2013

Infra Species Taxonomy of Seed and Graft Propagated Mango (Mangifera Indica L.) in Chapai Nawabganj

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INFRA SPECIES TAXONOMY OF SEED AND GRAFT PROPAGATED MANGO (*MANGIFERA INDICA* L.) IN CHAPAI NAWABGANJ

**THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN THE DEPARTMENT OF BOTANY
UNIVERSITY OF RAJSHAHI
BANGLADESH**

SUBMITTED BY

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JUNE, 2013

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Ph. D.
THESIS

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Ph. D. Thesis

A Thesis Submitted to the Department of Botany, University of Rajshahi, for the Degree of Doctor of Philosophy in Botany.

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Examination: 2013

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DEDICATED

TO

MY PARENTS

ACKNOWLEDGEMENTS

All my respect to Almighty Allah.

I am extremely grateful to my supervisor Dr. Gour pada Ghosh, associate professor, Department of Botany, University of Rajshahi and co-supervisor Dr. M. I. Zuberi, Professor, Department of Botany, University of Rajshahi for their kind supervision.

I am grateful to Dr. A. K. M. Rafiul Islam and Dr. Monzur Hossain, Professors of Botany Department for their kind help and cooperation to complete my thesis.

I would like to express my thanks for help and suggestions from my brother and the local people of Chapai Nawabganj. Cordial thanks are due to my family members especially to my brother for his mental support and encouragement.

The Author

DECLARATION

I hereby declare that the entire research work submitted as a thesis for the Degree of Ph. D. in Botany at the University of Rajshahi, is the result of my own investigation.

(Farzana Shirin)
Signature of the candidate.

CERTIFICATE

It is my pleasure to certify that the research work presented in this dissertation entitled "INFRA SPECIES TAXONOMY OF SEED AND GRAFT PROPAGATED MANGO *(Mangifera Indica* L.*)* IN CHAPAI NAWABGANJ" submitted by Farzana Shirin to the Department of Botany, University of Rajshahi, Bangladesh for the Degree of Ph. D. in Botany done by herself and has not been submitted for any other degree.

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Certificate

This is to certify that the thesis presented by Farzana Shirin of Department of Botany, Rajshahi University for the Degree of Ph.D is her own work. I have gone through it and do recommend it for submission and examination.

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ABSTRACT

Phenotypic variation and diversity of mango (*Mangifera indica* L.) of Chapai Nawabganj district in Bangladesh was investigated. The mango cultivars were studied for the qualitative and quantitative characters under the agro-climatic condition of Chapai Nawabganj region where mango grows extensively. A total of three hundreds fifty seven trees were selected from the six villages named Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga for the assessment of thirty one qualitative characters and eleven quantitative characters of tree, leaf, inflorescence, fruit and stone following the Descriptor (IBPGR,1989 & IPGRI,2006). A wide range of variations were observed among the six villages and within the villages for both morphological and reproductive characters which indicated the existence of rich genetic diversity of mango in this region. The mango trees were grouped into three categories- 'commercial varieties', 'cultivated varieties' and 'gutee' trees to identify the pattern of phenotypic changes of variation among them. Two hundreds and seventy trees (90 from each category) were used for this purpose. The results strongly indicated a pattern of morphological change among the three categories. The differences in qualitative characters of the commercial varieties were more prominent than the cultivated varieties and 'gutee' trees. For quantitative characters, the commercial varieties showed better adaptation in respect to leaf, fruit and stone characters than the other two categories. Also, wide ranges of variations were observed among the mango trees grouped in two age groups (young and old). In this case, the differences for qualitative and quantitative characters were much pronounced in the commercial varieties whereas in 'gutee' trees it was least pronounced. The taxonomic study of mango was carried out to establish a suitable key for classification to identify them easily. The complete description of 14 local cultivars have been added which were not included earlier in any published monographs in Bangladesh. There were many locally cultivated varieties of mango which are superior in quality but not getting proper attention and become threatened or extinct before their documentation. Also the descriptions of hundred 'gutee' trees have been added as an indication of the richness of variations of diversity exists in the mango populations. These local cultivars and 'gutee' trees can be used to produce superior clones or in breeding programs. So it is important to put proper attention on to conserve these resources for future varietal development programme.

