperma* was studied using mechanical scarification, sulphuric acid treatment (5, 10 and 15 minutes) and dry heat treatment at 60, 80, and 100 0C (15, 30, and 60 minutes). The percentage germination was different between these treatments. Seeds of treated with sulphuric acid for 10 minutes showed better germination (100%). Germination was higher at 60 0C dry heat incubation compared to 80 0C and 100 0C. *Butea monosperma*, a legume tree species of ecological and economic importance, often exhibits poor seed germination due to hard seed coat impermeability. This study investigated the effects of pre-sowing treatments (mechanical scarification, hot water treatment, and sulfuric acid treatment) and seed size on germination. Results indicated that pre-sowing treatments significantly enhanced germination percentage compared to the control. Among the treatments, mechanical scarification followed by hot water treatment proved most effective. Seed size also influenced germination, with larger seeds showing higher germination rates. The findings suggest that employing appropriate pre-sowing treatments, particularly mechanical scarification and hot water treatment, can significantly improve germination success in *Butea monosperma*, facilitating its propagation and conservation efforts. Additionally, selecting larger seeds for sowing can further enhance germination success and seedling vigor. These findings have significant implications for the successful propagation and restoration of *Butea monosperma* populations.

Keywords: *Butea monosperma*, Mechanical Treatment, Scarification, Chemical Treatment, Seed Germination.

INTRODUCTION

Butea monosperma (Roxb.), a member of family Febaceae is a moderate sized deciduous tree with a rather open crown. This is one of the most beautiful of Indian flowering trees, vernacular name is Dhak and locally known as Palash [1]. The Fruit an indehiscent pod, (min. 9) 17-24 x (min. 3) 4-6 cm, stalked, covered with short brown hairs, pale yellowish-brown or grey when ripe, in the lower part flat, with a single seed near the apex. Seed ellipsoid, flattened, about 3cm long. It contains sugar, tartaric acid, malic acid, oxalic acid, one more acid catharatic acid considered the purgative principal of

Publisher: Maharaja Chhatrasal Bundelkhand University, Police Lines Road, Panna Road Chhatarpur (M.P) - 471001

the drug [2]. Natural regeneration of this species is very limited [3]. We know much about the species potential in terms of growth and productivity. There are certain factors (intrinsic and extrinsic) which determine seed germination. Critical among intrinsic factors are seed coat impermeability and status of the embryo. Likewise, external environmental factors such as temperature and moisture can affect seed germination. The power of germination of *Butea monosperma* is lost during the storage [4]. The seed coat of *Butea monosperma* is very hard due to the advancement of aril and crauncle during the time of megagametogenesis. Seed coat-imposed dormancy is a delaying mechanism, which prevent germination under condition that might prove to be unsuitable for establishment, thereby, distribution germination both in time and space. [5]. Find best pre-sowing treatment for enhancement of germination in *G. arborea*. Seeds were treated with different treatment includes growth regulators (GA3 100 and 20ppm), acid scarification (H_2SO_4), cold water and untreated seeds as control. Among all the treatments seeds treated with GA3 (200ppm) recorded the higher germination percentage (98.88%) followed by H_2SO_4 (93.33%) as compared to untreated seeds in control. [6] also studies the effect of different treatments on the seed germnation on Pterocarpus marsupium. [7] has studies Pre-sowing treatment in *Terminelia bellirica* and observed that Seeds of *Terminelia bellirica* shows best germination (100%) in seeds treated with H_2SO_4 for 10 minutes. [8] has studies in pre-sowing treatment in *Gmelina arborea*. Therefore, large, medium and small sized seeds of *Butea monosperma* (Roxb.), were treated with sulphuric acid, dry heat exposures and mechanical scarification to determine the germination.

MATERIAL AND METHODS

For experiment Seeds were collected from 20-22 years old *Butea monosperma* (Roxb.), trees situated at Banguan and Orchha forests in the month of April to May 2023. For investigation, the seeds were divided into three categories on the basis of their weight. Large (0.21-0.30g), medium (0.11-0.20g) and Small (0.05-0.10g). The seeds were treated mechanically as well as with chemicals. Effect of temperature was also studied on seed germination. Various Pre-sowing treatment made are summarized as under:

1. A small piece of the seed coat from distal end of cotyledon was removed mechanically using a nail clipper and sown (Scarification).
2. Seeds were treated with concentrated H_2SO_4 (98%) for 5, 10, 15 minutes and after treatment, the seeds were rinsed for about 3 minutes under tap water.
3. Dry heat treatment was given by keeping the seeds in preheated oven at 60o, 80o and 100oC for 15, 30 and 60 minutes and then sown.

Publisher: Maharaja Chhatrasal Bundelkhand University, Police Lines Road, Panna Road Chhatarpur (M.P) - 471001

The treated seeds were sown in Polythene bags of 25cm X 10cm sized at Botanical garden, P. K. University Campus, Shivpuri. The experiment was set up in completely randomized design and replicated twice. Regularly watering was done in the experiment. After the germination data were collected and statistically analyzed.

RESULTS AND DISCUSSION

The seeds of *Butea monosperma* (Roxb.), were subjected to various pre-treatments for enhancing germination percentage. It is interesting to note that all of the treatments were quite effective in enhancing seed germination percentage (table-1).

MECHANICAL TREATMENT

Removal of small part of seed from distal end before sowing enhanced seed germination (36.3%) as compared to 16.7% germination with intact seed coat (control) in medium sized seeds while in small sized seeds no germination occurred. Other sized seeds showed poor germination. With the perusal of the results it has been concluded that the enhanced germination in the medium sized seeds was due to better imbibition of water through the seed coat.

EFFECT OF ACID TREATMENT

Treatment with concentrated H_2SO_4 enhanced seed germination (table-1). High germination (100%) was obtained by treatment with the acid for 10 minutes in large and medium sized seeds. Acid treatment with concentrated H_2SO_4 for 5 minutes also showed good results (100%) in large sized seeds only but other large sized seeds did not show good results in 5 minutes acid treatment while treatment with 15 minutes showed less germination in all sized seeds. Thus, the suitable timing of breaking the dormancy of *Butea monosperma* (Roxb.), by acid treatment (Con. H_2SO_4) was 10 minutes. Acid scarification with concentrated h2so4 for 30 minutes improved seed treatment to the extent of 83% in acacia [9]. However, H_2SO_4 treatment for 60 minutes in Acacia *nilotica* seeds improved germination up to 90% [10]. During the course of present investigation treatment with concentrated H_2SO_4 for only 10 minutes was found to be much effective and enhanced seed germination could have been the reason that the seed coat of the seed would have become fully permeable to water.

DRY HEAT TREATMENT

Rate of germination differed significantly between dry heat treatment as well as incubation periods. In *Butea monosperma* the germination response to various dry heat treatments was not good. In general, dry heat treatment was not good. In general, dry heat treatment at 60°c gave better results than other temperature. Temperature exposure for 30 minutes and above proved lethal in *Butea monosperma*. Dry heat treatment of *Pongamia galbra* at 25°c showed maximum germination [11].

Publisher: Maharaja Chhatrasal Bundelkhand University, Police Lines Road, Panna Road Chhatarpur (M.P) - 471001

Treatment	Categories of Seeds		
	Large	Medium	Small
Scarification (Mechanical)	21.1 (3.1)	36.3 (4.2)	0 (0)
Sulphuric acid 5 minutes	100 (9.1)	66.7 (8.3)	50 (6.3)
10 minutes	100 (16.7)	100 (12.5)	83.3 (6.7)
15 minutes	50 (8.3)	66.7 (8.3)	66.7 (11.1)
Dry heat, 60°C 15 minutes	50 (3.33)	33.3 (2.1)	50 (3.1)
30 minutes	66.7 (6.1)	33.3 (4.2)	16.7 (2.8)
60 minutes	0 (0)	33.3 (3.3)	16.7 (2.8)
Dry heat, 80°C 15 minutes	33.3 (1.5)	16.7 (1.3)	33.3 (2.6)
30 minutes	31.3 (4.2)	16.7 (3.3)	0 (0)
60 minutes	16.7 (1.7)	16.7 (2.1)	16.7 (1.7)
Dry heat, 100°C 15 minutes	16.7 (2.8)	16.7 (1.1)	16.7 (2.1)
30 minutes	16.7 (3.3)	0 (0)	0 (0)
60 minutes	0 (0)	0 (0)	0 (0)
Control	0 (0)	16.7 (1.1)	0 (0)

Table 1. Effect of Seed treatment on seed germination of *Butea monosperma* (Roxb.),

Publisher: Maharaja Chhatrasal Bundelkhand University, Police Lines Road, Panna Road Chhatarpur (M.P) - 471001

REFERENCES

[1] Troop, R. S. (1921). The Silviculture of Indian Trees, Vol I, II and III, Charendon Press, Oxford.

