IDENTIFICATION OF MORPHOTYPE IN *Semecarpus anacardium* Linn. IN SELECTED PROVENANCE OF VIDARBHA REGION

THESIS

Submitted To
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirement for
the Degree of

MASTER OF SCIENCE
IN
FORESTRY
(FOREST BIOLOGY AND TREE IMPROVEMENT)

By
UIKE MANISHA VIJAYRAO

DEPARTMENT OF FORESTRY
POST GRADUATE INSTITUTE, AKOLA

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
KRISHINAGAR PO, AKOLA (MS) 444104

Enrolment Number: PP-879 **2023**

DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the Thesis entitled **"IDENTIFICATION OF MORPHOTYPE IN *Semecarpus anacardium* Linn. IN SELECTED PROVENANCE OF VIDARBHA REGION"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place: Akola (Manisha Vijay Uike)

Date: / / 2023 Enrolment No. PP/879

CERTIFICATE

This is to certify that the thesis entitled **"IDENTIFICATION OF MORPHOTYPE IN *Semecarpus anacardium* Linn. IN SELECTED PROVENANCE OF VIDARBHA REGION"** submitted in partial fulfillment of the requirements for the degree of **"Master of Science in Forestry (Forest Biology and Tree Improvement)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Manisha Vijayrao Uike** under my guidance and supervision.

The subject of this thesis has been apporved by the Student's Advisory Committee.

Place: Akola
Date: / / 2023

Dr. S.S. Harne
Chairman,
Advisory committee

Countersigned

Associate Dean
Post Graduate Institute
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE
INCLUDING EXTERNAL EXAMINER (AFTER VIVA-VOCE)

1.	Chairman	Dr. S.S. Harne	_____
2.	Member	Dr. H. K. Deshmukh	_____
3.	Member	Dr. V. V. Ujjainkar	_____
4.	Member	Dr. A. G. Deshmukh	_____
5.	External member	( )	_____

ACKNOWLEDGEMENT

The apex of research work is a keystone in life of any student with the research guide being the driving force behind. Gracias cannot be seen or explained; it can be felt deep in heart and is beyond description. Although ‘Thanks’ are poor expression of debt of gratitude one feel, yet there is no way to express it.

I consider myself to be extremely fortunate for an opportunity to work under the guidance of Dr. S. S. Harne, Associate Dean, College of forestry, Dr. PDKV, Akola. I feel myself privileged to get his guidance and constant supervision as well as for providing necessary information regarding this study his valuable, inspiring and scholastic guidance, during the course of this investigation.

It is of great pleasure for me to express my sincere thanks to my advisory committee member Dr. H. K. Deshmukh Assistant Professor Dr. V. V. Ujjainkar, Assistant Professor, Dr. A. G. Deshmukh, Assistant Professor, Department of medicinal Plant Garden Nagarjun and, for their valuable suggestions and needful counselling during the span of this investigation

My inexplicable gratitude goes to Dr. Y. B. Taide, Associate Dean, PGI, Dr. S. S. Harne, Associate Dean, College of forestry, Dr. PDKV, Akola for kind help of administration during my degree program.

It is my privilege to record sincere thanks to Professors of my Department Shri. S. M. Kachane, Dr. A. U. Nimkar, Shri. S. W. Chaudhari, Shri. A. J. Deshmukh and other academic faculty members for their inspiration and wholehearted support during my postgraduate study.

I gratefully acknowledge all authors whose literature has been cited in this thesis.

My family is my strength and source of motivation behind me. It seems one uses the choice would to measure the boundless love and fireless sacrifice of someone. I find no much measure in adequate quantity, for all that my beloved father Shri. Vijay Uike and mother Sau. Ratnamala Uike done for affection, moral support and me, whose love has no equivalent and

everlasting source throughout my life. I am grateful to my sister ApurvaUike for her love and care.

I heartly thanks to my close friends Gaurav Meshram, Deepak Jagtap, Savi Nimbarte, Rushikesh Telang, Dnyanesh Desale, Bhushan Khawale, Snehal Shende, Tushar Sarade, Priyanka Tayade, Aishwarya Deshmukh for their timely co-operation and emotional support during course of my research work.

Above all, I bow my head before almighty Lord Ganesha, whose constant blessing enabled me to complete this endeavor successfully and gave me courage to stand all.

Place: Akola (Manisha Vijay Uike)

Date: / / 2023 Enrolment No. PP/879

Table of content

(A) List of Tables

(B) List of Figures

(C) List of Plates

D) Abbreviations

%	:	per cent
/	:	per
@	:	At the rate of
B	:	Degree Brix
°C	:	Degree centigrade
Cm	:	Centimetre (s)
CV	:	Coefficient of variation
E	:	East
et al.	:	et alia (and associates)
Fig.	:	Figure
G	:	Gram (s)
Ha	:	Hectare
i.e.	:	il est (that is)
kg	:	Kilogram (s)
m	:	Metre (s)
ml	:	Milli litre (s)
N	:	North
No.	:	Number (s)
PP	:	Pages
R	:	Residual effect
R.H.	:	Relative humidity
S	:	South
S.D.	;	Standard deviation
S.E.	:	Standard error of mean
T.S.S.		Total Soluble Solids
viz.	:	Videlicet (Namely)
W	:	West

E) Thesis Abstract

a)	Title of the thesis	:	**"IDENTIFICATION OF MORPHOTYPE IN *Semecarpus anacardium* Linn. IN SELECTED PROVENANCE OF VIDARBHA REGION."**
b)	Full name of student	:	**UIKE MANISHA VIJAYRAO**
c)	Name and address of Major Advisor		**Dr. S. S. Harne** Associate Dean, College of Forestry Head of Department, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.)-444104.
d)	Degree to be awarded	:	M.Sc. (Forestry)
e)	Year of award of degree	:	2023
f)	Major subject	:	Forest Biology and Tree Improvement
g)	Total number of pages in the thesis	:	42
h)	Number of words in the abstract	:	260
i)	Signature of the student	:	
j)	Signature, name and address of forwarding authority	:	

Head
Department of Forestry,
PGI, Dr. PDKV, Akola

ABSTRACT

The present investigation entitled "**IDENTIFICATION OF MORPHOTYPE IN *Semecarpus anacardium* Linn. IN SELECTED PROVENANCE OF VIDARBHA REGION**" was carried out in the year 2022-23 .The aim of the study was to survey and identify Candidate plus Tree Selection (CPTs) in *Semecarpus anacardium* L. from selected provenance of Vidarbha region, and find out difference in morphological traits of *S.*

anacardium from selected area. Total 20 CPTs of *S.anacardium* were selected from Wardha, Washim, Buldhana and Bhandara district of Vidarbha regions in Maharashtra. The CPTs were identified from naturally existing populations of the region. In each district 5 superior trees were selected individually based on morphological characters and phytochemical characters.

Morphological characters of trees of *Semecarpus anacardium* L. ranged from 3.30 to 6.01 m for height of tree, 28.01 to 45.03 cm for GBH, 2.68 to 2.90 m north-south direction, 2.89 to 3.02 m east-west direction for canopy spread, 18.21 to 28.55 for seed weight, 1.6 to 4.8 for seed volume.

Phytochemical characters of seed oil ranged between12.50 to 37.50. Maximum oil was found in Buldhana district CPT 14(37.50) where the minimum oil content was found in Bhandara district CPT 16(12.50). Total phenol ranged between 112 to 159 mg/g. Maximum total phenol was found in Bhandara district CPT 18 (159 mg/g) and minimum was found in Bhandara district CPT 17(112mg/g) Further, All the genotypes shows considerable variability with respect to phytochemical characters. The morphological characterization of *Semecarpus anacardium* presented in this study provides a valuable contribution to the botanical knowledge of the species, laying the groundwork for further exploration and conservation initiatives.

CHAPTER I

INTRODUCTION

1.1 Background Information

Neglected and wild edible fruits were the important sources of food for mankind before dawn of civilization. The tribal groups inhabit in the forests depend on these fruits. They passed on valuable information on utility of fruits from generation to generation. Under estimation of their potential use, non-availability of their complete botanical information, inadequate research on their commercial exploitation, lack of knowledge on their food and nutrition potentiality and fast disappearance of ecosystem and habitat destruction make them remains as an underutilized. These crops are locally marketed after harvesting. They are not only medicinally and nutritionally rich but also thrive well under adverse climatic conditions. It can be the considered as a potential source of several desirable traits particularly for resistance to biotic and abiotic stresses. To recover the present crisis of nutritious food supply due to increasing population rate, exploitation of neglected crops can become a solution for malnutrition and hidden hunger problem (Dandin and Krishna 2016).

The Indian knowledge of herbal medicines is gaining widespread acceptance globally. In Ayurveda, almost all medicinal preparations are derived from plants, whether in the simple form of raw plant materials or in the refined form of crude extracts, mixtures and so on. In other parts of the world, the term Complementary and Alternative Medicine (CAM) is used for various forms of traditional drugs. Complementary and Alternative Medicine (CAM) can be defined as any treatment used in conjugation (complementary) or in place of (alternative) standard medical treatment. In alternative medicine, medicinal plant preparations have found widespread use particularly in the case of diseases not amenable to treatment by modern method (Semalty et al. 2010).

Semecarpus anacardium L., commonly known as the marking nut tree, is a valuable plant species with significant economic, medicinal, and ecological importance. The species belongs to the family Anacardiaceae and

is native to the Indian subcontinent. One of the key attributes of *Semecarpus anacardium* is the presence of biologically active compounds in various parts of the plant, making it a subject of interest for both traditional medicine and modern pharmaceutical research.

Medical industries extensively utilized its medical properties like anti-atherogenic, antiinfammatory, antioxidant, antimicrobial, hypoglycemic, anticarcinogenic etc. (Semalty et al. 2010). Most of the species of genus Semecarpus are distributed in the tropical Asia to Oceania and the plant is distributed at the outer Himalayas from Sutlej to Sikkim and fairly at hotter parts of India as far as east of Assam, Burma, Malaysia, and Australia (Press et al.2000). S. anacardium is found in various parts of the world right from the outer Himalayas to the Coromandel Coast Africa, East Asia to Indian subcontinent, Indo-Malaysian region, western peninsula, North Africa and in China, Nepal, India, Burma, Malaysia, N.Australia. It grows naturally in the tropical Moist deciduous and semi evergreen forests having dry climate.

In the Vidarbha region, which encompasses parts of the Indian states of Maharashtra, Madhya Pradesh, and Chhattisgarh, Semecarpus anacardium is found in diverse ecosystems. The region is characterized by varying climatic and edaphic conditions, contributing to the genetic diversity of the species. This diversity can influence the expression of key traits such as growth rate, nut production, and resistance to pests and diseases.

Scientific Classification:

- Kingdom: Plantae
- Division: Angiosperms
- Class: Eudicots
- Order: Sapindales
- Family: Anacardiaceae
- Genus: Semecarpus
- Species: anacardium

Semecarpus anacardium Linn. is a plant well-known for its medicinal value in Ayurvedic and Siddha system of medicine. Chemical and

phytochemical analyses of its nut reveal the presence of biflavonoids, phenolic compounds, bhilawanols, minerals, vitamins and amino acids. A variety of nut extract preparations from this source are effective against many diseases, viz., arthritis, tumors, infections and so on. However, the mechanism of the pharmacological action of its nut can be greatly aided by the isolation of its active principle and determination of structure–function relationship. *Semecarpus anacardium* L. is a native of Indio-Malaysian region and is commonly grown in the hotter parts of India. The tree has edible fruit (hypocarp) and kernel. The pericarp contains Bhilawan Shell Liquid (B.S.L.) which is a rich source of phenols (Chopra et al, 1956).

Botanical Description: It is a moderate-sized deciduous tree found in the outer Himalayas and hotter parts of India up to 3500 ft. height. The plant is found in abundance in Assam, Bihar, Bengal and Orissa, Chittagong, central India and western peninsula of East Archipelago, Northern Australia.The bark is grey in color and exudes an irritant secretion on incising (Semalty et *al* 2010).