CONTENTS

List of abbreviations

°	Degree
cm	Centimeter
m	meter
e.g.	exempli gratia, for example
et al.	*et alia* (and others)
etc.	et cetera, and the rest
Fig.	Figure
Pic.	Picture
g	Gram
K cal	Kilo calorie
ha	Hectare
L./Linn.	Linnaeus
m tons	Metric tons
mg	Milligram
No.	Number
%	Percentage
χ^2	Chi square
$>$	Greater than
$<$	Less than
N. S.	Non significant
viz.	Videli (Namely)
*	Significant
**	Highly Significant
***	Very highly significant

CHAPTER – I

1. INTRODUCTION

1.1. Mango- the King Fruit of Bangladesh

Mango is one of the most popular fruit crops of tropical and subtropical zones worldwide, particularly in Asia. The status and importance can easily be realized by the fact that it is often mentioned as “the king” of fruits in the tropical world (Purseglove, 1972). In Bangladesh Mango (*Mangifera indica* L.) is the most important fruit crop. This unique fruit is now recognized as one of the choicest fruit in the world market for its excellent flavor, attractive color and delicious taste. Different varieties of mango have different tastes and flavors and the best consumption of this fruit is in the form of fresh fruit. The rapid growth of mango production in recent years has been due to its expansion into new growing regions such as China, parts of Africa, *etc.* (Mukherjee, 1997). Bangladesh also produces a large number of superior varieties of mango such as *Khirshapat*, *Bombai*, *Langra*, *Gopalbhog*, *Fazli*, *Ashina etc*. Due to the certain variation in soil quality and climatic conditions, the mango grows better in some selective areas of Bangladesh. The leading mango growing districts are Rajshahi, Chapai Nawabganj and Dinajpur. A wide range of variations are observed in these regions. This research puts conserntration on Chapai Nawabganj district.

1.2 The Origin of Mango

The Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae. It has been cultivated for more than 4000 years as described by De Candole (1984). According to him, it originated in South Asia or Malayan Archipelago. Popnoe (1913) mentioned that it probably originated in Eastern India, Assam and Burma or further in the Malayan region. Mukherjee (1949) reported that the genus *Mangifera* originated in Burma, Siam, Indo-china and the Malayan Peninsula; but the mango itself had its origin in the Assam-Burma region which includes the area what is now Bangladesh. Vavilov (1926) had the same opinion that the mango originated in the Indo-Burma region.

The cultivated mangoes in different regions of the world belong to different species. The mango varieties of Philippines, Thailand, and Indonesia are poly-embryonic. However, the mango varieties of Bangladesh are mono-embryonic and cross pollinated in nature. In Bangladesh, only a small percentage of mango trees are graft, asexually propagated and are concentrated mostly in the North-Western region of Bangladesh. On the other hand mangoes of unknown varieties (seedlings mangoes) are grown all over Bangladesh (Bhuiyan & Guha, 1995). As mango largely propagated by seeds so there may have the potential of giving rise to innumerable varieties (Hossain, 1994).

1.3 Botany of Mango

Scientific Name: *Mangira indica* L.

Common Names: Mango, mangot, manga, mangou.

Taxonomic Position:

Kingdom	:	*Plantae*
Subkingdom	:	*Tracheobionta*
Superdivision	:	*Spermatophyta*
Division	:	*Magnoliophyta*
Class	:	*Magnoliopsida*
Subclass	:	*Rosidae*
Order	:	*Sapindales*
Family	:	*Anacardiaceae*
Genus	:	*Mangifera* L.
Species	:	*Mangifera indica* L.

(NRCS, 2009)

The mango (*Mangira indica* L.) which belongs to the family Anacardiaceae has 41 species, mentioned by Mukherjee (1949). Hooker and Jackson (1895) and Engler and Prantle (1897) reported 65 and 32 species, respectively. There are only two species found in Bangladesh. All cultivated varieties of mango of Bangladesh belong to *Mangifera indica.* The wild species *Mangifera sylvatica*, fruits of which are not edible, is found growing only in the forest of the Chittagong Hill Tracts.