[2] Bhattacharya, S. K. (2000). Hand book of medicinal plant. Popular offset services. Jaipur: 78.

[3] Singh, R. V., (1982). Folder trees of India Oxford and IBH Pub. Co. New Delhi. 82-83pp.

[4] Arya, Chitra and Arya, Arun (2006). Effect of storage on seed viability and germination of certain Leguminous trees. Indian For., 132 (5): 601-608.

[5] Berry, N., Shukla, A. and Barade, E., (2021). Pre-sowing treatment of seeds and its impact on germination of *Gmelina arborea* Roxb. The Pharma Innovation Journal, 10 (10): 239-243.

[6] Khan, M. R. (2015). The effect of different Treatments on the seed germination of *Pterocarpus marsupium* Roxb. Weekly Sci Res. J. 2 (28): 22.

[7] Kumar, V., (2020). Effect of Pre-sowing seed treatment on Germination of *Terminelia bellirica* (Gaetn.). Indian J. of Ecology. 43 (1): 237-238.

[8] Adebisi, M. A. and Bello, F. Y. (2015). Seed germination and seedling vigour attributes of Gmelina (*Gmelina arborea*) seed saffected by fruit maturity levels and pre-storage investigation treatment under ambient tropical conditions. Nigeria Agricultural Journal. 45 (1): 155-170.

[9] Singh, K. P., Dhake, G. and Chauhan, S. V. S. (2005). Effect of mechanical and chemical treatments on seeds germination in *Pongamia galbra* L. Seed Res. 33 (2): 169-171.

[10] Zodape, S. T. (1991). The improvement of germination of some forest species by acid scarification. Indian For., 117 (1): 65-67.

[11] Natarajan, N and Rai, R. S. V. (1998). Studies on maximization of germination in *A. auriculiformis*. Indian J. For., 11 (4): 304-306.

Publisher: Maharaja Chhatrasal Bundelkhand University, Police Lines Road, Panna Road Chhatarpur (M.P) - 471001

International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Butea Monosperma: Exploration of It's Therapeutic Application's

Manoj Kushwaha[1], Sachin Singh[2]

[1,2]Ecological Research Laboratory, Department Of Botany, P.K.University Shivpuri (M.P)

Abstract

Butea monosperma, commonly known as the "flame of the forest," is a versatile medicinal plant widely recognized in traditional medicine systems such as Ayurveda and Unani for its extensive therapeutic potential. This review explores its pharmacological applications, highlighting its antimicrobial, anti-inflammatory, antidiabetic, hepatoprotective, antioxidant, and anthelmintic activities. These effects are attributed to its rich composition of bioactive compounds, including flavonoids, tannins, alkaloids, and glycosides. Preclinical studies have demonstrated its efficacy in managing conditions like infections, diabetes, liver disorders, and oxidative stress. Additionally, *Butea monosperma* shows promise as a natural remedy for reproductive health, wound healing, gastrointestinal protection, and even cancer prevention, though these applications warrant further clinical investigation. Despite its traditional significance and growing scientific interest, more research is required to validate its therapeutic benefits, standardize dosages, and explore its synergistic potential with other treatments. This review underscores the need for advancing the pharmacological understanding of *Butea monosperma* for developing novel, plant-based therapeutic agents.

KEYWORDS: Butea monosperma, Medicinal plant, Flavonoids, Alkaloids, and Tannins

Introduction

Butea monosperma , commonly referred to as the "flame of the forest" due to its striking orange-red flowers, is a deciduous tree belonging to the Fabaceae family. Native to tropical and subtropical regions of South Asia, this plant has been revered in traditional medicine systems like Ayurveda, Unani, and Siddha for centuries. Known for its diverse pharmacological properties, *Butea monosperma* is a source of numerous bioactive compounds, including flavonoids (butein, butin), alkaloids, tannins, and glycosides, which contribute to its therapeutic potential. Traditionally, various parts of the plant, such as flowers, seeds, bark, and leaves, have been utilized for treating a wide array of ailments, including infections, inflammation, diabetes, liver disorders, and gastrointestinal conditions. Modern scientific studies have begun to validate these traditional claims, revealing the plant's antimicrobial, anti-inflammatory, hepatoprotective, antidiabetic, antioxidant, and anthelmintic properties. Given its vast array of medicinal applications, *Butea monosperma* has attracted significant attention in the field of phytopharmacology. This exploration aims to provide an overview of its tTherapeutic applications highlight the underlying mechanisms and bioactive compounds responsible for its effects. Moreover, it seeks to identify gaps in current knowledge and discuss potential areas for future research, particularly in translating its traditional uses into evidence-based clinical practices. This investigation underscores the

importance of *Butea monosperma* as a promising source of natural therapeutics, emphasizing the need for continued research to harness its full medicinal potential.

Methodology

Butea monosperma, also known as the Flame of the Forest, is a tree native to India and Southeast Asia. It has a long history of use in traditional medicine for a variety of ailments. The Seed are used to treat diarrhea, constipation and menstrual disorders. The bark is used to treat boils, wounds, and other skin problems. The flowers are used to reduce fever. The roots are used to treat urinary tract infection. Modern research has identified a number of active compounds in *Butea monosperma* including flavonoids, alkaloids, and tannins. These compound have been shown to have a variety of pharmacological effects, including Anti-inflammatory, Antioxidant, Antimicrobial and Anticancer.


Fig: A


Fig: B


Fig: C

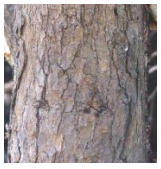

Fig: D


Fig: E

("In the Figure: A, B, C, D, and E represent the seed, root, flower, stem, and leaf, of *Butea monosperma* respectively.")

Therapeutic Application

1. Antimicrobial Activity

The antimicrobial activity of *Butea monosperma* has been extensively studied, revealing its effectiveness against a wide spectrum of microorganisms, including bacteria, fungi, and parasites. This therapeutic property is attributed to its diverse phytochemical composition, particularly flavonoids, tannins, alkaloids, and phenolic compounds, which exhibit potent antimicrobial effects.

Antibacterial Activity :-

Mechanism: The bioactive compounds disrupt bacterial cell membranes, inhibit enzymatic activity, and interfere with protein synthesis, thereby hindering bacterial growth and survival.

Evidence: Studies have shown significant antibacterial activity against both Gram-positive (e.g., Staphylococcus aureus, Bacillus subtilis) and Gram-negative bacteria (e.g., Escherichia coli, Pseudomonas aeruginosa).

Applications: Effective in treating skin infections, wounds, respiratory infections, and gastrointestinal disorders caused by bacterial pathogens.

Antifungal Activity :-

Mechanism: The plant's antifungal components interfere with fungal cell wall synthesis and impair fungal replication.

Evidence: Extracts of *Butea monosperma* have demonstrated inhibitory effects against pathogenic fungi such as Candida albicans and Aspergillusniger.

Applications: Useful in managing fungal infections, particularly dermal and mucosal conditions.

Antiparasitic Activity :-

Mechanism: Certain alkaloids and tannins in the plant exhibit toxic effects on parasites, disrupting their metabolism and survival.

Evidence: The seeds and bark of *Butea monosperma* have been traditionally used as anthelmintics to expel intestinal worms, and research confirms their efficacy against parasitic infections.
Applications: Treatment of helminthic infections and protozoal diseases.

2. Anti-inflammatory and Analgesic Activity

Butea monosperma is well-known for its anti-inflammatory and analgesic properties, which have been extensively studied in traditional and modern medicine. These properties are largely attributed to its bioactive compounds, including flavonoids (butein, butin), tannins, and phenolic compounds, which modulate inflammatory pathways and provide pain relief.

Anti-inflammatory Activity :-

Mechanism: The plant exerts its anti-inflammatory effects by Inhibiting the production of pro-inflammatory mediators like prostaglandins, leukotrienes, and cytokines (e.g., interleukins, TNF-α). Reducing the activity of cyclooxygenase (COX) and lipoxygenase (LOX) enzymes, which play a central role in inflammation. Scavenging free radicals to decrease oxidative stress, which contributes to inflammation.

Evidence: Animal studies have shown that extracts of *Butea monosperma* significantly reduce edema and inflammation induced by carrageenan and histamine. Its flavonoids, particularly butein, exhibit strong anti-inflammatory activity comparable to standard non-steroidal anti-inflammatory drugs (NSAIDs).

Applications: Management of inflammatory conditions such as arthritis, gout, and skin inflammation. Alleviation of respiratory inflammation in conditions like asthma and bronchitis.

Analgesic Activity :-

Mechanism: The plant provides pain relief by Modulating central and peripheral pain pathways. Inhibiting nociceptive signals through its interaction with opioid receptors and reduction of prostaglandin synthesis.