Eighty percent of the world population relies on the plan based drugs for their primary health care needs as estimated by World Health Organization. International market of medicinal plants is over US $ 60 billion per year which is growing at a rate of 7 %. The herbal drug market in India is about Rs.644.63 crores and it can be raised to Rs.3000 crores by 2006. The growing demand for plant-based medicine, health products and pharmaceuticals etc. led to the depletion of plant resources. Hence immediate focus on conservation and sustainable use of medicinal plants is required In Ayurveda and Siddha (Indian systems of medicine) classics, copious references regarding the properties and uses of *S. anacardium* nuts are found. The fruit of *S. anacardium* is acrid, hot, sweetish, edible aphrodisiac, anthelmintic, causes looseness of bowels, removes ascites, alleviates skin diseases, piles, dysentery, fever; loss of appetite, urinary discharges, heals ulcers, strengthens the teeth and is useful in insanity and asthma I . It is popularly known as 'Ardha Vaidya' (multipurpose medicine). (Premalatha, 2010)

Fruit - Pericarp differentiated into epicarp, mesocarp and endocarp; in longitudinal section pericarp shows outer epicarp consisting of single layer of epidermal cells which are elongated radially and lignified. Characteristic glands are found in pericarp which exude oil globules and arise as small protuberances in epicarp. Due to pressure exerted by cells of mesocarp, some of epidermal cells and cuticle rupture and oil globules exude from oil glands; mesocarp has a very broad zone, 30-40 layers thick, composed mostly of parenchymatous cells having lysigenous cavities and fibro-vascular bundles, below epidermis a few outer cells of parenchyma smaller as compared to rest; rosette crystals of calcium oxalate found scattered in parenchymatous cells, some cells get dissolved and form lysigenous cavities which increase in size with maturity of fruit, cavities do not have any special lining and contain an acrid and irritant yellowish oily secretion; 19 endocarp consists of two distinct layers, innermost prismatic having very much elongated radial walls, being highly thickened, the outer layer is shorter and thinner than prismatic layer but the cells similar to the former; number of mesocarp parenchyma contain rosette crystals of calcium oxalate and oil drops in oil glands. (Paras Jain and H P. Sharma 2013)

Medicine: Folk medicine *Semecarpus anacardium* is a one of most popular medicinal valuable plant in world of Ayurveda. Charak, Sushrut and Vagbhatt, the main three treatises of Ayurveda have described the medicinal properties of Semecarpus anacardium and its formulation. Bhallataka is used both, internally as well as externally. The fruits, their oil and the seeds have great medicinal value, and are used to treat the wide range of diseases. Detoxified nut of SA was used in Ayurveda for skin diseases, tumors, malignant growths, fevers, haemoptysis, excessive menstruation, vaginal discharge, deficient lactation, constipations, intestinal parasites. (Charaka, Sushruta), Before using *Semecarpus anacardium* for medicinal purpose, it’s necessary to detoxifying it because it is highly toxic for body if not use properly.

The seeds oil is mainly used for medicinal purpose. Seeds are generally boiled in milk and the milk is consumed. The seeds oil is used in minimum possible quantity, typically mixed with food items or mustard oil. Externally, the oil is applied on wounds to prevent pus formation and better

healing of wounds, It works well, when medicated with garlic, onion and ajavayana in sesame oil. In glandular swellings and filariasis, the application of its oil facilitates to drain out the discharges of pus and fluids and eases the conditions.It is also use as a brain tonic, blood purifier and haematinic tonic. The combination, *Semecarpus anacardium, Terminalia chebula, Sesamum indicum L.* seeds powders with jaggery, has excellent results in chronic rheumatic disorders. In dysmenorrheal (painful menstruation) and oligomenorrhea (scanty menstruation), the medicated milk or its oil is salubrious. It reduces the urinary output, hence beneficial in diabetes of kapha type, Bhallataka is the best rejuvenative (rasayana) for skin ailments, vata disorders and as a preventive measure to increase the body resistance. Winter is the best season for its usage. (Jain and Sharma 2013)

Physico-chemical properties of marking nut shell air is important in the use of medicinal dosage of oil. The vesicant nature of bhilwa juice and manufacturing difficulties of kernels prevent its usage. If this vesicant nature is abolished, this juice forms a good source for pharmaceutical industry.This juice is white when the fruit is immature, but brownish or quite black when the fruit is ripe. The black corrosive juice is largely used throughout the India as an efficacious drug: internally in the cases of dyspepsia, nervous debility, acute rheumatism, asthma and cough; externally for swellings, piles and various cutaneous affections. It is also largely used by washerman as an indelible marking ink, and in certain parts of the country an aqueous extract of the crushed seeds is used in conjunction with iron salts for producing a jet-black dye on the cloth (Gouthaman, et al 2008).

The quality of the oil depends upon a recovery of oil which was enhancing effective extraction of the oil from the shell. Optimum moisture. content, heating time and heating temperature are much important for oil extraction. These studies help to decide optimum moisture content, heating time and heating temperature for oil extraction, which helps to improve oil recovery.

Semecarpus anacardium has cultural significance in traditional medicine and rituals in certain regions of India.

While *Semecarpus anacardium* has historical and cultural importance, it's crucial to approach its use with caution due to its toxicity. Any use for medicinal or industrial purposes should be guided by appropriate knowledge and expertise**.**

1.2. Need of Study

In this study, an effort has been made to generated and identify Biba plants with special emphasis on morphological and biochemical traits which is necessary for effective crop improvement programs. Comprehensive information regarding variability as required by the breeder for evaluation and characterization of various traits, to enhance its productivity and commercial value is lacking. The best efforts were put in describing the underutilized plant taking into consideration all the important morphological and biochemical traits. Studying *Semecarpus anacardium* is important for several reasons, encompassing its traditional medicinal uses, potential therapeutic applications, toxicology, and industrial significance.

The crop improvement program mainly depends on the superior mother plants for hybridization and the knowledge of inheritance pattern. Characterization of germplasm is essential to maximize its utility on yield and quality traits, as well as descriptions of available variation and estimates of trait heritability and encourage the development of efficient ex-situ conservation (Rubenstein et al. 2006). Phenotypic characters (Mostly quantitative) are mainly influenced by environments and plant developmental stages and genotypic character is based on the quality of the plant materials which is required for testing the varieties.

1.3. Objectives

With this consideration the present investigation Identification of morphotype in *Semecarpus anacardium* linn. Has been carried out with the following objectives.

1. To survey and identify Candidate plus Tree Selection (CPTs) in *Semecarpus anacardium* L. from selected provenance of Vidarbha region.
2. To find out difference in morphological traits of *S. anacardium* from selected area.

1.4. Hypothesis.

High variability may expect in *Semecarpus anacardium* .Having variability for morphological character along with fruits and seeds characteristic which may be uses as criteria for selection of desirable CPT's as expected for future breeding and tree improvement programme.

CHAPTER II

REVIEW OF LITERATURE

The selection of Plus Tree is the important step in any tree improvement programme. The selection of candidate plus tree (CPT) is solely based on their phenotypic appearance and morphological characters.

The relevant and available literature on a different aspect studied during the course of investigation are reviewed here on Morphological traits and phytochemical analysis.

2.1 Morphological characters

Raut et al. (2006) experimented on bhallatak use for medicinal and non-medicinal purpose, that all the three brihatrayeen (tree majar treaties) viz. Charak, Sushrut and Vagbhat of Ayurveda elaborately described Bhallatak formulation.

Seyed et al. (2006) conducted study on the physical properties of watermelon seed. Linear dimensions, mean diameters, sphericity, surface area, volume, true and bulk densities, porosity, reposeangles and static coefficient of friction of the three varieties' seeds were measured using standard methods.

Kesari et al. (2008) conducted study on Candidate plus trees (CPTs) of *Pongamia pinnata*, a potential biodiesel plant occurring across 10 locations in North Guwahati, were identified based on morphological markers (vegetative and reproductive) using combined analysis over locations. Identified CPTs were then multiplied using seed propagation technique in a nursery bed. The performance of the candidate trees with respect to seed and pod traits, the two most important characters with regard to oil, were evaluated using CROPSTAT software for inferring potential genotypes that can be included in programmes aimed at genetic improvement of the species.

Gouthaman et al. (2008) review deals with distribution, phytochemical and pharmacological aspects of *S. anacardium*. The safety evaluation of Siddha preparation of *S. anacardium* nut extract has been

discussed. Plant improvement studies (seed germination and in vitro propagation) of *S. anacardium*

Ndukwu, M. C. (2009) studied on Determination of selected physical properties of Brachystegia eurycoma seeds. such as axial dimension,roundness, sphericity, surface area, bulk density, solid density, porosity, and volume which are essential in the design and construction of the processing and handling equipments of Brachystegia eurycoma.

Deshmukh et al. (2010) Surveyed on markingnut in growing area (Aurangabad, Beed, Hingoli, Nanded and Parbhani districts) of Marathwada region in Maharashtra (India) during 2005-07 to assess existing natural variability for superior genotypes and good fruitquality among 264 markingnut seedling trees and 27 superior clones. All the genotypes showed considerable variability with respect to physico-chemical characters.

Semalty et al. (2010) studied on *Semecarpus anacardium* Linn. (Family: Anacardiaceae), commonly known ‘Ballataka’ or ‘Bhilwa’, has been used in various traditional system of medicines for various ailments since ancient times. Its nuts contain a variety of biologically active compounds such as bifl avonoids, phenolic compounds, bhilawanols, minerals, vitamins and amino acids, which show various medicinal properties.

Carrasquinho et al. (2010) conducted study on Multivariate statistical analysis was used to define different developmental stages for stone pine (*Pinus pinea* L.) considering tree size and cone production, without site-specific information. • This was achieved in two steps. First, trees from permanent plots were classified using cluster analysis in five different stages. Second, discriminant analysis was applied to confirm the robustness of the groups generated by cluster analysis and to allow the assignment of new stone pine trees to one of the five development stages.

Naima et al. (2010) conducted survey on Genetic Variability of Argan Tree and Preselection of the Candidate Plus Trees. Within each provenance, measurements related to 6750 fruits and the morphometric data were subjected to the analysis of the variance, according to the general linear

model, where the genotype factor (mother tree) is hierarchical to provenance factor.

Iijima et al. (2011) investigated for calculations of pesticides residue levels determined utilizing both the Japanese and international definitions portions to be analysis of Flesh and seed weights of stone fruits such as cherry, ume(Japanese apricot), sumomo (Japanese plum), nectarine, and peach . These results indicate that calculated pesticide residue levels in whole commodities (international standard) are slightly lower than the actual concentrations without seeds (current Japanese regulations).

Ilanchezhian et al. (2012) studied cow's urine, cow's milk and brick powder, were used as media. The impact of shodhana was evaluated by pharamaceutical, physico, chemical and chromatographical parameters. Shodhana (purificatory procedure) increases the anacardol level in shodhita bhallataka fruit samples. More percentage of the anacardol was due to the conversion of toxic urushiol into Anacardol.

Menghani et al. (2012) investigations attempts were made to screen the Indian medicinal plants as antimicrobial agent. The extract was tested against selected test bacteria and fungi through disc diffusion assay where Tetracycline and Mycostatin were used as standard. Traditional use of the various extracts of Capparis decidua and Pistacia integerrima. Indian Medicinal Plants have potentials as antimicrobials.

Pavithra et al. (2013) studied that Provenance variation and genetic variability in pod and seed traits were carried out with 232 candidates plus trees of *Pongamia pinnata* collected from selected agro-ecological zones of southern peninsular India during February-March 2008 to 2010. Significant variation ($P < 0.01$) for pod and seed traits across zones and provenances within zones was recorded. The southern dry and transition zone of Karnataka showed the highest mean value for all the pod and seed traits.

Singh et al. (2016) conducted study on identification of candidate genes for 100-seed weight and root/total plant dry weight ratio under rainfed conditions in chickpea. Identified candidate genomic regions and genes may be useful for molecular breeding for chickpea improvement.

Dandin et al. (2016) stuided on Neglected and underutilized fruit species: an insurance against global mal and under nutrition. Wild edible fruits were the important sources of food for mankind before dawn of civilization. The tribal groups inhabit in the forests depend on these fruits. They passed on valuable information on utility of fruits from generation to generation.30000 edible plant species are known to mankind.

Chauhan et al. (2018) conducted the study of Twenty Candidate Plus Trees (CPTs) of *Melia dubia* were selected from different places covering Valsad, Narmada and The Dangs districts of South Gujarat region of India. Selection was made through individual selection method by considering qualitative and quantitative traits of economic interest like stem straightness, roundness, tree height, and clear bole height, girth at breast height and disease resistance. The selected candidate plus trees will be useful in development of superior quality planting material for mass propagation and future tree improvement programmes.

Daneva et al. (2018) conducted survey in Plus tree selection and progeny testing of superior candidate plus trees (CPTs) of *Ailanthus excels*. Twenty one plus trees of Mahaneem (*Ailanthus excelsa* Roxb.) were selected through intensive survey from Haryana, Rajasthan and Gujarat. The selection was made on phenotypic assessment of desirable characters of economic interest such as stem straightness, self-pruning ability; clear bole height, low branching habit, disease resistance, etc.

Ghawade et al. (2018) conducted investigation on “Study of Correlation and Index Ranging of Markingnut (*Semecarpus anacardium* L.) Genotypes in Nanded District of Marathwada Region” was carried out on twenty strains of Markingnut from Nanded district of Marathwada region in Maharashtra.

Sukhadiya et al. (2019) studied on *Semecarpus anacardium* L. popularly known as marking nut is a moderate to large sized deciduous tree found fairly at hotter parts of India up to a elevation of 1300 ft. The tree is not found under cultivation but is common in forests as a associates of Sal tree. The plant has become a wild plant and found only in forest areas. Marking nut

is a lesser known and underutilized tree species. Its various parts such as fruits, seeds and bark are used for a variety of ethnomedicinal purposes.