Maheswari (1934), Roy (1939) and Darlington and Ammal (1945) reported different number of chromosomes in *M. indica.* However, Mukherjee (1950) reported the chromosome number to be 2n=40 in *M. indica.* The mango tree is generally large, spreading, and evergreen with umbrella shaped top which provides a majestic look (Fig. 1.1). There are a few of dwarf varieties. The tree height may range from 7.5 to 30.0 m and spread from 6.0 to 18.0 m. Each tree may have a number of primary, secondary and tertiary branches. The lower branches spread horizontally while the upper ones gradually ascending and thus giving an umbrella shape of the plant.

Leaves are pink or copper color at emergence and turn to deep or light green at maturity. Leaves are long, pointed at the end and attached to long petioles, resinous in smell when bruised. The leaves are simple, alternate and irregularly placed along the branches but invariably crowded at the terminal shoots.

The inflorescences which emerge in terminal shoots of 8-10 months have different shades of color, quite big and widely branched. These are either of spreading type or pyramidal in shape with or without bracts and pubescence. Flowers are small, monoecious and almost sessile. Male and bisexual flowers are borne on the same panicle. There are more male flowers than bisexual flowers. Each flower has 4-5 sepals, shorter than petals, having different color. Stamens 4-5, very unequal, 1-2 large and fertile and the rest are sterile. Stigma is small and simple. Disc is large and fleshy, placed above the base of the petals and 4-5 lobed. Ovary in bisexual flower is prominent while ovule is solitary and one celled. Fruits are of different shapes and sizes. Color of fruits are also different both

Fig.1.1 Mango tree of *Khirshapat* variety at Chapai Nawabganj

at green and ripe stages. Peel is thick and pulp is yellow or orange colored and juicy. Stone is solitary, woody and more or less fibrous containing one large seed having thin, papery testa.

1.4 Nutritional Value of Mango

Mango has medium calorific and high nutritional value. Carbohydrate content in ripe mango pulp is 16.9 % (Salunkhe and Desai, 1984). Among all major fruits mango is second only to Bael (wood apple) in containing niacin and has more thiamin (vitamin B-1) and riboflavin (vitamin B-2) than most other fruits (Gopalan *et. al.*, 1971; Popnoe, 1964). Ripe mango contains carotene which causes blindness and other diseases relating to eye-sight. Both ripe and unripe mangoes are a good source of vitamin C (ascorbic acid). The unripe fruits contain nearly 50 percent more vitamin C than the ripe ones (Hossain, 1989). The vitamin content of mango compared with other fruits is given in Table 1.1. Mango provides a lot of energy with as much as 74 K cal per 100 g edible portion which nearly equals the energy values of boiled rice of similar quantity by weight. In mineral content, mango holds an average position among fruits.

Table 1.1 Vitamin content of mango compared with other fruits (Per 100 gram edible portion).

Fruits	Vitamin A	Vitamin B			Vitamin C
	Carotene (microgram)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic acid (mg)
Amra (Hog plum)	270	0.02	0.02	0.3	21
Apple	3	0.03	0.05	0.2	6
Bael	55	0.13	1.19	1.1	8
Banana	78	0.05	0.08	0.5	7
Guava	0	0.03	0.03	0.4	212
Jack fruit	175	0.03	0.13	0.4	7
Lemon	0	0.02	0.01	0.1	39
Orange	1104	0.08	0.03	0.3	30
Mango	**2743**	**0.08**	**0.09**	**0.9**	**16**
Papaya (ripe)	666	0.04	0.25	0.2	57
Pineapple	18	0.20	0.12	0.1	39
Pummelo	120	0.03	0.03	0.2	20
Sapota	97	0.02	0.03	0.2	6
Tomato (ripe)	351	0.12	0.06	0.4	27

(Adapted from Gopalan *et al.*, 1971.)

1.5 Consumption of Mango

The best consumption of mango is in the form of fresh fruit. The ripe fruit is peeled out and the pulp is eaten as such, the fleshes either cut into pieces or made into small slices. Green fruits are often put into curries or '*dal'* (pulse soup) for extra taste. A considerable quantity of both ripe and green fruits is used for making other products. Some of the more important ones are jam, jelly, slice in brine, pickle (*achar*), mango bars, cereal-flakes, gelatinized pastes, custard powder and sweetened mango powder. There can be many more products using different types of mangoes at their various stages and suiting different tastes and requirements.