Evidence: Preclinical studies demonstrate the analgesic efficacy of Butea monosperma extracts in reducing pain perception in models of thermal and chemical-induced pain. The seeds and bark have been traditionally used to alleviate muscle pain and joint discomfort.

Applications: Pain management in musculoskeletal disorders like osteoarthritis and rheumatoid arthritis. Relief from headaches, menstrual pain, and neuropathic pain.

Key Bioactive Compounds

Flavonoids (e.g., Butein, Butin): Potent inhibitors of inflammatory mediators.
Tannins: Contribute to anti-inflammatory and astringent properties.
Phenolic Compounds: Scavenge free radicals and reduce oxidative stress.

3. Antidiabetic Properties of *Butea monosperma*

Butea monosperma has been extensively studied for its potential to manage diabetes mellitus, particularly type 2 diabetes. The plant's antidiabetic effects are attributed to its bioactive compounds, such as flavonoids, tannins, alkaloids, and phenolic compounds, which regulate blood glucose levels and mitigate complications associated with diabetes.

Mechanisms of Action

1. Regulation of Blood Glucose Levels

- Stimulates insulin secretion from pancreatic β-cells.
- Enhances glucose uptake in peripheral tissues, improving insulin sensitivity.

- Inhibits intestinal carbohydrate-digesting enzymes like α-amylase and α-glucosidase, reducing postprandial hyperglycemia.

2. Oxidative Stress Reduction

- The antioxidant properties of flavonoids and phenolics neutralize reactive oxygen species (ROS), preventing oxidative damage to pancreatic cells.

3. Anti-inflammatory Effects

- Suppresses inflammation-mediated insulin resistance by inhibiting pro-inflammatory cytokines such as TNF-α and IL-6.

4. Lipid Metabolism Regulation

- Reduces hyperlipidemia by modulating lipid profiles, thus lowering the risk of cardiovascular complications in diabetic patients.

Evidence from Research

In Vitro Studies: Extracts of *Butea monosperma* have shown α-amylase and α-glucosidase inhibitory activity, demonstrating their ability to reduce carbohydrate digestion and absorption.

Animal Studies: Diabetic animal models treated with *Butea monosperma* extracts exhibited significant reductions in fasting blood glucose levels, improved lipid profiles, and enhanced antioxidant enzyme activity.

Bioactive Compounds: Flavonoids like butin and lutein are key contributors to the plant's antidiabetic effects, acting as insulin mimetics and antioxidants.

Applications

Glycemic Control: Effective in managing hyperglycemia in type 2 diabetes.

Prevention of Complications: Protects against diabetic nephropathy, neuropathy, and retinopathy by mitigating oxidative and inflammatory damage.

Adjunct Therapy: Can be used alongside conventional antidiabetic medications to enhance therapeutic outcomes.

4. Hepatoprotective Activity of *Butea monosperma*

The hepatoprotective potential of Butea monosperma has garnered attention in both traditional and modern medicine. This activity is primarily attributed to its rich array of bioactive compounds, including flavonoids, tannins, phenolics, and alkaloids, which protect the liver from oxidative damage, inflammation, and toxic insults.

Mechanisms of Action

Antioxidant Effects

- Scavenges free radicals and prevents lipid peroxidation, reducing oxidative stress on liver cells.
- Enhances the activity of antioxidant enzymes like superoxide dismutase (SOD), catalase, and glutathione peroxidase.

Anti-inflammatory Effects

- Inhibits pro-inflammatory cytokines (e.g., TNF-α, IL-6) and reduces inflammation in the liver.

Detoxification Support

- Boosts the liver's enzymatic detoxification pathways, aiding in the clearance of toxic substances.

Membrane Stabilization

- Prevents damage to hepatocyte cell membranes caused by toxins or oxidative stress.

Evidence from Research

Animal Studies: *Butea monosperma* extracts have shown significant hepatoprotective effects in animal

models subjected to chemically induced liver damage (e.g., carbon tetrachloride, paracetamol, and alcohol-induced hepatotoxicity). Treatment restored liver enzyme levels (ALT, AST, ALP) and reduced markers of oxidative stress.

Histopathological Studies: Liver tissues from treated animals showed reduced necrosis, inflammation, and fibrosis, indicating protective and regenerative effects.

Key bioactive compound:

Flavonoids(e.g., Butein, Butin): Protect against oxidative damage and stabilize hepatocyte membrane.

Tannins: Exhibit astringent and detoxifying properties.

Phenolic Compound: Combat oxidative stress and support detoxification pathways.

Application

Liver Damage Prevention: Effective in preventing liver injury caused by toxins, drugs, and alcohol.

Treatment of Liver Disorders: Useful in managing conditions like hepatitis, fatty liver disease, and cirrhosis.

Supportive Therapy: Enhances recovery in cases of acute liver damage or chronic liver conditions.

5. Antioxidant Effect of *Butea monosperma*

Butea monosperma, widely used in traditional medicine, exhibits significant antioxidant activity. This property is attributed to its rich phytochemical profile, including flavonoids, tannins, phenolic acids, and other bioactive compounds, which play a crucial role in neutralizing free radicals and preventing oxidative damage.

Mechanisms of Action

1. Free Radical Scavenging: Neutralizes reactive oxygen species (ROS) and reactive nitrogen species (RNS), thereby protecting cellular components from oxidative damage.
2. Enhancement of Antioxidant Enzymes: Stimulates the activity of endogenous antioxidant enzymes such as superoxide dismutase (SOD), catalase, and glutathione peroxidase.
3. Lipid Peroxidation Inhibition: Prevents the oxidative degradation of lipids in cell membranes, reducing the risk of cellular dysfunction and damage.
4. DNA Protection: Protects DNA from oxidative stress-induced damage, which is crucial in preventing mutagenesis and carcinogenesis.

Evidence from Research

In Vitro Studies: Extracts of *Butea monosperma* have demonstrated strong scavenging activity against DPPH (2,2-diphenyl-1-picrylhydrazyl) radicals, superoxide anions, and hydroxyl radicals.

High ferric reducing antioxidant power (FRAP) values indicate its ability to reduce oxidized compounds effectively.

In Vivo Studies: Animal studies have shown that *Butea monosperma* reduces oxidative stress markers, such as malondialdehyde (MDA), while increasing levels of antioxidant enzymes.

Key Bioactive Compounds

Flavonoids (e.g., Butein, Butin): Known for stimulating the production of sex hormones and improving sexual performance.

Alkaloids: May have mild stimulant properties that improve libido and energy.

Tannins: Contribute to antioxidant effects, enhancing overall reproductive system health.

Applications

Chronic Disease Management: Reduces oxidative stress associated with diabetes, cardiovascular diseases, and neurodegenerative disorders.

Cancer Prevention: Protects against oxidative DNA damage, which can lead to cancer development.
Skin Health: Prevents oxidative damage caused by UV radiation and environmental pollutants.

6. Anthelmintic Activity of *Butea monosperma*

Butea monosperma, commonly known as flame of the forest, has a long history of use in traditional medicine for its anthelmintic properties. Various parts of the plant, particularly the seeds, flowers, and bark, are known to effectively expel intestinal parasites and treat helminthic infections. This activity is attributed to its bioactive constituents, including flavonoids, alkaloids, tannins, and phenolic compounds.

Mechanisms of Action

Paralysis of Parasites: The active compounds interfere with the neuromuscular coordination of parasites, causing paralysis and eventual death.

Damage to Parasite Integrity: Disruption of the parasite's cell membrane and metabolic pathways, leading to structural and functional impairment.

Inhibition of Egg Development: Prevents the maturation and hatching of helminth eggs, breaking the lifecycle of the parasite.

Evidence from Research

In Vitro Studies: Extracts of *Butea monosperma* have shown significant activity against various helminths, including Ascarislumbricoides and Haemonchuscontortus. The methanolic and ethanolic extracts of seeds exhibit dose-dependent paralysis and death of parasites.

In Vivo Studies: Animal studies demonstrate the effectiveness of *Butea monosperma* in reducing worm burdens in infected models. Extracts significantly decrease the fecal egg count and improve the overall health of the host.

Key Bioactive Compounds

Flavonoids (e.g., Butein): Contribute to neuromuscular disruption in parasites.

Tannins: Bind to proteins and inhibit the survival and motility of worms.

Alkaloids: Interfere with parasite metabolism and cellular function.

Applications

1. Treatment of Intestinal Worm Infections: Effective in managing roundworms, hookworms, and tapeworm infections.
2. Agricultural Use: Potential as a natural anthelmintic agent for livestock.
3. Complementary Therapy: Can be used in conjunction with other anthelmintic drugs to enhance efficacy and prevent resistance.