Ikram M. et al. (2020) studied on Identification of QTNs and Their Candidate Genes for 100-Seed Weight in Soybean (*Glycine max* L.) Using Multi-Locus Genome-Wide Association Studies. To better understand the genetic architecture underlying the trait and improve the precision of marker-assisted selection.

Ghosh et al. (2022) studied that *Semecarpus anacardium* L. is a potential underutilized edible, highly nutritious fruit crop with ample medicinal properties grown in some localized pockets of India. Being a hardy crop, it can be easily used for climate resilient horticulture adaptation. But due to inadequate knowledge it is remains in underused position. Therefore, the investigation was carried out to study the morphological and biochemical characteristics of the plant which will help in further improvement of the crop.

Ujjainkar et al. (2022) conducted the experiment for candidate plus tree (CPTs) is considered as an important and foremost stage in tree improvement program in forest species. The tree breeding or tree improvement is a branch of forestry, emerging as an integral part of afforestation and reforestation activities along with commercial production of forest products through the development of genetically improved planting stock for utilization.

2.2 Phytochemical characters.

Singleton and Rossi (1965) Investigated the improvements include the use of Folin-Ciocalteu reagent rather than the Folin-Denis reagent, gallic acid as a reference standard, and a more reproducible time-temperature color development period. The values obtained are less subject to variation and interference from several nonphenols, yet are directly comparable to the "tannin" values obtained by the previously standard method.

Rao et al. (1973) Analyzed methylated bhilawanol from *S. anacardium* nuts and its oxidation product, the methyl ester of an aromatic carboxylic acid, conclusively proved that it contains more than seven closely related compounds. Two of them are major components which were isolated

and shown to be 1-pentadec-Δ5′-enyl-2,3-dimethoxybenzene (I) and 1-pent biflavanoids A, B and C have been also isolated from defatted nuts of *S. anacardium*.

Gil et al. (1995) Studied From the seeds of *Semecarpus anacardium*, a new phenolic glucoside, anacardoside, was isolated, and its structure and configuration were elucidated by a combination of NMR techniques as-l-O-fl-D-glucopyranosyl- (1 ~ 6)-fl-D-glucopyranosyloxy-3-hydroxy-5-methylbenzene. Anacardoside (1) gave a negative reaction with acetic anhydride-H2SO4 for a steroid, but, gave a positive Mollisch test for sugars and FeCla test for phenols.

Premalatha et al. (2000) Conducted the experiment on Chemical and phytochemical analyses of *Semecarpus anacardium* nut reveal the presence of biflavonoids, phenolic compounds, bhilawanols, minerals, vitamins and amino acids. All these indicate that the *S. anacardium* nut extract is a lifesaving non-toxic drug, and has its own unique character with respect to physiology, pathology, pharmacology and the rapeutics.

Tripathi et al. (2001) Analyzed alcoholic extract of pericarp showed significant protection against FeSO4 induced lipid peroxidation, as compared with whole native nut and seeds. Mechanism of action may be through metal chelation or activation of endogenous antioxidant enzymes, because the extract did not show hydroxyl and super oxide anion scavenging property. Further in vitro experiments against FeSO4, it did not maintain the level of reduced glutathione.

Ramprasath et al. (2004) Investigation of the anti-inflammatory effects of *Semecarpus anacardium* LINN. nut extract (SA), and also an anti-inflammatory drug, indomethacin, on carrageenan-induced paw edema and cotton pellet granuloma tests for their effects on acute and chronic phases of inflammation, respectively.

Mohanta et al. (2007) Evaluation on Aqueous and organic solvent extracts of the plant were screened for antimicrobial (disc diffusion method) and phytochemical properties. The preliminary antibacterial screening, indicated petroleum ether extract (PEE), aqueous extract (AQE),

chloroform extract and ethanol extracts of *Sermicardium anacardium* L. f. to be effective against the test organisms.

Nair et al. (2009) investigated was to isolate and characterize the anticancer compound from the kernel of *Semecarpus anacardium* nut. SA-3C isolated from the kernel of *Semecarpus anacardium* can be developed as an important anticancer agent for single agent and/or multiagent cancer therapy.

Bagewadi et al. (2012) studied on *Semecarpus anacardium* nuts are used for various medicinal and pharmacological purposes from ancient period. *Semecarpus anacardium* is significantly active against Salmonella typhi. The preliminary phytochemical analysis of *Semecarpus anacardium* revealed the presence of Triterepenoids, steroids, Anthraquinones and phenols which have contributed to effective antibacterial activities.

Menghani et al. (2012) investigations attempts were made to screen the Indian medicinal plants as antimicrobial agent. The extract was tested against selected test bacteria and fungi through disc diffusion assay where Tetracycline and Mycostatin were used as standard. Traditional use of the various extracts of Capparis decidua and Pistacia integerrima. Indian Medicinal Plants have potentials as antimicrobials.

Poornima et al. (2013) description, chemical composition, pharmacological activities of *Semecarpus anacardium*. It has been used since hundreds of years in Indian system of medicine (Ayurveda).It has lots of medicinal property due to various chemical compounds, which are present in it, like bhilawanol, biflavonoids, phenolic compounds etc.

Mohd-Setapar et al. (2013) studied on Soxhlet extraction which is also known as solvent extraction refers to the preferential dissolution of oil by contacting oilseeds with a liquid solvent. This is the most efficient method to recover oil from oilseeds, thus solvent extraction using hexane has been commercialized as a standard practice in today’s industry. soxhlet extraction had been used to extract the rubber seed oil which contains high percentage of alpha-linolenic acid. In addition, the different solvents will be used for the extraction of rubber seed oil such as petroleum ether, n-hexane, ethanol and

water to study the best solvent to extract the rubber seed oil so the maximum oil yield can be obtained.

Jain and Sharma (2013) Studied that it nut's extract have various phytochemical which is able to fight against several disease but due to theit's poisonous nature it should be used with caution. Nut contain a variety of biologically active compounds such as biflavonoids, phenolic compounds, bhilawanols, minerals, vitamins and amino acids, which shows various medicinal properties.

Jain et al. (2014) evaluated that phytochemicals and antifungal activity of methanolic extract of *Semecarpus anacardium* L. nuts oils. The preliminary phytochemical studies showed the presence of alkaloids, saponins, tannins, flavonoids, steroids, glycosides. Different Concentration of methanolic extract (6.25, 12.5, 25, 37.5, 50, 62.5 µg/ml) of *S. anacardium* were tested against four fungal strains namely *Fusarium oxysporum, Rhizctonia solanii, Alternaria spp.,* and *Sclerotium rolfsii.*

Anumalla et al. (2015) Studied on genetic diversity and analysis of genetic variation for crop improvements as they form the basis of world’s food security. The value of conserved germplasm can be assessed for the useful traits in plant breeding and the economic impact on germplasm utilization in crop production and productivity.

Upreti et al. (2016) *Semecarpus anacardium* can be used as an alternative therapy for various ailments however the precise mechanism underlying its various effects has not been determined fully. The phyto-constituents present in this plant need to be isolated and can be developed into phyto-pharmaceuticals.

Srinivasan et al. (2016) study investigated the physicochemical properties and phytochemical constituents of seed oil of *Semecarpus anacardium* L. to understand its biopesticidal and therapeutic potential. Preliminary phytochemical studies showed the presence of polyphenolic compounds, flavonoids, tannins, saponins, steroids in seed oil which is extracted using various organic solvents such as n-hexane, petroleum ether, methanol and acetone.

Panda (2017) conducted the experiment different strains of Agrobacterium rhizogenes (A4, ATCC15834 and LBA 9402) were used for induction of hairy roots in in vitro grown tissues of the plant. Hairy root initiation was observed after 25–30 days of infection. Optimum transformation frequency of 61% was achieved on leaf explants with ATCC15834 strain. Infection time of 30 min resulted in greater transformation frequency compared to 10 and 20 min, respectively. The hairy roots cultured in growth regulatorfree semi-solid woody plant medium differentiated into callus.

CHAPTER III

MATERIAL AND METHODS

The present investigation entitled on "**Identification of Morphotype in *Semecarpus anacardium* Linn. in selected provenance of vidarbha region"** was carried out in the Department of Forestry, Department of Biotechnology, Nagarjun, Dr.P.D.K.V. Akola during 2022-2023.

The material used and methods followed during the course of present investigation are as follows.

3.1 Study area

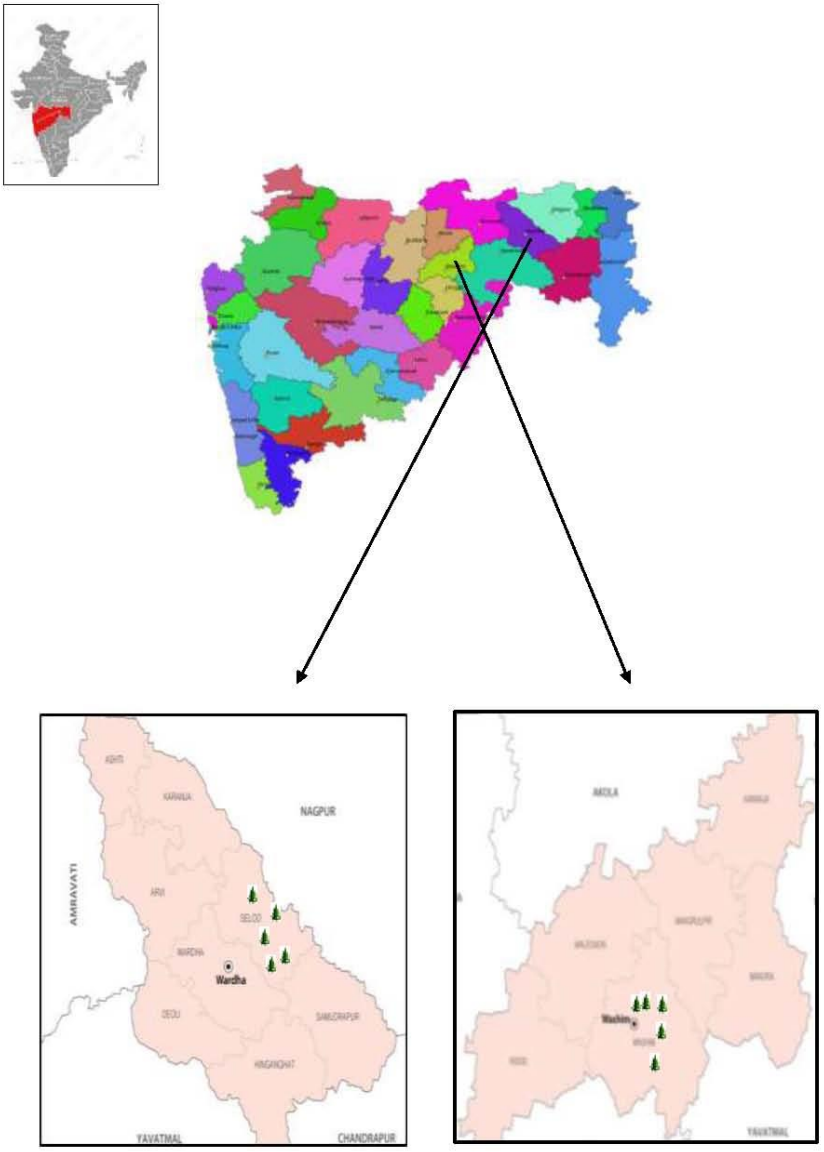
The Extensive survey was undertaken purposively where the location at villages is Bordharan, Sakara, Ajishpur, Sakoli from the district of Wardha, Washim, Buldhana, Bhandara shown in Table 1 respectively.