7. Aphrodisiac and Reproductive Health Properties of *Butea monosperma*

Butea monosperma, traditionally known for its medicinal benefits, is also renowned for its aphrodisiac and reproductive health-promoting properties. These effects are attributed to its bioactive compounds, including flavonoids, alkaloids, and tannins, which are believed to enhance sexual health, libido, fertility, and overall reproductive function in both men and women.

Mechanisms of Action

1. Enhancement of Sexual Function: Increases blood flow to the genital area by improving circulation, contributing to enhanced libido and sexual performance. Acts as a mild stimulant for the nervous system, potentially increasing sensitivity and arousal.
2. Hormonal Regulation: Modulates the endocrine system, including the balance of sex hormones like

testosterone and estrogen, supporting healthy reproductive function. Helps in balancing the hypothalamic-pituitary-gonadal axis, which plays a crucial role in sexual health and reproduction.

3. Adaptogenic Effects: Reduces stress and anxiety, which are often contributing factors to reduced sexual desire and performance. Increases energy and stamina, supporting overall vitality, including sexual health.
4. Sperm Quality Improvement: Enhances sperm count, motility, and morphology, which is beneficial for male fertility. Protects sperm cells from oxidative damage, promoting healthy reproductive outcomes.

Evidence from Research

Animal Studies: Animal experiments demonstrate increased sexual behavior, enhanced mating performance, and improved fertility outcomes when treated with *Butea monosperma* extracts. Studies on male rats have shown an increase in serum testosterone levels, sperm count, and motility, suggesting its role in male reproductive health.

Human Studies: Limited clinical trials suggest improvements in sexual desire and performance, although more extensive research is needed. In traditional medicine, it has been used to treat sexual dysfunction and enhance vitality, further supporting its aphrodisiac properties.

Phytochemical Analysis: Key bioactive compounds such as butein and butin contribute to the plant's aphrodisiac activity by stimulating the nervous and hormonal systems.

Key Bioactive Compounds

Flavonoids (e.g., Butein, Butin): Known for stimulating the production of sex hormones and improving sexual performance.

Alkaloids: May have mild stimulant properties that improve libido and energy.

Tannins: Contribute to antioxidant effects, enhancing overall reproductive system health.

Applications

1. Libido Enhancement: Used as a natural remedy to enhance sexual desire and combat issues such as low libido or sexual fatigue. Useful in treating sexual dysfunctions, including erectile dysfunction (ED) and premature ejaculation.
2. Fertility Support: Promotes both male and female fertility by improving sperm quality and supporting healthy ovulation. Helps regulate menstrual cycles in women and may be beneficial for conditions like Polycystic ovary syndrome (PCOS).
3. General Reproductive Health: Supports overall reproductive health, enhancing vitality and general wellness. Can be incorporated into treatments for menopausal symptoms and age-related reproductive issues in women.

8. Wound Healing Properties of *Butea monosperma*

Butea monosperma, commonly known as the flame of the forest, has been widely used in traditional medicine for treating wounds, cuts, and skin ailments. Its wound healing properties are attributed to its rich phytochemical composition, including flavonoids, alkaloids, tannins, and phenolic compounds, which possess anti-inflammatory, antimicrobial, and regenerative effects.

Mechanisms of Action

1. Anti-inflammatory Effects: Reduces inflammation at the site of injury, helping to accelerate the healing process by inhibiting the production of pro-inflammatory cytokines such as TNF-α and IL-6.
1. Prevents excessive swelling, which can delay healing and cause further tissue damage.

2. Antioxidant Activity: Protects the wound area from oxidative stress by scavenging free radicals and preventing oxidative damage to cells. This action supports faster tissue regeneration and minimizes scarring.
3. Antimicrobial Properties: The plant's antimicrobial compounds inhibit bacterial and fungal infections, which can complicate wound healing. This is particularly important in preventing secondary infections that may delay recovery.
4. Collagen Synthesis and Tissue Regeneration: Enhances the synthesis of collagen, a key structural protein involved in tissue repair. This promotes the formation of new tissue at the wound site, accelerating the healing process and reducing scarring. Stimulates fibroblast proliferation and angiogenesis (formation of new blood vessels), which are essential for wound closure and tissue repair.
5. Astringent and Moisturizing Effects: The astringent properties of the plant's extracts help in tightening the skin and reducing fluid loss, which can aid in faster wound healing. It also helps maintain an ideal moist environment for wound healing, reducing the risk of infection and promoting faster recovery.

Evidence from Research

In Vitro Studies: Studies have demonstrated that *Butea monosperma* extracts can stimulate the proliferation of human dermal fibroblasts, an essential cell type in wound healing, and enhance collagen production. The extracts also exhibit potent antibacterial activity against common wound pathogens like Staphylococcus aureus and Pseudomonas aeruginosa.

Animal Studies: In animal models, *Butea monosperma* extracts have shown significant acceleration of wound healing. Rats treated with *Butea monosperma* extracts displayed faster epithelialization and enhanced wound contraction compared to untreated control groups. Topical application of *Butea monosperma* extract on excision wounds resulted in reduced inflammation, faster tissue regeneration, and improved overall wound healing outcomes.

Human Studies: While there are fewer human clinical studies, some traditional applications and anecdotal evidence support the effectiveness of *Butea monosperma* in promoting wound healing and reducing scarring.

Key Bioactive Compounds

Flavonoids (e.g., Butein, Butin): These compounds have antioxidant and anti-inflammatory properties that support tissue regeneration and protect against oxidative stress.

Tannins: Known for their antimicrobial and astringent properties, they help in controlling infection and reducing fluid loss from the wound.

Alkaloids: Provide antimicrobial benefits and contribute to the overall wound healing process by supporting tissue regeneration and reducing infection.

Applications

1. Topical Wound Healing Formulations: Extracts from *Butea monosperma* can be used in topical creams, ointments, and gels for the treatment of cuts, abrasions, burns, and ulcers. These formulations can promote faster healing, reduce inflammation, and prevent infection.
2. Chronic Wound Management: It is particularly useful for chronic wounds, such as diabetic ulcers or pressure sores, by promoting tissue regeneration and preventing secondary infections.
3. Skin Care Products: *Butea monosperma* is increasingly incorporated into skin care formulations aimed at improving skin texture, reducing scars, and enhancing overall skin health.

9. Anti-Cancer Potential of *Butea monosperma*

Butea monosperma, a plant with a long history of medicinal use in traditional medicine, has shown promising anti-cancer potential due to its bioactive compounds, including flavonoids, alkaloids, tannins, and phenolic acids. These compounds exhibit various mechanisms of action that can inhibit cancer cell growth, induce apoptosis (programmed cell death), and reduce metastasis. The plant's antioxidant, anti-inflammatory, and immunomodulatory properties further contribute to its cancer-fighting abilities.

Mechanisms of Anti-Cancer Action

1. Induction of Apoptosis: *Butea monosperma* has been shown to induce apoptosis in cancer cells by activating the mitochondrial pathway and caspase cascades. This leads to the controlled death of cancerous cells, thereby preventing their proliferation.
2. Inhibition of Tumor Growth: The plant's extracts inhibit the growth of cancer cells by blocking the cell cycle at various stages, particularly at the G1 and G2 phases, preventing uncontrolled cell division.
3. Anti-Inflammatory Effects: Chronic inflammation is a major contributor to cancer progression. The anti-inflammatory compounds in *Butea monosperma* inhibit the production of pro-inflammatory cytokines and enzymes such as COX-2 and NF-κB, reducing the inflammatory environment that promotes tumor growth.
4. Antioxidant Properties: *Butea monosperma* antioxidant properties help neutralize free radicals, which are implicated in DNA damage and cancer initiation. By reducing oxidative stress, the plant reduces the risk of mutations that could lead to cancer development.
5. Inhibition of Metastasis: Studies suggest that *Butea monosperma* extracts can inhibit the migration and invasion of cancer cells, preventing metastasis (the spread of cancer to other organs). This is especially important for aggressive cancers, where metastasis is a significant cause of mortality.
6. Angiogenesis Inhibition: Angiogenesis, the process by which tumors develop their own blood supply, is crucial for tumor growth and metastasis. The compounds in *Butea monosperma* may inhibit angiogenesis, thus starving the tumor of essential nutrients and oxygen.

Evidence from Research

In Vitro Studies: Various studies have shown that *Butea monosperma* extracts can inhibit the proliferation of multiple cancer cell lines, including those from breast, colon, lung, and liver cancers. Extracts of the plant induce apoptosis in human cancer cell lines such as MCF-7 (breast cancer), HepG2 (liver cancer), and A549 (lung cancer) through the activation of the caspase pathway.

In Vivo Studies: In animal models, *Butea monosperma* extracts have demonstrated tumor-suppressive effects, with significant reductions in tumor size and weight. These effects are likely due to a combination of direct cytotoxic effects on tumor cells and the inhibition of angiogenesis. Animal studies also reveal that *Butea monosperma* may reduce the side effects of chemotherapy by mitigating oxidative stress and enhancing immune function.

Phytochemical Composition: The plant's key bioactive compounds, such as flavonoids (e.g., butein), alkaloids, tannins, and phenolic compounds, have shown significant anti-cancer activity. These compounds exhibit antioxidant, anti-inflammatory, and anti-metastatic effects that contribute to the plant's overall anti-cancer potential.

Key Bioactive Compounds

1. Butein: A flavonoid that has been shown to exhibit anti-cancer activity by inhibiting cancer cell growth and inducing apoptosis in various cancer types.

2. Butin: Another flavonoid with potent antioxidant and anti-inflammatory properties that contribute to its anti-cancer effects.
3. Tannins: These compounds have demonstrated the ability to suppress tumor cell proliferation and induce apoptosis.
4. Alkaloids: Known to have cytotoxic effects on cancer cells by inducing cell cycle arrest and apoptosis.

Applications

1. Cancer Chemoprevention: *Butea monosperma* extracts could be used as a complementary treatment for cancer prevention, particularly for individuals at high risk of developing cancers due to genetic or environmental factors.
2. Adjuvant Cancer Therapy: The plant may enhance the effects of conventional chemotherapy or radiation therapy by reducing side effects such as oxidative stress, inflammation, and immune suppression.
3. Formulation of Anti-Cancer Drugs: Isolated bioactive compounds from *Butea monosperma* could be developed into new drug formulations for cancer treatment, either alone or in combination with existing therapies.

10. Gastroprotective Effect of *Butea monosperma*

Butea monosperma, a plant widely used in traditional medicine, has demonstrated significant gastroprotective properties. Its potential to treat various gastrointestinal disorders, such as ulcers, acid reflux, and inflammation, is attributed to its bioactive compounds, including flavonoids, alkaloids, tannins, and phenolic acids. These compounds contribute to its ability to protect the stomach lining, reduce inflammation, and promote the healing of gastric lesions.

Mechanisms of Gastroprotective Action

1. Antioxidant Effects: The antioxidant properties of *Butea monosperma* help neutralize free radicals, which are implicated in oxidative stress and gastric mucosal damage. By scavenging reactive oxygen species (ROS), the plant protects the gastric lining from damage caused by excessive acidity and inflammation.
2. Anti-inflammatory Action: *Butea monosperma* reduces the secretion of prO-inflammatory cytokines such as TNF-α and IL-6, which play a key role in the development of gastric inflammation and ulceration. This anti-inflammatory effect helps to alleviate the symptoms of conditions like gastritis and peptic ulcers.
3. Mucosal Protection and Healing: The plant's extracts promote the synthesis of mucus in the stomach, which forms a protective barrier against stomach acid and harmful enzymes. This mechanism helps prevent ulcer formation and accelerates the healing of existing gastric lesions. Additionally, *Butea monosperma* has been shown to stimulate the regeneration of gastric epithelial cells, further promoting mucosal healing and tissue repair.
4. Inhibition of Gastric Acid Secretion: *Butea monosperma* has been found to reduce excessive gastric acid secretiOn, which is a common cause of gastric ulcers and acid reflux. This is particularly beneficial in managing conditions like peptic ulcers, where high acid levels can damage the stomach lining.
5. Antibacterial Activity: The antimicrobial properties of *Butea monosperma* are effective in combating Helicobacter pylori, a bacterium commonly associated with gastric ulcers. By inhibiting H. pylori infection, the plant helps prevent ulcer formation and promotes healing in infected individuals.

Evidence from Research

In Vitro and In Vivo Studies: Animal studies have demonstrated that *Butea monosperma* extracts can significantly reduce gastric ulcers induced by various agents such as aspirin, ethanol, and stress. The extracts not only reduce ulcer size but also promote faster healing of the gastric mucosa. Research has shown that the plant's flavonoids and alkaloids contribute to its ability to reduce gastric acid secretion and increase mucus production, thereby enhancing mucosal protection.

Phytochemical Studies: The plant contains active compounds such as flavonoids (e.g., butein, butin), tannins, and alkaloids, which have demonstrated significant gastroprotective and anti-ulcer activities. These compounds work synergistically to provide protection to the gastric mucosa, reduce acid secretion, and heal existing gastric lesions.

Helicobacter pylori Inhibition: Studies have shown that *Butea monosperma* extracts inhibit the growth of Helicobacter pylori, a major causative agent of gastric ulcers. This antibacterial effect contributes to the plant's overall gastroprotective benefits.

Key Bioactive Compounds

1. Flavonoids (e.g., Butein, Butin): Known for their antioxidant, anti-inflammatory, and ulcer-healing properties.
2. Alkaloids: Provide antimicrobial and anti-inflammatory benefits, aiding in the prevention and treatment of gastric ulcers.
3. Tannins: These compounds possess astringent properties that help in mucosal protection and wound healing.
4. Phenolic Compounds: Provide antioxidant activity, reducing oxidative stress and promoting gastric mucosal repair.

Applications

1. Treatment of Gastric Ulcers: Butea monosperma can be used in the treatment of peptic ulcers, particularly for reducing ulcer size, alleviating pain, and promoting faster healing of the gastric lining.
2. Management of Gastritis and Acid Reflux: The plant's anti-inflammatory, mucosal-protective, and acid-reducing effects make it useful in managing conditions like gastritis, acid reflux, and other inflammatory gastrointestinal disorders.
3. Complementary Therapy for Helicobacter pylori Infection: The antibacterial properties of Butea monosperma can be used as an adjunct to antibiotic treatment for Helicobacter pylori infection, enhancing the eradication of the bacterium and supporting gastric healing.
4. Prevention of Gastric Damage: The plant can be used preventively in individuals prone to gastric ulcers or acid reflux, particularly those who consume non-steroidal anti-inflammatory drugs (NSAIDs) or have a history of gastrointestinal problems.

Conclusion

Butea monosperma exhibits significant therapeutic potential across a range of health conditions due to its diverse bioactive compounds. From antimicrobial to anti-cancer, hepatoprotective, and gastroprotective effects, the plant shows promise as a natural remedy for various ailments. However, while there is substantial preclinical evidence supporting its efficacy, more clinical studies, particularly human trials, are needed to fully establish its therapeutic applications and safety. Further research into standardized formulations and dosage will be crucial for integrating *Butea monosperma* into mainstream healthcare. The World Health Organization (WHO) has already acknowledged the value of indigenous

people' traditional medical practises. It is crucial to have accurate records of medicinal plants and to be aware of their capacity for enhancing health and sanitation by environmentally amicable systems. Therefore, it is important to consider the possibilities of ethnomedical research as they can offer a very efficient method for identifying helpful medicinally active individuals. In order to identify, classify, and record plants in a way that will help advance traditional knowledge of the herbal medicinal plants, a thorough and methodical study is required. According to a recent assessment, *Butea Monopserma* is used to treat a variety of illnesses.

REFERENCES

1. Jhade D, Ahirwar D, Sharma NK. Butea monosperma(Lam.)taubert:areview.Journalof Pharmacyresearch.2009Jul;2(7):1181-3.
2. Hajare AG, Choudhary MD, Gupta NS. Plant review: Phytochemical constituents and their importantcharacterizationofButeamonosperma (palash). International Journal ofApplication or Innovation in Engineering & Management. 2013;5:1-4.
3. Chawla Anshul; A valuable insight into the phytochemistry, pharmacognosy B & pharcology of palash; International Journal of Pharmaceutical Science and Research; 2016, Vol 1(6);22-32
4. Varsha S. Therapeutic Significance of Butea monosperma: A Review. JofDrug Delivery and Therapeutics.2011;1(2):63-7.
5. Sutariya BK, Saraf MN. A comprehensive review on pharmacological profile of Buteamonosperma (Lam.) Taub .Journal of Applied Pharmaceutical Science. 2015 Sep27;5(9):159-66.
6. Ghoshal KP, Meshram SM and Akare SM; EthnobotanicalsurveyofsomemedicinaltreesfromDeoriTaluka, Gondia dist. (M.S); international JournalofLifeSciences;2013;110-114.
7. Lohitha P, Kiran VR, Babu KM, et al. Phytochemical screening and in vitro antimicrobial activity of butea monosperma (L) barkethanolicandaqueousextract.International Journal of Pharmaceutical Sciences and Research. 2010 Oct1;1(10):150.
8. Choudhary RK, Swarnkar PL. Antioxidant activity of phenolic and flavonoid compounds in some medicinal plants of India. Natural product research.2011Jul1;25(11):1101-1109.
9. Tiwari P, Jena S, Sahu PK. Butea monosperma: phytochemistry and pharmacology.ActaScietificPharmaceuticalScience.2019;3(4):19-26.
10. Mishra MK. Preliminary phytochemisticalscreeningandpharmacologicalevaluationofthe leaves of Butea monosperma. International Journal of Pharmaceutical Sciences and Research.2016Feb1;7(2):714.
11. Deshmukh M, Sahare KN, Patidar RK, et al. Antifilarial activity of Butea monosperma L. leaves extracts against Setariacervi. Trends in VectorResearchandParasitology.2014;1(1):1-5.
12. Katewa SS, Chaudhary BL, Jain A. Folk herbal medicines from tribal area of Rajasthan, India. Journal of ethnopharmacology. 2004 May 1;92(1):41-46.
13. Harish M, Ahmed F, Urooj A. In vitro hypoglycemic effects of Butea monospermaLam.leavesandbark.Journaloffoodscienceand technology.2014Feb;51(2):308-314.
14. VaishaliB,KottaNiranjanGoud,NareshKetal; Evaluation of wound healing activity of Gel containing the flower extract of Butea MonospermaLam; International Journal of PhamacognosyandphytochemicalResearch;2014;vol6(1);39-44