Table 1. Geographical Hierarchy

Sr.no	Vidharbha region	Division	District	Village
1.	Northeast	Nagpur	Wardha	Bordharan
2.	Northeast	Nagpur	Bhandara	Sakoli
3.	Southwest	Amravati	Washim	Sakara
4.	Southwest	Amravati	Buldhana	Ajishpur

3.2 Identification of Candidate Plus Tree (CPTs)

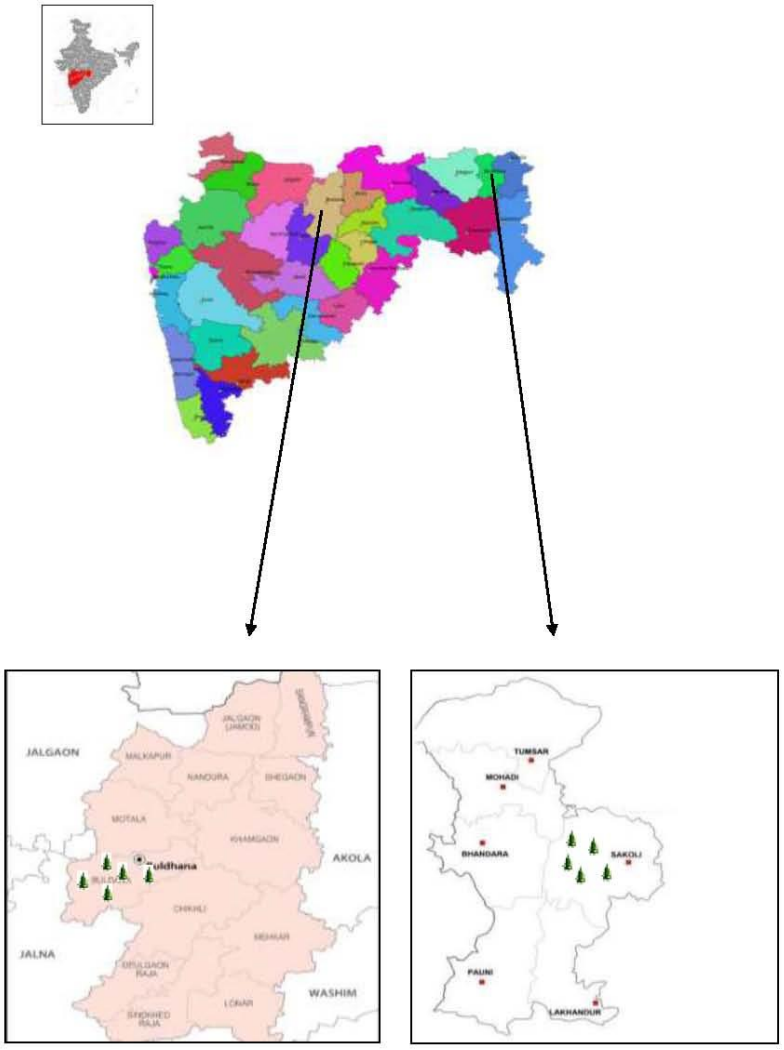
The Candidate Plus Tree Selection (CPT) approach is a valuable method in forestry and agroforestry that involves the identification and selection of superior individual trees based on desirable traits. The selection criteria for CPTs vary from species to species but many of the basic characteristics are quite considerable. For CPTs selection standards was set and marked with white band. by focusing on key characteristics such as growth, disease resistance, and nut quality. CPT facilitates the propagation of individuals with a higher likelihood of passing on these favourable traits to their offspring. The individuals having diseases, dead branches, or attacked by any pathogen



Site I. Wardha

Site II. Washim

Plate 1(a): Location map of CPTs in *Semecarpus anacardium* from selected provenance of Wardha and Washim District.



Site III. Buldhana Site IV. Bhandara

Plate 1(b): Location map of CPTs in *Semecarpus anacardium* from selected provenance of Buldhana and Bhandara District.

and pests were rejected in the initial stage of selection. The co-ordinates were taken through the GPS Waypoint app.

Table 2. Candidate Plus Tree's in Vidarbha Provenance and their GPS Location

Sr.no	Code no. for CPTs	Name of Locations	GPS location	
			North	East
1.	CPT-1	Wardha	20.92694	78.7347929
2.	CPT-2		20.9262959	78.7342001
3.	CPT-3		20.9262999	78.7342134
4.	CPT-4		20.9262619	78.7343173
5.	CPT-5		20.9262684	78.7342122
6.	CPT-6	Washim	20.154815	77.223485
7.	CPT-7		20.154743	77.223479
8.	CPT-8		20.155613	77.222824
9.	CPT-9		20.155197	77.223569
10.	CPT-10		20.155272	77.223569
11.	CPT-11	Buldhana	21.2655	79.9570
12.	CPT-12		21.270713	79.959644
13.	CPT-13		21.154856	79.792132
14.	CPT-14		21.345666	80.045991
15.	CPT-15		21.395525	80.093730
16.	CPT-16	Bhandara	19.974200	76.194494
17.	CPT-17		19.957895	76.183304
18.	CPT-18		19.957927	76.183293
19.	CPT-19		19.957903	76.183284
20.	CPT-20		19.957909	76.183306

a. Site I (Wardha)

b. Site II (Washim)

c. Site III (Buldhana)

d. Site IV (Bhandara)

Plate 2. CPTs of *S. anacardium* in four different Locations of Vidharbha region

3.3 Materials and Equipment

Instruments used during the course of CPTs selection were Biometric measuring Tape, Ravi Altimeter, Electric weighing balance, volumetric flask, Petri plates etc.

Table 3. Materials and Equipment

Sr.no	Materials and Equipment	Use
1.	Biometric measuring Tape	Measuring the diameter of a tree.
2.	Ravi Altimeter	Height Measurement
3.	Electric weighing balance	Measure the weight of materials.
4.	Volumetric flask	Measuring accurate volumes of liquid materials.
5.	Soxhlet apparatus	The extraction of lipids and other molecules from a solid sample.

3.4 Observations for CPT'S Identification.

The identification of CPTs was done on the basis of following parameters.

3.4.1 Measurements

I. **Tree Height (m) –**

Tree height was measured by using Ravi altimeter from base of tree to tip of the tree in meters. Measurement of tree height of *S. anacardium* is shown in plate 3.(a)

II. Tree GBH (cm) –

Girth at Breast Height (GBH) was measured at 1.37 m from the base of tree using Biometric measuring tape and expressed in nearest centimetre. Measurement of tree GBH of *S. anacardium* is shown in plate 3.(b)

(a)

(b)

Plate 3. Measurement of Tree Height and Girth of S. *anacardium*

III. Canopy spread (m) –

The spread of tree in North-South and East-West directions was measured in meter. The average of both the side was recorded as canopy spread.

3.6.2 Foliage parameters

I. Leaf shape –

Leaf shape was recorded visually on matured leaf as oblong to oblong. Leaf shape of *S. anacardium* is shown in plate 4. (a).

II. Leaf base shape –

The leaf base shape was observed on matured leaf. A photography of Leaf base shape of *S. anacardium* is shown in plate 4. (a).

III. Fruit shape:

The Fruit shape of ten randomly selected fruits from each CPT was recorded at peak harvesting stage. Fruit shape of *S. anacardium* is shown in plate 4. (b).

IV. Fruit Colour–

Mature fruit colour was recorded at harvesting stage.Fruit colour of *S. anacardium* is shown in plate 4. (b).

V. Fruit Type –

Fruit type is single seeded fruit with a hard, stone endocarp.

VI. Fruit Texture –

Fruit texture was identified by taking ten fruits from each CPTs at harvesting stage. Fruit texture of *S. anacardium* is shown in plate 4. (b).

3.6.3 Seed Characters

I. Seed Shape–

Seed shape was recorded on mature nut by visual observation. Seed Shape of *S. anacardium* is shown in plate 4. (c).

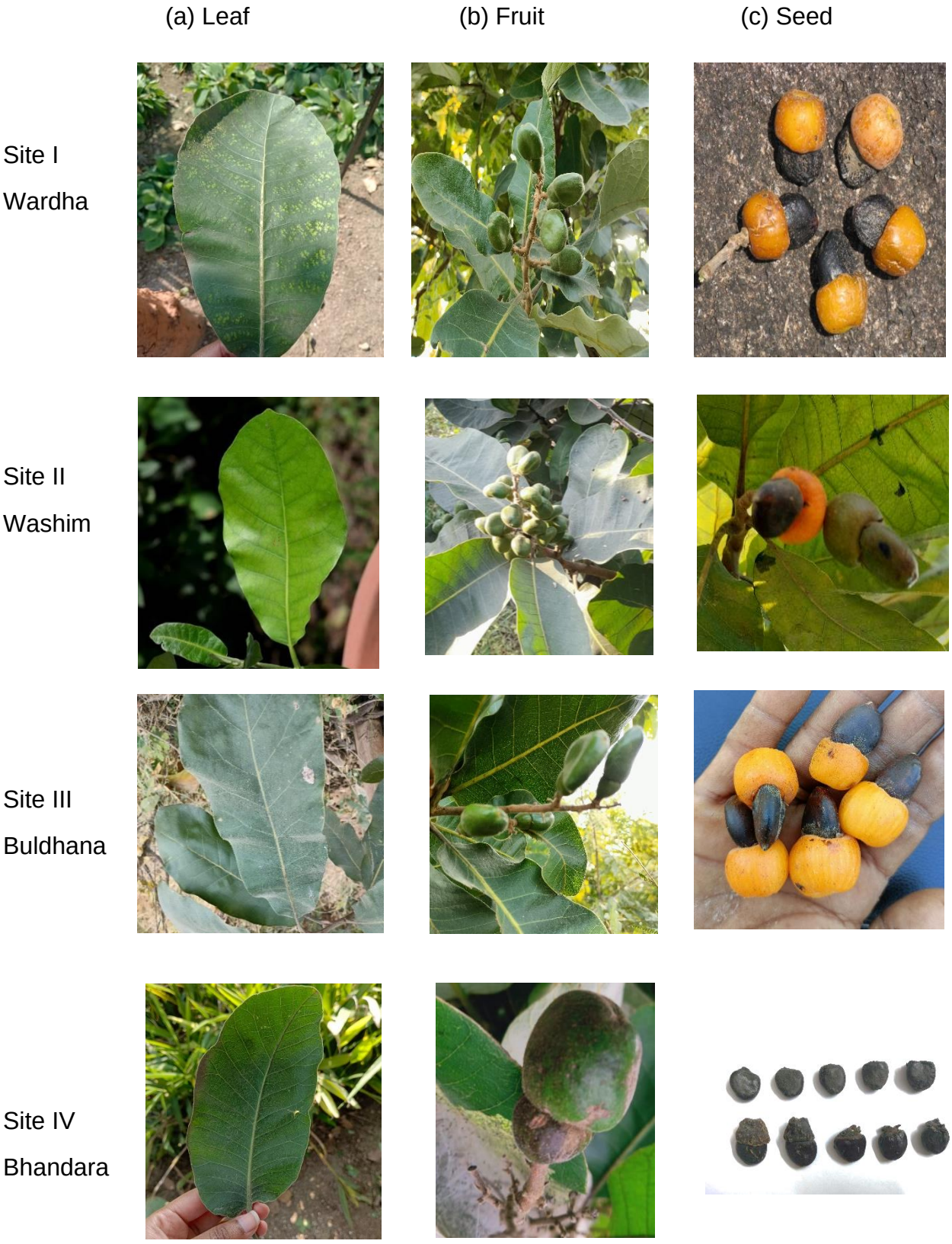


Plate 4. Morphological characters of *Semecarpus anacardium* in four district of Vidharbha region

II. Seed Colour–

Seed colour was recorded from ten randomly selected seeds from each CPT at harvesting stage. Seed Colour of *S. anacardium* is shown in plate 4. (c).

III. Test weight of 100 seeds (g) –

The weight of hundred Seed was taken by using digital weighing balance and recorded in gram.

IV. Seed Texture –

Seed texture was estimated by observing outer portion of seed. Seed Texture of *S. anacardium* is shown in plate 4. (c).

V. Seed Volume –

The volume of ten randomly selected seeds from each CPT was recorded by using measuring cylinder filled with water and increased volume due to seed was recorded and average volume per seed calculated in ml.

3.6.3 Oil Extraction Process

10g of *Semecarpus anacardium* seeds powder was transferred into a thimble, and 100 ml of n-hexane (bp: 68°C) was poured into a round-bottomed flask. Then, the Soxhlet's apparatus was heated using a heating mantle for 4 hours. The oil was recovered from the n-hexane solvent used in the extraction by solvent evaporation under reduced pressure in a rotary vacuum evaporator. 100 ml of solvent was added into a 250 ml round-bottomed flask, and was fitted to the bottom of the extractor. Then, the condenser was attached to the extractor with water supply tubes to complete the extraction apparatus. Then, the heating mantle was switched on after water was supplied to the condenser. The extraction time started when the first drop of solvent enters the thimble stuffed with the sample.