15. SharmaD,PatelS,VermaK,etal.AntibacterialandantidiarrhealactivityofButeaMonospermea bark extract against waterborne enterobacterCloacaeinrodents:In-vitro,Ex-vivoandIn-Vivo evidences. Journal of ethnopharmacology. 2019 Sep15;241:112014.
16. Sharma AK, Deshwal N. An overview: on phytochemical and pharmacological studies of Buteamonosperma.IntJPharmTechRes.2011 Apr;3(2):864-871.
17. Mendhe BB, Umesh N, Piyush G, et al. Evaluation of anthelmintic activity of leaf extracts of Butea monosperma. International JournalofPharmaceuticalSciencesandResearch (IJPSR).2010;1(3):69-72.
18. Piyush G, Mendhe BB, Namrata S, et al. Antioxidant activity of flavonoidal content of Butea monosperma. International Journal of Pharmaceutical Sciences and Research (IJPSR). 2010;1(4):85-88.
19. KumarJN,KumarRN,BhoiRK,etal.Seasonalchangesofbioelementsinlitterandtheirpotential return to green leaves in five species of tropical dry deciduous forest, western India. Journal of Forestry Research.2010 Mar 30;21(1):33-38.
20. Kumar JN, Kumar RN, PATEL K, et al. ConsequenceofButeamonospermaplantationon the nutrient cycling in a semiarid grazingland, Rajasthan, India. Int. J. Plant Sci. 2010 Jan;5(1):16-23.
21. Sindhia VR, Bairwa R. Plant review: Butea monosperma. International journal of pharmaceutical and clinical research. 2010;2(2):90-94.

Phytosociological Analysis of Mixed Deciduous Forests of Bundelkhand Region

Manoj Kushwaha[1], Sachin Singh[2]
[1,2] *Ecological Research Laboratory, Department of Botany, P.K.University Shivpuri (M.P)*
doi.org/10.64643/IJIRTV11I11-174847-459

***Abstract*—A phytosociological study was conducted in the mixed deciduous forests of the Bundelkhand region to analyze the community structure, species composition, and diversity patterns. Bundelkhand's unique semi-arid climate and varied edaphic conditions support a distinct flora. This research aimed to understand the ecological dynamics of these vital forests, crucial for biodiversity conservation and ecosystem services. Quadrat sampling was employed to collect data on species presence, abundance, and frequency. Various ecological indices, including species richness, diversity indices (Shannon-Wiener, Simpson), and dominance patterns were calculated. The study revealed the dominant tree species and their associated communities. Analysis of the data provided insights into the forest's current ecological status and its response to environmental factors. The findings contribute to effective conservation strategies and sustainable management of these ecologically important forests in the Bundelkhand region.**

***Index Terms*—Bundelkhand, mixed deciduous forests, phytosociology, species diversity, dominance, community structure, ecological dynamics, biodiversity conservation.**

I. INTRODUCTION

Phytosociological analysis of a plant community is an important aspect of ecological study of any piece of vegetation. It reveals the structural picture of the vegetation and helps in analysis the community dynamics. Among the various kinds of ecosystem encountered in the Mixed deciduous forest, due to their unique features have always attracted ecologists. These ecosystems have evolved their own ways of complex biological processes and deserve attention as special ecological entities (Vidyasagaran et al. 2004). Vegetation analysis is important as the structure of the vegetation expresses most relevant results and is a flexible tool in the analysis of complex system (Weed et al. 1977). Bundelkhand region is covered by the mixed deciduous forest. Jhansi is situated between latitude 24°11′- 26°27′ and Longitude 78°17′- 81°34 E at 275mm above sea level. Temperature ranges from 20°C -45.7°C and minimum from 2.5°C-29°C. The climate of Jhansi is semi-arid with an average rainfall of 900mm mostly between last week of June to September (Pandey et al. 2002). A thorough knowledge of the community can be best acquired if ecology of individual plant species, forming a constituting part of the community is studied (Joshi and Gupta, 1982). To have complete idea of the structure and composition of a community, it is essential to understand it is various analytical characters. Analytical characters viz. Relative frequency, Relative density. Relative basal area and IVI are very useful in the composition of two different forest communities. From the above information it is evident that is a scope for studying the Phytosociological attributes of Bundelkhand region in view to understand their conservation status. Thus, A thorough knowledge of the community can be helpful in understanding the ecological implication of the forest. Phytosociological studies in forest have carried out by many workers viz. Das and Lahiri (1997), Jose et al. (1994) and Balaji and Nitant(2002). There is paucity of data on performance, adaptability association and growth architecture of individual species.

The present study envisages Phytosociological behavior of Mixed deciduous forest in relation to its other associates at different topographic region of Banguon and Orchha forests.

II. MATERIAL AND METHOD

Phytosociological studies were carried out through quadrate methods. The both Banguon and Orchha forest were divided in the equal compartments arbitrarily 40 of 10X10m size each placed at equal distance in parallel lines. The study was carried out in July 2023. Three analytical characters viz. Relative frequency, Relative density. Relative basal area were considered for the calculation of IVI of each species (Curtis and Cotton,1962). The formulae for the determination of these parameters are given below.

$$\text{Relative Frequency} = \frac{\text{Frequency of species} \times 100}{\text{Sum of Frequency value of all species}}$$

$$\text{Relative density} = \frac{\text{Density of species} \times 100}{\text{Sum of Density of all species}}$$

$$\text{Relative Basal area} = \frac{\text{Basal area of a species} \times 100}{\text{Sum of Frequency value of all species}}$$

IVI = Relative frequency+ Relative density+ Relative Basal area

The species distribution of species in different stands has been derived from whitford index of A/F ratio (Whitford, 1949). The A/F ratio if below 0.025 indicates regular distribution, between 0.025-0.05 indicates random distribution and when above 0.05 indicates a contagious distribution (Curtis and Cottam, 1956). The similarity between the two-forest stand (Banguon and Orchha) was determined by using the community coefficient.

III. RESULTS AND DISCUSSION

Botanical composition, Percentage frequency, density/m^3, Abundance, frequency class and IVI of each species of Banguon and Orchha forest are given in the Table 1 and 2.

Tatallt 16 species were present in Banguon forest and 19 species in Orchha forest. The 8 species were found common in both forests viz. *Butea monosperma, Cassia fistula, Tectona grandis, Flacourtia indica, Holoptelia intrigrifolia, Acacia leucophloea, Carissa carandas* and *Capparis aphylla*. The *Alangium lamarkii* was most frequent in Banguon forest whereas in Orchha forest it was lacking. This might have due to microclimate and edaphically variation at these two sites. *Tectona grandis* appeared to be both the forests. *Capparis aphylla, Butea frondosa* and *Holoptelia intrigrofolia* were noted more frequent in Banguon forest as compared to Orchha forest. *Cassia fistula* which is a miscellaneous tree occur in the both forests. *Wrightia tinctoria, Anogeissus pendula, Lantana camara* and *Azadiacta indica* were totally absent in Orchha forest. In Banguon forest *Zizyphus xylopyrus, Terminalia belerica, Albizia lebbek, Mitragyana parvifolia, Diospyrus melonoxylon, Aegle marmelos, Eugenia jambolana, Melia azedarach, Terminalia arjuna* and *Cordia myxa* completely absent. In view of the above the Orchha forest appear rich as regard to species diversity than Banguon forest most provably this variability should associate with the reserve nature of Orchha forest. *Butea monosperma* which is the common species in both the forest has higher average height (8.670m) in Banguon forest. The average height of *Butea monosperma* in the Orchha forest is 9.5m.