3.6.4 Total Phenol Estimation.

Total phenols content was determined by Folin-Ciocalteu procedure given by Singleton and Rossi (1965) in which absorbance was measured at 765 nm in a colorimeter against water blank. One gram of sample was taken and grinded with 10 ml of 80 per cent ethanol in pestle and mortar

Plate 5. Soxhlet Extractor

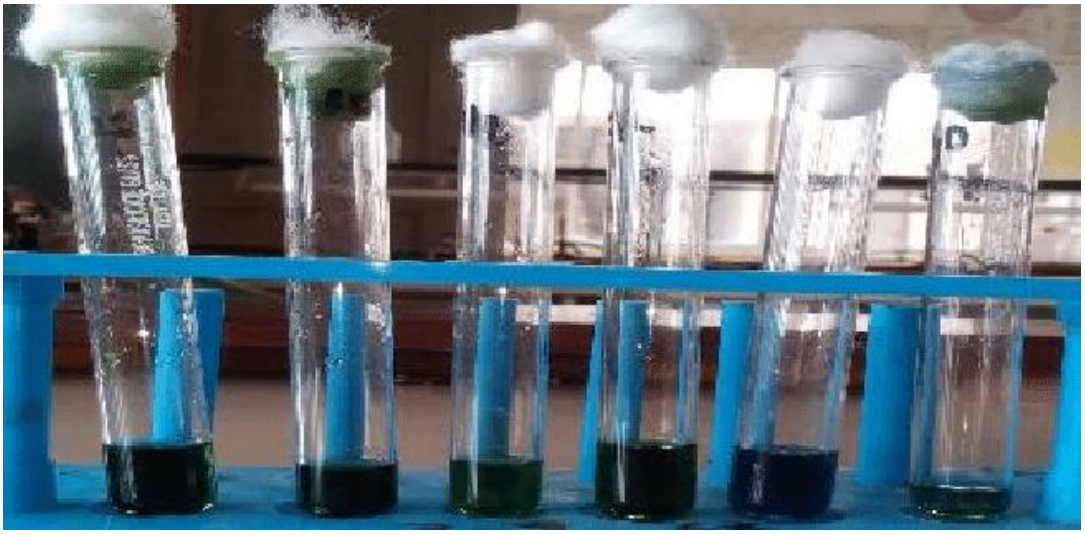


Plate 6. Estimation of Total Phenol content in *Semecarpus anacardium*

and centrifuged for 20 minutes at 10000 rpm and filtered. Filtrate was evaporated in oven up to the dryness and dried extract was dissolved in 5 ml distilled water. 2 ml aliquot was taken in separate test tubes and volume was made up to 3 ml. Then 0.5 ml Folin-Ciocalteu reagent was added. Phenols with phosphomolybdic acid in Folin Ciocalteu reagent and in alkaline medium produce a highly dark blue coloured complex (molybdenum blue). After 3 minutes 2 ml of Na_2CO_3(20 %) was added and mixed. Test tubes were placed in boiling water bath for one minute and then cooled. Optical density of these prepared sample solutions was recorded at 765 nm. The concentration was determined as per the standard procedure from the standard curve. A standard calibration curve of Gallic acid using its different concentrations was prepared. Stock solution was prepared by dissolving 0.5 g of dry Gallic acid in water to make the final volume 100 ml in a volumetric flask. Aliquot 0, 1, 2, 3, 5 and 10 ml of Gallic acid were taken in separate volumetric flasks and then final volume was raised up to 100 ml with distilled water. 1 ml of each from these in separate 100 ml volumetric flask. Water (60 ml) and Folin Ciocalteu (5 ml) reagent were added to the respective flasks and mixed well. Then, 15 ml Na_2CO_3 (20%) solution was added. The contents were mixed properly and final volume was made to 100 ml with distilled water. After 2 hr. absorbance was recorded at 765 nm. Absorbance was then plotted against concentration and concentration of total phenols in the given sample was calculated and expressed as mg/100 g of sample.

3.7. Statistical analysis

The data collected was subjected to the statistical analyses following the method as described by Panse and Sukhatme (1967). The analysis of variance, co-variance, estimates genotypic and phenotypic variability and correlation was done using standard statistical software computed to estimate the variability parameters.

Estimation of mean and range

a) **Mean**- The mean value for each character was worked out by dividing the total by corresponding number of observations

$$\bar{X} = \frac{\sum Xi}{N}$$

Where,

$\bar{X}$ = Mean of the character

$\sum Xi$ =Total of the character

N =Number of observation

b) Range- The lowest and highest values from mean of each character were recorded as range.

c) Standard Deviation (S.D.)= $\sqrt{1/n \sum (X - \bar{X})^2}$

Where,

N = Total number of individuals

X = Individual mean overline

$\bar{X}$= Population mean

d) Variance components

Phenotypic and Environmental Variances were calculated as follows,

Phenotypic variance (VP) =VG+ Error mean sum of squares

Environmental variance (VE) = Error mean sum of squares

Heritability (h^2)

Heritability in percentage was calculated by the formula suggested by Burton and De Vane (1953).

h^2= (VG / VP) ×100

Where,

h^2 = Heritability (broad sense)

VG = Genotypic variance

VP = Phenotypic variance

Genetic Advance (GA)

The expected genetic improvement at five percent selection intensity was calculated by the formula suggested by Lush (1940) and further used by Burton and De Vane (1953).

Genetic advance (GA) = (VG / VP) ×$\sqrt{VP}$ × K

Where,

VP = Phenotypic variance

VG = Genotypic variance

K = Selection differential at 5% selection intensity. The value of K = 2.06 (Allard, 1960).

Genetic Gain

Genetic gain was worked out to the genetic advance as percent of population mean following the method suggested by Johnson et al. (1955) as under.

$$\text{Genetic gain} = GA / MEAN \times 100$$

CHAPTER IV

RESULT AND DISCUSSION

In the present investigation entitled" "Identification of morphotype in *Semecarpus anacardium* Linn. in selected provenance of Vidarbha region". the observation were recorded on purposively selected trees from each districts of in Vidarbha region.

4.1 Results

4.1.1 Selection of Candidate Plus Tree (CPTs) from Vidarbha provinance

The Candidate plus Tree Selection (CPT) approach is a valuable method in forestry and agroforestry that involves the identification and selection of superior individual trees based on desirable traits. The selection criteria for CPTs vary from species to species but many of the basic characteristics are quite considerable. The CPTs selection standards was set and marked with white band. by focusing on key characteristics such as growth, disease resistance, and nut quality. CPT facilitates the propagation of individuals with a higher likelihood of passing on these favorable traits to their offspring.The individuals having diseases, dead branches, or attacked by any pathogen and pests were rejected in the initial stage of selection. The co-ordinates taken by the help of GPS Waypoint.

4.1.2 Growth parameters of the selected Candidate Plue Tree's (CPTs)

The data on growth parameters were recorded for further evaluation. Growth parameters like height of the tree, girth at breast height, crown height was recordedfor selected CPTs. The observations recorded are presented in table 4.the Phenotypical observation were also recorded for selected CPTs as seed characters and fruit characters.

4.1.2.1 Tree height (m):

The Tree Height was recorded from ground level to the tip of the tree and data presented in table 4. Among the selected CPT's tree height ranged between 3.30 to 6.01 m. The genotype CPT-3 (3.30m) had least height, while CPT-18(6.01m) was a taller accession followed by CPT-

17(5.55m). Among twenty genotypes of *S. anacardium*, twelve genotypes had more height and eight genotype had lower than mean. The mean height of tree is 36.43 as shown in Fig 1. The work on the same aspect has been reported by Ghosh *et al.* (2022) noticed in *Semecarpus anacardium* L., Chauhan et al. (2018) revealed in *Melia dubia* Cav, and Kesari et al. (2008) reported in *Pongamia pinnata*.

4.1.2.2. Girth at breast height (cm):

The data varied significantly for girth at breast height is presented in table 4 and it ranged from 28.01 to 45.03cm. Minimum girth at breast height was recorded in CPT-3(28.01cm), while CPT-18(45.08cm) showed maximum girth at breast height followed by CPT-13(41.02cm) and CPT-17(39.08cm) Among twenty genotypes of *S. anacardium*, seven genotypes had more girth and thirteen genotype had lower than mean. The mean of girth at breast height is 4.62, as shown in Fig 2. The result of this investigation are in confirmation of Ghosh et al. (2022) in *S.anacardium* , Naima et al. reported in Argan Tree and Chauhan et al. (2018) revealed in *Melia dubia* Cav.

4.1.2.3. Canopy spread

The data on canopy spread is presented in table no 4.1.The tree canopy spread was recorded in two dimentions. The result varied for canopy spread ranged between 2.68 to 2.90 in north-south and in east-west direction ranged between 2.89 to 3.02. Maximum canopy was recorded in CPT-19 (2.90 m), followed by CPT-18 (2.87m). The minimum canopy spread found in north-south direction in CPT-1, CPT-2, CPT-3 is (2.68). while the maximum canopy spread in east-west direction in CPT-19 (3.02m) and the minimum canopy spread in CPT-1 (2.89m).Similar results has been noticed by Daneva *et al.* (2018) in *Ailanthus excels.*

Table 4. Mean performance of twenty CPTs of *Semecarpus anacardium* L. for growthparameters.

Sr.no	CPTs	Tree Height (m)	Tree GBH (cm)	Canopy Spread (N-S) (m)	nopy Spread (E-W)(m)
1.	CPT-1	4.05	34.01	2.68	2.89
2.	CPT-2	4.30	35.02	2.68	2.89
3.	CPT-3	3.30	28.01	2.68	2.89
4.	CPT-4	5.32	38.05	2.69	2.90
5.	CPT-5	4.11	34.07	2.70	2.91
6.	CPT-6	4.15	37.05	2.71	2.92
7.	CPT-7	5.41	37.01	2.71	2.92
8.	CPT-8	5.47	37.02	2.72	2.94
9.	CPT-9	3.97	30.01	2.74	2.96
10.	CPT-10	4.47	38.03	2.76	2.98
11.	CPT-11	5.23	38.01	2.79	3.01
12.	CPT-12	4.00	37.08	2.79	3.01
13.	CPT-13	5.47	41.02	2.70	2.99
14.	CPT-14	4.56	37.03	2.69	3.00
15.	CPT-15	4.22	38.07	2.72	2.97
16.	CPT-16	5.03	38.01	2.71	2.96
17.	CPT-17	5.55	39.08	2.74	2.98
18.	CPT-18	6.01	45.03	2.87	3.01
19.	CPT-19	3.39	29.08	2.90	3.02
20.	CPT-20	4.58	38.09	2.70	2.98
Mean	-	**4.629**	**36.43**	**2.734**	**2.95**
S.D	-	**0.762**	**3.967**	**0.061**	**0.0453**
S.E	-	**0.164**	**0.887**	**0.022**	**0.0153**

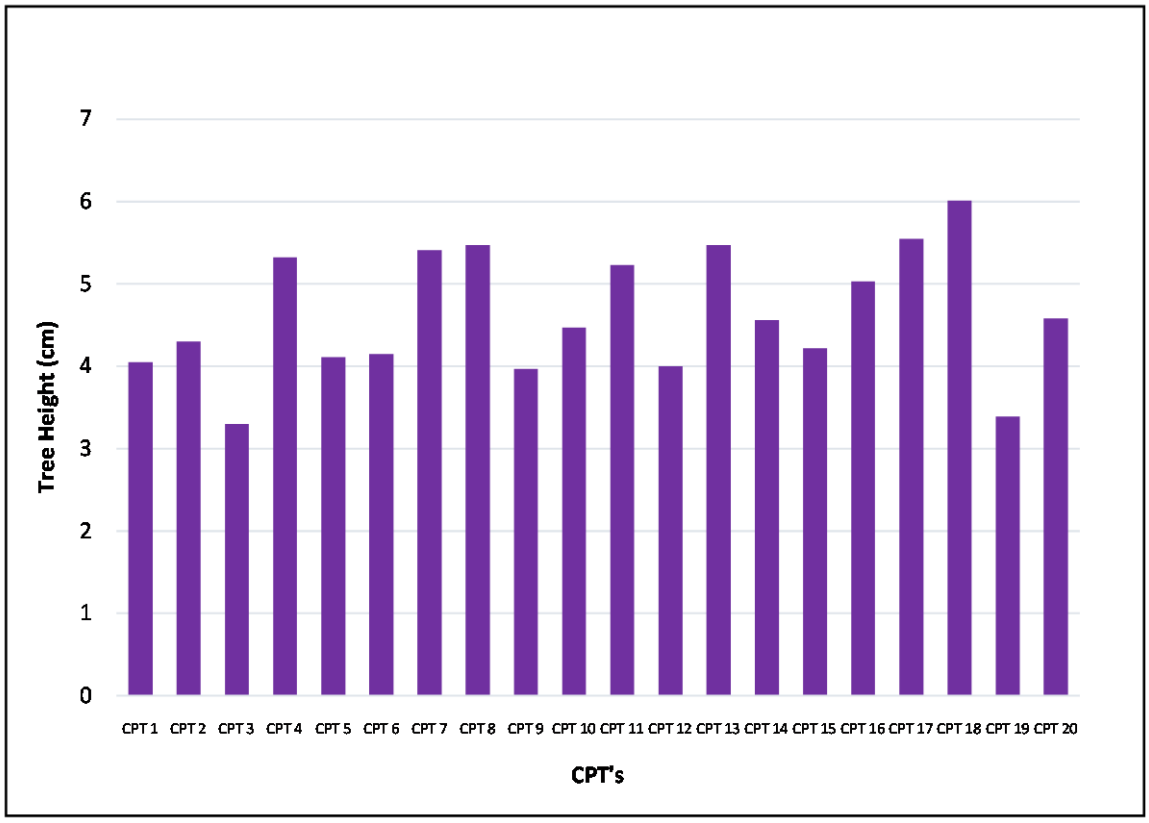


Fig 1. Variation in Tree Height of selected Candidate Plus Tree of *Semecarpus anacardium*

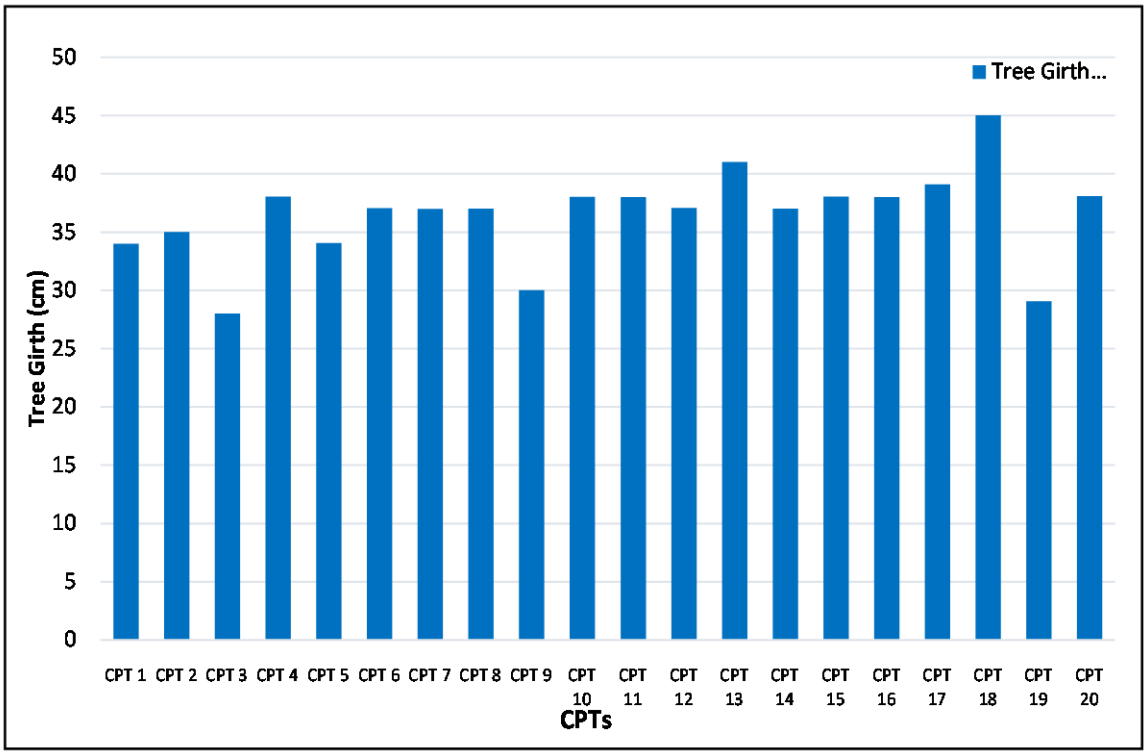


Fig 2. Variation in Tree Girth of selected Candidate Plus Tree of *Semecarpus anacardium*

4.1.3 Seed Characters

4.1.3.1 Seed Weight

The Data on the seed weight is presented in Table 5. The result shows that the average 100 seed weight range between 18.21 to 28.55 g with the mean value of 22.06 g. Minimum 100 seed weight was recorded in CPT-4(18.21g) while the maximum seed weight was observed in CPT-10 (28.55g) followed by CPT-6(27.02g) .The data reveled that the ten genotypes had more and ten had less seed weight than mean, as shown in Fig 3. However it is concluded that the data recorded for average seed weight showed significant differences between the CPTs. Similar result has been noticed by Ikram M. *et al.* (2020) in Soybean, iijima K. *et al.* (2011) in stone fruits

4.1.3.2 Seed Volume

The Data on the seed volume is presented in Table 5. The result shows that the average seed volume among the selected CPTs range between 1.6 to 4.8 ml with the mean value of 2.91. Minimum Seed volume 1.6 ml was recorded in both CPT-4, CPT-5 while the maximum seed volume was observed in CPT -13 (4.8ml) followed by CPT- 14(4.1ml). The data reveled that eleven genotypes had more and nine had less seed volume than mean. However it is concluded that the data recorded for average seed volume showed significant differences between the CPTs. Similar result has been noticed by Seyed R. *et al.* (2006) revealed in watermelon seeds, M. C. Ndukwu (2009) in Brachystegia eurycoma seeds. and Boydaş, M. G. (2017) in potato planter.

4.1.3.3 Seed Shape

Data pertaining to seed shape was recorded as broadly kidney shaped on matured seed Table 7.

4.1.3.4 Seed Colour

Observation on mature seed colour was recorded as Black .whereas the seed in semi maturity the seed colour is green in the month of novermber December.(Table7).

4.1.3.5 Seed Texture

Smooth Seed Texture was recorded for CPTs in all four districts and presented in Table 7.

Table 5. Mean performance of seed attribution of selected CPTs *Semecarpus anacardium*

Sr.no	CPTs	100 Seed Weight (g)	Seed Volume(ml)
1.	CPT-1	20.15	2.3
2.	CPT-2	20.14	2.1
3.	CPT-3	19.42	1.8
4.	CPT-4	18.21	1.6
5.	CPT-5	18.55	1.6
6.	CPT-6	27.02	3.8
7.	CPT-7	26.08	2.9
8.	CPT-8	23.23	2.5
9.	CPT-9	26.21	3.6
10.	CPT-10	28.55	3.4
11.	CPT-11	23.15	3.2
12.	CPT-12	23.16	4.1
13.	CPT-13	26.23	4.8
14.	CPT-14	21.25	4.1
15.	CPT-15	19.23	2.6
16.	CPT-16	18.23	2.1
17.	CPT-17	19.25	3.3
18.	CPT-18	20.29	3.1
19.	CPT-19	20.56	2.6
20.	CPT-20	22.31	2.7
MEAN		**22.06**	**2.91**
SD		**3.239**	**0.886**
SE		**0.724**	**0.198**

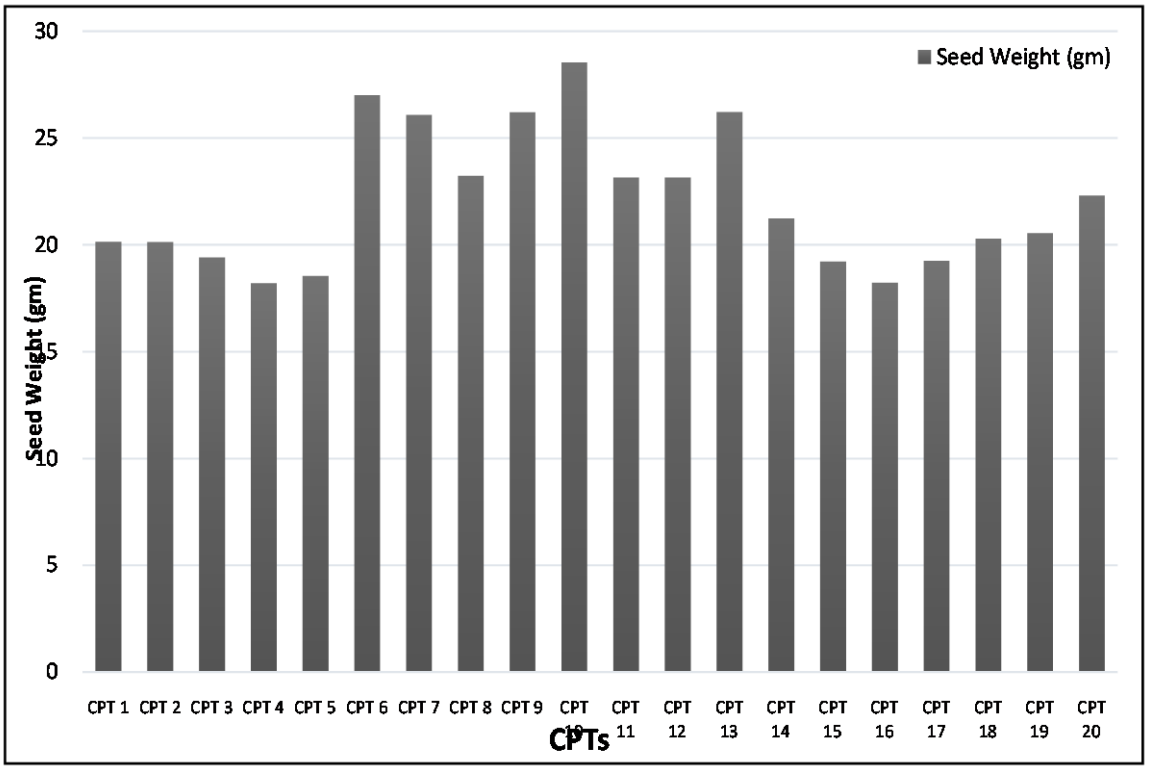


Fig 3. Variation in Seed Weight of selected Candidate Plus Tree of *Semecarpus anacardium*

4.1.4 Foliage parameters

4.1.4.1 Leaf Shape-

Leaf shape of the plant were recorded visually on matured leaf as in theWardha division the leaf shape seen elliptical. In the area of Washim and Buldhana the leaf shape observed obvate to oblong and in the region of Bhandara the leaf shape was obvate (Table 7)

4.1.4.2 Leaf Base Shape-

As presented in Table 7 the Leaf base shape in wardha district showed obtuse, in the area of Washim and Buldhana the leaf base shape is rounded and in Bhandara District the leaf base shape is rounded.

4.1.4.3 Fruit Shape

The fruit shape observation is presented in Table 6 recorded as ‘U’ shaped atpeak harvesting stage.

4.1.4.4 Fruit Colour

Data presented in Table 6 in respect to time of maturity exhibited at peak of maturity the fruit colour is reddish orange in all four division. The fruit matured at the time of November December. Whereas the unriped fruit is in green colour.

4.1.4.5 Fruit Type

Data given on the Fruit Type in Table 6 shows that the Fruit type is Drupesimilar in all four provenance of vidarbha region.

4.1.4.6 Fruit Texture

Data regarding Fruit Texture was recorded as smooth and shining in all fourdistricts and presented in Table 6.

Table 6. Fruit characters from selected CPTs of *Semecarpus anacardium*

Sr.no.	Name of Districts	Fruit shape	Fruit Type	Fruit Colour	Fruit Texture
1.	Wardha	'U' shaped	Drupe	reddish orange	smooth and shining
2.	Washim	'U' shaped	Drupe	reddish orange	smooth and shining
3.	Buldhana	'U' shaped	Drupe	reddish orange	smooth and shining
4.	Bhandara	'U' shaped	Drupe	reddish orange	smooth and shining

Table 7. Leaf characters from selected CPTs of Semecarpus anacardium in differentlocations

Sr.no.	Name of Districts	Leaf shape	Leaf Base shape	Seed Shape	Seed Colour	Seed Texture
1.	Wardha	elliptic	Obtuse	Broad Kidney	Black	smooth
2.	Washim	Obovate to oblong	rounded	Broad Kidney	Black	smooth
3.	Buldhana	Obovate to oblong	rounded	Broad Kidney	Black	smooth
4.	Bhandara	Obovate	Obtuse	Broad Kidney	Black	smooth

4.1.5 Phytochemical Parameters

4.1.5.1 Oil Content (%)

The data of seed oil content is presented in Table 8. Within a species, there can be considerable variation in seed oil content among different individuals or populations. The results regarding to variations in Seed oil ranged between 12.50 to 37.50.The Maximum oil is obtained from

Buldhana District i.e 37.50 per cent (CPT 14) followed by 36.60 per cent (CPT 11).The lowest range of oil was found in Bhandara District is 12.50 per cent (CPT 16). The maximum oil content from seed was obtained to be 33.50(CPT 1) from Wardha district followed by 32.60(CPT 7) from Washim district. While 37.50(CPT 14) shown in buldhana district and 30.09(CPT 20) shown in bhandara district. The Maximum oil is obtained from Wardha District i.e 34.50 per cent (CPT 3) and minimum in CPT 2(17.50). The Maximum oil is obtained from Washim District i.e 32.60 per cent (CPT 7) and minimum in CPT 10 (12.60). The Maximum oil is obtained from Buldhana District i.e 37.50 per cent (CPT 14) and minimum in CPT 13 (25.90). The Maximum oil is obtained from Bhandara District i.e 30.09 per cent (CPT 20) and minimum in CPT 16 (12.50).The mean value for oil seed content were obtained to be 25.82.The value obtained from standard deviatation is 7.53 and from standard error of mean is 1.68. Nine CPTs had less oil content than its meanvalue, while eleven has more oil content.

The results indicate considerable variability in seed oil content across different districts and CPTs. Buldhana district appears to consistently produce cultivars with high oil content, while Bhandara district has the lowest recorded oil content. The mean, standard deviation, and standard error provide statistical measures for understanding the central tendency and dispersion of the data. Fig 4 visually represents how individual CPTs compare to the mean oil content.

This variation may be influenced by genetic factors, environmental conditions, and interactions between genetics and the environment. Similar result has been noticed by Setapar et al. (2014) in *Hevea brasiliensis*, Deshmukh *et al*. (2010) revealed in *Semecarpus anacardium* L. and Ghawade *et al*. (2018) noticed in *Semecarpus anacardium*.