Density gives the numerical strength of a species in a community. In Banguon forest Lantana camara had the highest density (8.615 individual/m^2). Followed by *Alangium lamarkii* ((7.6 individual/m^2), *Butea monosperma* (4.75 individual/m^2) and *Tectona grandis* (3.45 individual/m^2). At Orchha forest *Tectona grandis* had the highest density (18.05 individual/m^2). *Butea monosperma* had 1.2 individual/m^2 density other species of Orchha forest have density less than 1.

The Abundance gives the number of individuals of a habitat. On Banguon forest *Lantana camara* has highest Abundance value (10.147). Other highest Abundance species are *Alangium lamarkii* (7.6) and *Wrightia tinctoria* (5.842). On orchha forest *Tectona grandis* has highest Abundance value (18.05). Other higher Abundance species are *Eugenia jambolana* (6.5) and *Terminalia arjuna* (6). Other species of Orchha forest have Abundance between the range of 1 to 2. The higher Dbh value in Banguon forest is reported in *Butea monosperma* (56.78cm.). Other higher Dbh value in Banguon is *Alangium lamarkii* (27.95cm) and *Cassia fistula* (33.28cm.). in Orchha forest the higher Dbh value is reported in *Butea monosperma* (56.78cm.) and *Cassia fistula* (35.37cm.).

Importance value index (IVI) represents the extent of dominance of a species in the community. In Banguon forest *Lantana camara* represent hightest IVI value (57.263) followed by *Alangium lamarkii* (46.113) and *Butea monosperma* (33.459)

respectively. At Orchha forest *Tectona grandis* represent highest IVI value (138.135).

The analysis of distribution pattern of individual species on Banguon and Orchha forest indicates that among the three-distribution pattern viz. regular, random and contagious, the contagious distribution was found most common in the study area. The dominance of contagious distribution may be due to the fact that a majority of trees species reproduce vegetatively in addition to sexually and most of the species occur low frequency and high Abundance.

The value of community coefficient of the two forests was reported to be 53.537 which indicate marked dissimilarities of the species composition.

Table-1 Vegetation Characteristics of Banguon forest

Name of the species	Frequency %	Density	Abundance	Frequency class	A/F ratio	Relative frequency	Relative Density	Relative dominance	IVI
Alangium lamarkii	100%	7.6	7.6	E	0.076	12.853	20.416	12.844	46.113
Wrightia tinctoria (R.Br.)	47%	2.775	5.842	C	0.124	6.041	7.454	9.87	23.365
Butea monosperma (Roxb.)	97%	4.75	4.871	E	0.502	12.467	12.760	8.232	33.459
Cassia fistula (Linn.)	15%	0.15	1	A	0.067	1.928	0.4029	1.690	2.733
Tectona grandis (Linn,)	77%	3.45	4.451	D	0.057	9.897	9.267	7.522	26.686
Anogeissus pendula (Edgew.)	45%	1.75	3.889	C	0.086	5.784	4.701	6.572	17.057
Flacourtia indica (Burm.f.) Merr.	60%	1.425	2.375	C	0.039	7.712	3.828	4.013	15.553
Laucaena leucocephala (Benth.)	30%	0.75	2.5	B	0.083	3.856	2.014	4.225	10.095
Lantana camara (Linn.)	85%	8.625	10.147	E	0.119	10.925	23.169	17.149	57.263
Azadiracta indica (Adr. juss)	7%	0.075	1	A	0.142	0.899	0.2014	1.690	2.7904

Holopteli a intrifolia (Planch.)	45%	1.125	2.5	C	0.055	5.784	3.022	4.225	13.031
Acacia leucophl oea (Willd.)	47%	0.85	1.789	C	0.038	6.041	2.283	3.023	11.347
Albizia odoratiss ima (Benth.)	7%	0.075	1	A	0.142	0.899	0.2014	1.690	2.790
Zizyphus oenoplia (mill.)	27%	0.5	1.818	B	0.067	3.470	1.343	3.072	7.885
Carissa carandas (Linn.)	5%	0.05	1	A	0.2	0.642	0.134	1.690	2.466
Capparis aphylla (Roth.)	67%	2.725	4.037	D	0.060	8.611	7.320	6.822	22.753

Table-2 Vegetation Characteristics of Orchha forest

Name of the species	Frequenc y %	Densit y	Abundanc e	Frequenc y class	A/F ratio	Relative frequenc y	Relativ e Density	Relative dominanc e	IVI
Butea monosper ma (Roxb.)	65%	12	1.846	D	0.028 4	15.987	5.189	3.630	24.80 6
Acacia leucophloe a (willd.)	57%	0.95	1.652	C	0.028 9	14.004	4.108	3.249	21.36 1
Tectona gandis (Linn.)	100%	18.05	18.05	E	0.180 5	24.579	78.054	35.502	138.1 35
Cassia fistula (Linn.)	27%	0.3	1.090	B	0.403	6.633	1.297	2.143	10.07 3
Zizyphus oenoplia (mill.)	25%	0.4	1.6	B	0.064	6.142	1.729	3.147	11.01 8
Zizyphus xylopyrus (Willd.)	10%	0.125	1.25	A	0.125	2.457	0.540	2.4562	5.453
Terminalia belerica (Roxb.)	27%	0.325	1.181	B	0.043 7	6.633	1.405	2.322	10.36
Carissa	10%	0.15	1.5	A	0.15	2.457	0.648	2.950	6.055

carandas (Linn.)									
Flacourtia indica (Burm.f.) Merr.	32%	0.625	1.923	B	0.0600	7.862	2.702	3.782	14.346
Capparis aphylla (Roth.)	7%	0.075	1	A	0.1428	1.719	0.324	1.966	4.009
Albizia lebbak (Benth.)	2%	0.025	1	A	0.5	0.491	0.108	1.966	2.565
Mitragyna parvifolia (Roxb.) Korth	7%	0.1	1.333	A	0.1904	1.719	0.432	2.556	4.707
Holoptelia intrifolia (Planch)	7%	0.05	0.666	A	0.0951	1.719	0.216	1.309	3.244
Diospyros melanoxylon (Roxb.)	7%	0.075	1	A	0.1428	1.719	0.324	1.966	4.009
Aegle marmelos (Correa.)	10%	0.125	1.25	A	0.125	2.457	0.540	2.456	5.453
Eugenia jambolana (Lom.)	5%	0.325	6.5	A	1.3	1.228	1.405	12.784	15.417
Melia azedarach (Linn.)	5%	0.05	1	A	0.2	1.228	0.216	1.966	3.41
Terminalia arjuna (Bedd.)	2%	0.15	6	A	3	0.491	0.648	11.801	12.94
Cordia myxa (Linn.)	2%	0.025	1	A	0.5	0.491	0.108	1.966	2.565

IV. SUMMARY

Forest is a grandest biological association of the nature predominated by the trees and other plant species. The present study deal with investigation and characterize the floristic composition and vegetation diversity of the two Mixed deciduous forests (Banguon and Orchha) of Bundelkhand region. The climate of the two forests almost similar and can be said as semi-arid with undulating topography. The 19 trees species were found in Orchha forest while 16 trees species occur in Banguon forest. *Alangium lamarkii* was most frequent in Banguon forest whereas in Orchha forest *Tectona grandis* appeared to most frequent. Only 8 species were common in both forests. *Lantana camara* had the highest density (8.625 individual/m^2) on Banguon Forest while highest density (18.05 individual/m^2) tree of Orchha forest was *Tectona grandis.* The community

coefficient value of these forests was 59.537% which indicates less similarity.

REFERENCES

[1] Balaji, B. and Nitant, H.C. (2002). Phytosociological studies of Yamuna ravies. Range management and Agroforestry 23(2): 110-114.

[2] Curtis, J.T. and Cottam, G. (1956). Plant Ecology work book. Laboratory field reference manual. Burgess Publishing Co., Minnesota. pp.193.

[3] Curtis, J.T. and Cottam, G. (1962). Plant Ecology work book. Laboratory field reference manual. Burgess Publishing Co., Minneapolis, Minn. U.S.A.

[4] Das, A.S. and Lahiri, A.K. (1997). Phytosociological studies of the ground flora in different types of vegetation on Tiger hill, Darjeeling district, West Bengal. Indian Forester 123(12):1176-1187.

[5] Joshi, S.A., Sreepathy, Kumar, B. and Venugopal (1994). Structural floristic and edaphic attributes of the grassland- shola forest of Eravikulam in Peninsular India. For. Eco. Management 65(2-3): 279-291.

[6] Joshi, A.P. and Gupta, S.K. (1982). The structure of the vegetation and community coefficient of certain sub-tropical forest of western Himalaya. Indian J. For., 5(4): 277-281.