Table 8. Phytochemical Characters of Oil Content (%) in *S. anacardium*

Sr.no	CPTs	Name of Locations	Oil Content (%)
1.	CPT-1	Wardha	33.50
2.	CPT-2	Wardha	17.50
3.	CPT-3	Wardha	34.50
4.	CPT-4	Wardha	24.60
5.	CPT-5	Wardha	19.50
6.	CPT-6	Washim	19.10
7.	CPT-7	Washim	32.60
8.	CPT-8	Washim	24.50
9.	CPT-9	Washim	29.60
10.	CPT-10	Washim	12.60
11.	CPT-11	Buldhana	36.60
12.	CPT-12	Buldhana	27.30
13.	CPT-13	Buldhana	25.90
14.	CPT-14	Buldhana	37.50
15.	CPT-15	Buldhana	28.50
16.	CPT-16	Bhandara	12.50
17.	CPT-17	Bhandara	17.20
18.	CPT-18	Bhandara	23.50
19.	CPT-19	Bhandara	29.50
20.	CPT-20	Bhandara	30.09
MEAN			**25.82**
SD			**7.531**
SE			**1.684**

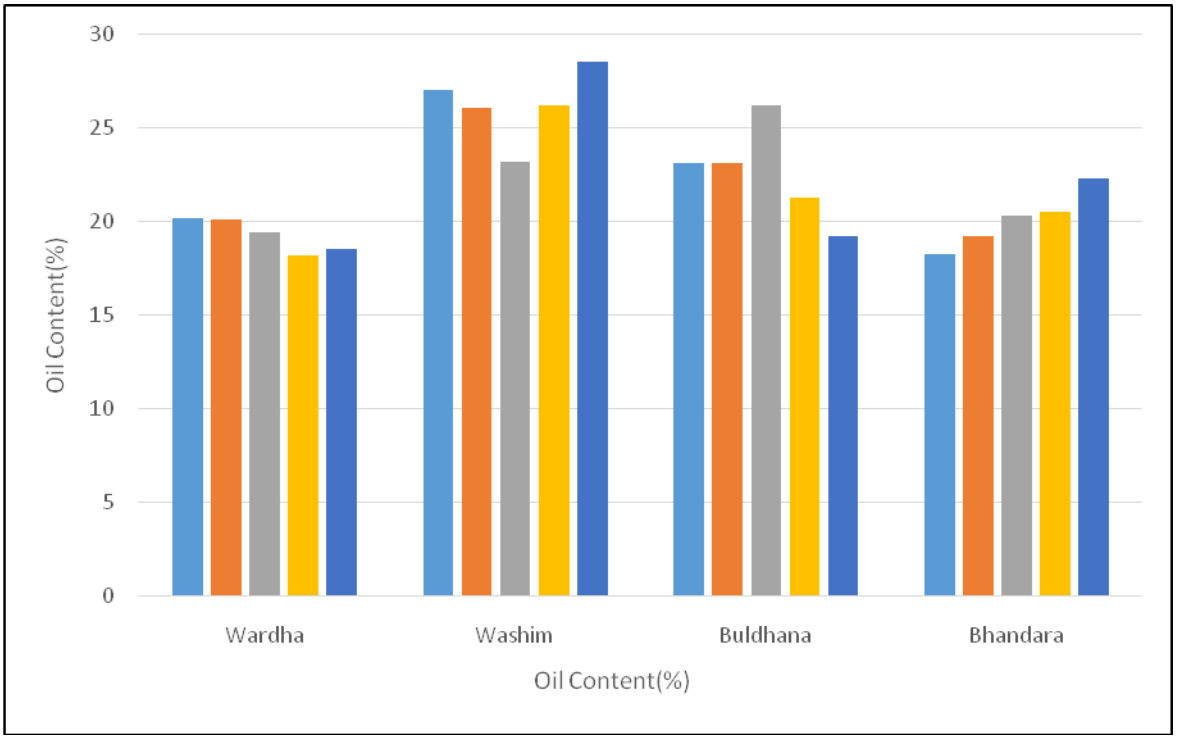


Fig 4. Variation in oil content of selected Candidate Plus Tree of *Semecarpus anacardium* L.

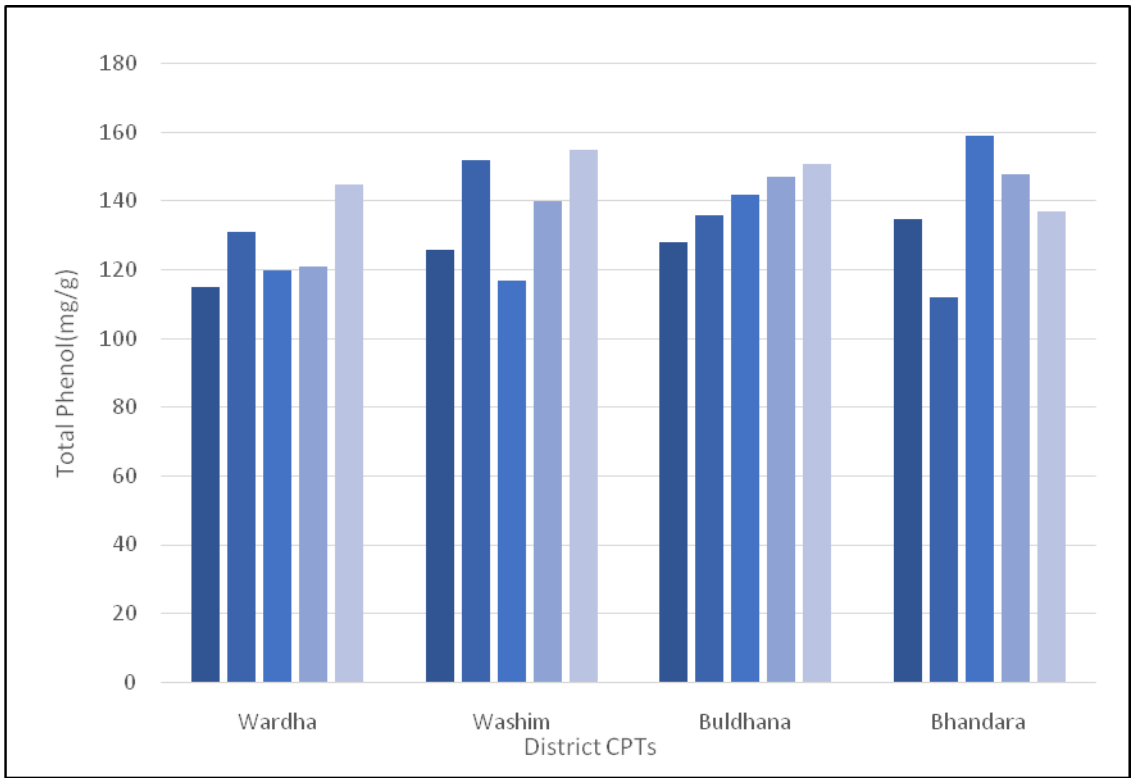


Fig 5. Variation in Total Phenol of selected Candidate Plus Tree of *Semecarpus anacardium* L.

Table 9. Phytochemical Characters of Phenol Content (mg/g) in *Semecarpus anacardium*

Sr.no.	CPT's	Name of Locations	Total phenol (mg/g)
1.	CPT-1	Wardha	115
2.	CPT-2	Wardha	131
3.	CPT-3	Wardha	120
4.	CPT-4	Wardha	121
5.	CPT-5	Wardha	145
6.	CPT-6	Washim	126
7.	CPT-7	Washim	152
8.	CPT-8	Washim	117
9.	CPT-9	Washim	140
10.	CPT-10	Washim	155
11.	CPT-11	Buldhana	128
12.	CPT-12	Buldhana	136
13.	CPT-13	Buldhana	142
14.	CPT-14	Buldhana	147
15.	CPT-15	Buldhana	151
16.	CPT-16	Bhandara	135
17.	CPT-17	Bhandara	112
18.	CPT-18	Bhandara	159
19.	CPT-19	Bhandara	148
20.	CPT-20	Bhandara	137
MEAN			**135.85**
SD			**14.176**
SE			**3.169**

4.1.1.1 Total phenol (mg/g)

The data on Total Phenol content in oil, as presented in Table 9, revealed a range of 112 to 159 mg/g. The highest phenol content was recorded in Bhandara District (CPT 18) at 159 mg/g, while the lowest was observed in Bhandara District (CPT 17) at 112 mg/g. In Wardha District, CPT 5 exhibited the maximum total phenol at 145 mg/g, while in Washim District, CPT 10 showed the highest at 155 mg/g. In Buldhana District, CPT 15 and CPT 18 displayed the maximum phenol content at 151 mg/g and 159 mg/g, respectively.

The mean value for Total Phenol was calculated to be 135.85, with a standard deviation of 14.17 and a standard error of the mean of 3.16. Eight CPTs exhibited phenol content below the mean value, while twelve had higher phenol content, as depicted in Figure 5. The distribution of phenol content across the selected CPTs indicates variability within the studied population.

The findings align with previous research conducted by Srinivasan et al. (2016) on Semecarpus anacardium L. and Rao et al. (1973) in Semecarpus anacardium, suggesting consistency in results across different studies.

CHAPTER V

SUMMARY AND CONCLUSION

The present study entitiled “Identification of morphotype in *Semecarpus anacardium* Linn. In selected provenance of vidharbha region” was carried out in the Department of Forestry and Department of Biotecnology Nagarjun, Dr.P.D.K.V. Akola during 2022-2023. The CPTs were selected from different location of Wardha, Washim, Bhandara, Buldhana provenance during 2022-2023 (plate 1). The CPT selection was carried out after survey of the natural existing populations in the region. In each populations superior individuals based on morphological and phonological observations were selected.

Growth parameter like height of tree, girth at breast height, canopy spread was recorded for selected CPTs. The tree selected as CPTs, were having GBH ranging from 28.01 to 45.03cm. Minimum girth at breast height was recorded in CPT-3(28.01m) followed by CPT-19(29.08cm), while CPT-18(45.08cm) showed maximum girth at breast height followed by CPT-13(41.02cm). The Tree Height was recorded from ground level to the tip of the tree. Among the selected CPT’s tree height ranged between 3.30 to 6.01 m. The genotype CPT-3 (3.30m) followed by CPT-19(3.39m) had least height, while CPT-18(6.01m) was a taller accession followed by CPT-17(5.55m). The canopy spread was recorded in two dimentions. The result varied for canopy spread ranged between 2.68 to 2.90 in north-south direction, and in east-west direction ranged between 2.89 to 3.02. Maximum canopy was recorded in CPT-19 (2.90 m), followed by CPT-18(2.87m). The minimum canopy spread found in north-south direction in CPT-1, CPT-2, CPT-3 is (2.68). while the maximum canopy spread in east-west direction in CPT-19 (3.02m) and the minimum canopy spread in CPT-1 (2.89m).

Seed oil content within a species, revealing considerable variation among different individuals or populations. The seed oil content ranges from 12.50 to 37.50, with the highest oil content observed in Buldhana District 37.50% in (CPT 14) followed by 36.60% in (CPT 11). Conversely, the lowest oil content is found in Bhandara District at 12.50% (CPT 16). Wardha

District shows the maximum oil content at 33.50% (CPT 1), followed by 32.60% (CPT 7) in Washim district. Buldhana District displays the highest oil content at 37.50% (CPT 14), with Bhandara District having the lowest at 30.09% (CPT 20). This variation may be influenced by genetic factors, environmental conditions, and interactions between genetics and the environment.

Total phenol in oil ranged between112 to 159 mg/g in all provenance of Vidarbha. the highest recorded Total phenol in oil content is in CPT-18 from Bhandara (159%), and the lowest is in CPT-17 from Bhandara (112%). Overall, these values can help assess the performance and variability of Total phenol in oil content in the different cultivars and districts.

CONCLUSION

The study aimed to characterize and identify the morphotypes of *Semecarpus anacardium*, providing valuable insights into the variability of this plant species. The Observation involved thorough morphological analyses and assessments, with a focus on key traits such as leaf morphology, fruit characteristics, and overall plant architecture.

The significant variations in seed oil content among different regions and species. The findings demonstrate that Buldhana District tends to have higher oil content compared to other districts, while Bhandara District generally has lower oil content.

The data revealed that out of 20 selected CPTs from Buldhana and Bhandara district; four CPTs namely CPT 14, CPT 16, CPT 17, CPT 18 were identified as Candidate Plus Trees based on their distinctive characteristics.

S. anacardium seed oil has good physicochemical characters. The seed oil of *S. anacardium* has number of bioactive compounds useful to control insect pests and diseases of agricultural and forestry importance.

The performance of crop with regards to productivity and fruit quality was quite satisfactory and indicative for commercial exploitation in future. This information can be applied in crop improvement, proper conservation and better use of this underutilized plant species.

CHAPTER VI

LITERATURE CITED

Allard, R.D., J. Wiley and Sons, (1960). Principles of Plant breeding. Inc. New York 485 p.

Anumalla M, R. Roychowdhury, C.K Geda , M. Mazid , A.K Rathoure, (2015). Utilization of plant genetic resources and diversity analysis tools for sustainable crop improvement with special emphasis on Rice. Int J Adv Res 3(3):1155–1175.

Bagewadi, Z. K., R. S., Siddanagouda, & P. G. Baligar, (2012). Phytochemical screening and evaluation of antimicrobial activity of *Semecarpus anacardium* nuts. International Journal of pharmacology and pharmaceutical technology, 1(2), 68-74.

Boydaş, M. G. (2017). Effect of cup size, seed characteristics and angular speed on the performance of an automatic potato planter under laboratory conditions. Journal of agricultural sciences, 23(3), 317-327.

Burton, G.W. and E.W. Devane, (1953). Estimating heritability in tall fescue from replicated clonal materials Agron. J., 45(1):478-481

Carrasquinho, I., J. Freire, A. Rodrigues, and M. Tomé, (2010). Selection of *Pinus pinea* L. plus tree candidates for cone production. Annals of Forest Science, 67(8), p.814.

Chauhan, R.S., D.B. Jadeja, N. S. Thakur, S.K. Jha, and M.S. Sankanur ,(2018). Selection of Candidate Plus Trees (CPTs) of Malabar Neem (*Melia dubia* Cav.) for Enhancement of Farm Productivity in South Gujarat, India. Int. J. Curr. Microbiol. App. Sci, 7(5), pp.3582-3592.

Chopra, R. N., & Nayar, S. L. (1956). Glossary of Indian medicinal plants. Council of Scientific and Industrial Research.

Dandin S. B, N. K Krishna, (2016). Neglected and underutilized fruit species – an insurance against global mal and under nutrition. Regional Expert Consultation of NUS, FAO Regional Office, Bangkok; pp. 1-40.

Daneva, V., R. S., Dhillon, & V. Johar, (2018). Plus tree selection and progeny testing of superior candidate plus trees (CPTs) of *Ailanthus excelsa*. Journal of Pharmacognosy and Phytochemistry, 7(2), 543-545.

De Vicente MC, F.A Guzma´n, J. Engels, V.R. Rao, (2006). Genetic characterization and its use in decision making for the conservation of crop germplasm. Ruane J, SonninoA (eds) The role of biotechnology in exploring and protecting agricultural genetic resources. Food and Agriculture Organization, Rome, pp 121–128

Deshmukh, N. A., D. P. Waskar, and P. B. Sable, (2010). "Variability in markingnut (*Semecarpus anacardium* L.) Accessions from Marathwada region of Maharashtra State." Journal of Horticultural Sciences 5.1: 71-74.

Ghawade, P. M., L. V. Pimpalpalle , & K. B. Palepad, (2018). Study of correlation and index ranging of markingnut (*Semecarpus anacardium* L.) Genotypes in Nanded district of Marathwada region. Journal of Pharmacognosy and Phytochemistry, 7(1), 1326-1330.

Ghosh, A., K. M. Dey, Hassan, F.K. Bauri, B.C. Das, N. Bhowmick, A. N. Dey, S. Das, P.K.Sahu, (2022). Descriptors for morphological and biochemical characterization of Bhela (*Semecarpus anacardium* L.): An underutilized plant of tropics. Genet Resour Crop Evol 69, 2585–2604.

Gil, R. R., L. Z., Lin, G. A., Cordell, M. R., Kumar, M. R., Ramesh, M., Reddy, B. M., ... & Rao, A. V. N. A. (1995). Anacardoside from the seeds of *Semecarpus anacardium*. Phytochemistry, 39(2), 405-407.

Gouthaman, T., M. S. Kavitha, B. A. Ahmed, T. S.Kumar, & M. V.Rao, (2008). A review on *Semecarpus anacardium* L: An anticancer medicinal plant. Phytopharmacology and therapeutic value, 193-221.

Hadian, J., S. N.,Ebrahimi, & P. Salehi,(2010). Variability of morphological and phytochemical characteristics among *Satureja hortensis* L. accessions of Iran. Industrial Crops and Products, 32(1), 62-69.

Iijima, K., T. Yajima, M. Nagata, S.Sugimoto, M. Fujita, K. Sato, & Y. Kato, (2011). Effect of seed weight on estimation of pesticide residue levels in stone fruits. Journal of Pesticide Science, 36(4), 492-494.

Ikram, M., X.,Han, J. F., Zuo, J.,Song, C. Y.,Han, Y. W., Zhang, & Zhang, Y. M. (2020). Identification of QTNs and their candidate genes for 100-seed weight in soybean (*Glycine max* L.) using multi-locus genome-wide association studies. Genes, 11(7), 714.

Ilanchezhian, R., R. N. Acharya, J. C. Roshy, & V. J. Shukla, (2012). Impact of Ayurvedic Shodhana (purificatory procedures) on Bhallataka fruits (*Semecarpus anacardium* Linn.) By measuring the anacardol content. Glob J Res Med Plants Indig Med, 1, 286-94.

Jain, P., & Sharma, H. P. (2013). A potential ethnomedicinal plant *Semecarpus anacardium* Linn. A review. Int *J* Res Pharm Chem, 3(3), 564-72.

Jain, P., S.K. Singh, H.P. Sharma, and F. Basri, (2014). Phytochemical screening and antifungal activity of *Semecarpus anacardium* L. (an anti-cancer plant). Int J Pharmaceut Sci Res, 5(5), pp.1884-1891.

Johnson, H.W., H.F. Robinson and R.E. Comstock, (1955). Estimates of genetic and environmental variability in Soyabean. Agron.J., 47: 314-318

Kesari, V., A. Krishnamachari, and L. Rangan, (2008). "Systematic characterisation and seed oil analysis in candidate plus trees of biodiesel plant, *Pongamia pinnata*." Annals of Applied Biology 152.3: 397-404.

Lush, J.K., (1949). Heritability of quantitative charcters in farm animals. *Proc. Int. Cong. Genet.,* Heriditas (suppl): 356-357.

Madhuri, S ., C. A. Dholariya, L. K. Behera, A. A. Mehta, S. K. Sinha, and S. M. Patel, (2019) "Biography of lesser known and medicinal tree species marking nut (*Semecarpus anacardium* L.)." MFP News 29, no. 1: 9-13.

Maňkovská, B., B., Godzik, O.,Badea, Y., Shparyk, & P. Moravčík, (2004). Chemical and morphological characteristics of key tree species of the Carpathian Mountains. Environmental Pollution, 130(1), 41-54.

Marjenah, M., & Putri, N. P. (2017). Morphological characteristic and physical environment of Terminalia catappa in East Kalimantan, Indonesia. Asian Journal of Forestry, 1(1), 33-39.

Menghani¹, E., & S. kumari Sharma, (2012). Search for antimicrobial efficacy of certain Indian medicinal plants.

Mishra, S. K., K., Rout, S. K. Prusty, & P. K. Sahu, (2016). Shodhana decreases nootropic activity of *Semecarpus anacardium*. Asian J Pharm Clin Res, 9(2), 294-297.

Mohanta, T. K., J. K.Patra, S. K. Rath, D. K.Pal, & H. N. Thatoi,(2007). Evaluation of antimicrobial activity and phytochemical screening of oils and nuts of *Semicarpus anacardium* Lf. Sci. Res. Essay, 2(11), 486-490.

Mohd-Setapar, S.H., Nian-Yian, L. and Mohd-Sharif, N.S., 2014. Extraction of rubber (*Hevea brasiliensis*) seed oil using soxhlet method. Malaysian Journal of Fundamental and Applied Sciences, 10(1).

Mohsenin NN (1970). Physical properties of plant and animal materials. New York: Gordon and Breach Science Publishers. pp. 51-87

Mukherjee, D. (2013). Improved agricultural practices for high value medicinal plants under mid to high altitude situation. Journal of Crop and Weed, 9(1), 201-206

Naima, A. I. T., F., El AYADIDI, F., Msanda, & El Mousadik, A. (2010). Genetic variability of argan tree and preselection of the candidate plus trees. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 38(3), 293-301.

Nair, P. R., S. J. Melnick, S. F. Wnuk, M. Rapp, E. Escalon, & C. Ramachandran, (2009). Isolation and characterization of an anticancer catechol compound from *Semecarpus anacardium.* Journal of ethnopharmacology, 122(3), 450-456.

Ndukwu, M. C. (2009). Determination of selected physical properties of Brachystegia eurycoma seeds. Research in Agricultural Engineering, 55(4), 165-169.

Panda, B.M., U.J. Mehta, and S. Hazra, 2017. Optimizing culture conditions for establishment of hairy root culture of *Semecarpus anacardium* L. 3 Biotech, 7, pp.1-10.

Panse, V.G. and P.V. Sukhatme, 1967. Statistical methods of agricultural workers. p. 610. ICAR, New Delhi.*

Pavithra, H.R., B. Gowda, K.T. Prasanna, and M.B. Shivanna, 2013. Pod and seed traits in candidate plus trees of *Pongamia pinnata* (L.) Pierre from southern peninsular India in relation to provenance variation and genetic variability. Journal of Crop Science and Biotechnology, 16, pp.131-142.

Poornima, M., S. A. Gothecha, & V. Kumar (2013). *Semecarpus anacardium*: a review. International Ayurvedic Medical Journal, 1(6), 69-76.

Premalatha, B., 2000. *Semecarpus anacardium* Linn. Nuts-a boon in alternative medicine. Indian Journal of Experimental Biology,Vol.38,pp.1177-1182.

Press, J. R., K. K. Shrestha, & D. A. Sutton (2000). Annotated checklist of the flowering plants of Nepal. Natural History Museum Publications.

Ramprasath, V. R., Shanthi, P., & Sachdanandam, P. (2004). Anti-inflammatory Effect of *Semecarpus anacardium* L INN. Nut Extract in Acute and Chronic Inflammatory Conditions. Biological and Pharmaceutical Bulletin, 27(12), 2028-2031.

Rao, NS Prakasa, L. Ramachandra Row, and R. T. Brown. (1973) "Phenolic constituents of *Semecarpus anacardium*." Phytochemistry 12.3: 671-681.

Raut, A. K. A., Sawant, N. S., Badre, A. S., Amonkar, A. J., & Vaidya, A. D. (2006). Bhallatak (*Semecarpus anacardium* Linn.)—a review.

Razavi, S., & Milani, E. (2006). Some physical properties of the watermelon seeds. African Journal of Agricultural Research, 1(3), 65-69.

Rubenstein DK, M. Smale, M.P. Widrlechner, 2006. Demand for genetic resources and the U.S. National Plant Germplasm System Crop Sci 46:1021–1031

Semalty M. A. Semalty, G.P. Badola, Joshi, and M.S.M. Rawat (2010) *Semecarpus anacardium* Linn .: A review. Pharmacog Rev. 4(7):88–94.

Singh V. K. A. W., Khan, D. Jaganathan, M. Thudi, M. Roorkiwal, H. Takagi, V. Garg, V. Kumar, A. Chitikineni, P.M. Gaur, T. Sutton.(2016) QTL-seq for rapid identification of candidate genes for 100-seed weight

and root/total plant dry weight ratio under rainfed conditions in chickpea. Plant Biotechnology Journal 14, pp. 2110-2119.

Singleton, Vernon L., and Joseph A. Rossi (1965). "Colorimetry of total phenolics with phosphomolybdic- phosphotungstic acid reagents." American journal of Enology and Viticulture 16.3: 144-158.

Srinivasan, A., B. D., Suresh, N. Senthilkumar, & S. Murugesan, (2016). Physicochemical properties and phytochemical constituents of *Semecarpus anacardium* L. seed oil. Advances in Applied Science Research, 7(3), 151-154.

Sukhadiya, M., C. A. Dholariya, L. K. Behera, A. A. Mehta, S. K. Sinha, & S. M.Patel(2019)Biography Of Lesser Known And Medicinal Tree Species Marking Nut (*Semecarpus anacardium* L.).

Tripathi, Y.B. and A. V. Singh, 2001. Effect of *Semecarpus anacardium* nuts on lipid peroxidation.

Ujjainkar, V., and Sharma, R. 2022 A Review on Tree Improvement through Candidate Plus Tree Selection (CPTs) in Indian Butter Tree (*Madhuca* spp) 11 (7), pp 84284

Upreti, S., M. S. Anam, S. V. Rajendra, K. Das, & R. Dang, (2016). *Semecarpus anacardium* Varied Medicinal Properties. Journal of Pharmaceutical Research, 15(4), 162.

VITA

1. Name of student : **Uike Manisha Vijayrao**
2. Date of birth : 19-02-2000
3. Name of college : Post Graduate Institute, Dr. PDKV, Akola
4. Residential address : At. Post.Manasmandir,Tal.-Wardha
   Dist. Wardha, (MS)
   Pin- 442001
   Mobile No. **-** 9503276796

5. Academic Qualification

Sr no.	**Name of degree awarded**	**Year in which obtained**	**Division/ Class**	**Name of awarding university**	**subject**
1	B.Sc. (Agriculture)	2021	First	Dr. P.D.K.V, Akola	Agriculture

6. Research paper Published : Nil
7. Field of interest : Research & Development

Place: Akola **Signature of student**

Date : / /2023

Uike Manisha Vijayrao