[7] Pandey, A. K., Soalnki, K.R. and Gupta, V.K. (2002). Periodical growth and Phenology of 4 years old Neem in semi-arid region. Range management and agroforestry 23(2): 122-125.

[8] Swarupanandan, K., sasidharan, N., Chacko, K.C. and Basha, S. Chand (1996). Studies on the shoal forests of Kerala. KFRI Research Report. 158.

[9] Vidyasagaran, K., Gopikumar, K. and Ajithkumar (2004). Phytosociological analysis of selected Shola forests of the Nilgiri hills of Western ghats. Indian forester 130(3): 283-290.

[10] Wedd, L.J., dale, M. B., Tracey, J. G. and Kikkawa, J. (1977). Structural classification as a method to predict site potential in the development and conservation of tropical humid forest lands. In trasaction of the internation MAB IUFRO work shop on tropical Rain Forest Ecosystem Research (Ed. R.F. Bruing) Homburg Reinbek, chair of world forestry report No.1: 32-148.

[11] Whitford, P.B. (1949). Distribution of woodland plants in relation to successive and colonial growth. Ecol. 30: 199-208.

International Journal For Multidisciplinary Research

An International Open Access Peer Reviewed Journal • Impact Factor: 9.24 • E-ISSN: 2582-2160

Certificate of Publication

The editorial board of IJFMR is hereby awarding the certificate of publication to

Manoj Kushwaha

in recognition of publication of the paper titled

Butea Monosperma :- Exploration of Its Therapeutic Application's

Co-Authors: Sachin Singh

Published In: Volume 7, Issue 1 (January-February 2025)

Paper Id: 37030

Editor / Publisher
IJFMR

International Journal For Multidisciplinary Research

An International Open Access Peer Reviewed Journal • Impact Factor: 9.24 • E-ISSN: 2582-2160

Certificate of Publication

The editorial board of IJFMR is hereby awarding the certificate of publication to

Sachin Singh

in recognition of publication of the paper titled

Butea Monosperma :- Exploration of Its Therapeutic Application's

Co-Authors: Manoj Kushwaha

Published In: Volume 7, Issue 1 (January-February 2025)

Paper Id: 37030

Editor / Publisher
IJFMR

International Journal of
Innovative Research in Technology
An International Open Access Journal Peer-reviewed, Refereed Journal
www.ijirt.org | editor@ijirt.org An International Scholarly Indexed Journal

Certificate of Publication

The Board of International Journal of Innovative Research in Technology (ISSN 2349-6002) is hereby awarding this certificate to

MANOJ KUSHWAHA

In recognition of the publication of the paper entitled

PHYTOSOCIOLOGICAL ANALYSIS OF MIXED DECIDUOUS FORESTS OF BUNDELKHAND REGION

Published in IJIRT (www.ijirt.org) ISSN UGC Approved (Journal No: 47859) & 7.37 Impact Factor

Published in Volume 11 Issue 11, April 2025

Registration ID 174847 Research paper weblink:https://ijirt.org/Article?manuscript=174847

EDITOR

EDITOR IN CHIEF

ISSN 2349-6002

International Journal of
Innovative Research in Technology
An International Open Access Journal Peer-reviewed, Refereed Journal
www.ijirt.org | editor@ijirt.org An International Scholarly Indexed Journal

Certificate of Publication

The Board of International Journal of Innovative Research in Technology (ISSN 2349-6002) is hereby awarding this certificate to

SACHIN SINGH

In recognition of the publication of the paper entitled

PHYTOSOCIOLOGICAL ANALYSIS OF MIXED DECIDUOUS FORESTS OF BUNDELKHAND REGION

Published in IJIRT (www.ijirt.org) ISSN UGC Approved (Journal No: 47859) & 7.37 Impact Factor

Published in Volume 11 Issue 11, April 2025

Registration ID 174847 Research paper weblink:https://ijirt.org/Article?manuscript=174847

EDITOR

EDITOR IN CHIEF

ISSN 2349-6002

S.No. - 28

5TH NATIONAL SYMPOSIUM & KISAN MELA

on

"Climate Change based on Agriculture, Pharmacy and Industrial Department"

(November 24-25, 2023)

Jointly Organized by
Indian Meterological Department (IMD)
Ministry of Earth Sciences Goverment of India, New Delhi &
P.K. UNIVERSITY, SHIVPURI (M.P.)

CERTIFICATE OF PARTICIPATION

This is to certify that Prof./Dr./Mr./Mrs./Ms. Manoj Kushwaha from P.K. UNIVERSITY, SHIVPURI (M.P.) has participated in the 5th National Symposium on "Climate Change based on Agriculture, Pharmacy and Industrial Department" at P.K. University, Shivpuri (M.P) on November 24-25, 2023. He/She also presented a Oral Presentation on the topic Phytosociological analysis of mixed deciduous forests of Bundelkhand region.

Prof. (Dr.) G. Pavan Kumar
Dean Academic

Mr. Jitendra Mishra
Director

Prof. (Dr.) Ranjeet Singh
Vice Chancellor

P.K. UNIVERSITY

University established under section 2(f) of the UGC Act 1956 vide M.P. Government Act No. 17 of 2015.

ज्ञान-विज्ञान विमुक्तये

2nd INTERNATIONAL CONFERENCE

on Collaborative Futures :
Bridging Ideas, Cultures, and Disciplines.

ICCFBCD-25

Date: 14th June 2025 (Saturday) | Venue: Visvesvaraya Auditorium, Admin Block, P.K. University, Shivpuri (M.P.)

CERTIFICATE OF PARTICIPATION

This is to certify that Prof./Dr./Mr./Ms. Manoj Kushwaha

from Department of Botany, P.K University

participated/presented a paper titled Influence of Leaf Leachate on Seed Germination of Butea Monosperma.

at the ***2nd International Conference on Collaborative Futures: Bridging Ideas, Cultures, and Disciplines,*** *at P.K. University, Shivpuri (M.P.), organized by the Faculty of Science & Commerce.*

We appreciate their valuable contribution and participation in making the conference a success.

Vice-Chancellor	Director	Dean Academics	Organizing Secretary

P.K. UNIVERSITY, SHIVPURI (M.P.)

EARTH DAY | 22ND APRIL, 2025

ONE-DAY INTERNATIONAL WEBINAR

Organized by

Faculty of Science, P.K. University, Shivpuri (M.P.)

In Collaboration with

Indian Biodiversity Conservation Society, Jhansi (U.P.)



CERTIFICATE OF PARTICIPATION

This is to certify that **Mr. Manoj Kushwaha** participated in the **International Webinar** on "**Our Power, Our Planet**" organized by the Faculty of Science, P.K. University in collaboration with the Indian Biodiversity Conservation Society on the occasion of Earth Day, 22nd April 2025.

It is expected that this International webinar has inspired participants to reflect deeply on the importance of sustaining life on Earth.

Vice-Chancellor	Patron (Director)	Convenor (Dean Academics)	President (IBCS, Jhansi, U.P.)	Organizing Secretary (HOD, Faculty of Science)

S.No. -24

6th National Symposium on Agricultural Meteorology

28th December 2024

"Digital Development of Agricultural, Industrial & Pharmaceutical Technologies"

Jointly Organized by

India Meterological Department (IMD)

Ministry of Earth Sciences Goverment of India, New Delhi &

P.K. UNIVERSITY, SHIVPURI (M.P.)







CERTIFICATE OF PARTICIPATION

This is to certify that Prof./Dr./Mr./Mrs./Ms. Manoj Kushwaha from P.K. University has participated in the 6th National Symposium on "Digital Development of Agricultural, Industrial & Pharmaceutical Technologies" at P.K. University, Shivpuri (M.P.) on December 28, 2024.

Dean Academic

Director

Vice-Chancellor

NATIONAL SEMINAR
ON
SCIENCE, SPIRITUALITY & TRADITION AT MAHAKUMBH-2025

BASED ON MAHAKUMBH THEME: *UNITY IN DIVERSITY*

February 24 - 25th, 2025

Department of Chemistry, Bundelkhand University, Jhansi

CERTIFICATE

This is to certify that

Prof./Dr./Mr/Ms/Er. Manoj Kushwaha, P.K. University has attended /participated as Invited speaker / Delegate in the National Seminar on "Science, Spirituality & Tradition at Mahakumbh - 2025".

He /She has presented /delivered the paper / poster/talk entitle

Sustainable Practices and Waste Management Strategies at Mahakumbh: Towards an Eco-friendly Mega Event

Dr. Prakash Chandra	Dr. Gauri Khanwalkar	Prof. R. K. Saini	Vinay Kumar Singh
Convenor	Co-Chairperson	Chairman	Registrar