Mango has a large number of medicinal uses in addition to its great popularity as fresh fruit. Dried mango flowers, containing 15% tannin, serve as astringents in cases of diarrhea, chronic dysentery, catarrh of the bladder and chronic urethritis resulting from gonorrhea (Gani, 2003). The bark contains mangiferine and is astringent and employed against rheumatism and diphtheria in India. The resinous gum from the trunk is applied on cracks in the skin of the feet and on scabies and is believed helpful in cases of syphilis.

Mango kernel decoction and powder (not tannin-free) are used as vermifuges and as astringents in diarrhea, hemorrhages and bleeding hemorrhoids. The fat is administered in cases of stomatitis. Extracts of unripe fruits and of bark, stems and leaves have shown antibiotic activity. In some of the islands of the Caribbean, the leaf decoction is taken as a remedy for diarrhea, fever, chest complaints, diabetes, hypertension and other ills. A combined decoction of mango and other leaves is taken after childbirth.

The timber of mango tree is considered valuable as fuel-wood, being light in weight and burns easily. The timber of the old trees is useful in making packing boxes, cheap doors and windows and in the making of plywood.

1.6 Phenotypic Variants and Varieties in India and Bangladesh

Wide variation exists not only the species level, there are many 'varieties of mango', for example about one thousand varieties belonging to *Mangifera indica* reported in India (Mukherjee 1949). Of the two distinct types- polyembryonic and monoembryonic; about twenty polyembryonic types are reported in India (Yadav and Rajan 1993) and the rest are known to be monoembryonic, for which there are three main centers of development of mango varieties– (1) Lucknow, Saharanpur belt of Uttar Pradesh (2) Murshidabad area of West Bengal and (3) Hyderabad area of Andhra Pradesh (Yadav and Rajan 1993). The varieties and types are described in this study mainly belong to the Murshidabad Center.

Considering characters like color of emerging leaves and panicle axis and laterals, size of flowers, intensity of pubescence of panicle and branches; 72 varieties from West Bengal were classified by Mukherjee (1948). Naik and Gangolly (1950) also described 135 South Indian varieties, taking fruit character as the main basis. Singh and Singh (1956) described 156 varieties of Uttar Pradesh (India) based on different characters. Several workers described likewise the varieties collected as the germplasm in various centers (Yadav and Rajan 1993, Yadav I. S. 1997).

The North Indian varieties are generally alternate bearers and the South Indian varieties are regular bearers. However, there are some varieties which flower twice or thrice in a year or may continuously flower throughout the year, *viz.*, *Amino-Do-Phasla*, *Teenphasla*, *Baramasi* types, *Chiratpudi Goa* (Royal Special). In Kanyakumari also continuous flowering variety has been noticed (Chacko and Randhawa, 1971).

Table 1.2 Popular varieties of mango in different regions of India

Region	Varieties
Eastern	*Himsagar, Fazli, Langra, Bombay*
Western	*Alphonso, Pairi, Rajapuri, Kesar.*
Northern	*Dashehari, Langra, Bombay Green, Chausa.*
Southern	*Neelum, Banganapalli, Totapuri, Mulgoa, Raspuri, Swarnarekha, Rumani, Badami.*

[Yadav,1993: Germplasm conservation and utilization in breeding of mango]

Although morphological and growth characters in mango are genetically controlled. The genetic-environmental interaction results different taste, quality and growth pattern under different agro-climatic conditions. Commercial varieties of different regions behave differently when grown in other agro-climatic zones. For example, the variety *Amrapali* which remains dwarf under North Indian condition does not remain so under the South Indian condition. *Dashehari*, *Langra* and *Chausa* rarely flower under South Indian conditions. Yadav and Singh (1985) opined that the North and South Indian varieties belong to two different groups representing two different ecotypes of *M. indica,* based on physiology of flowering.

Mango grows better in some selective areas of Bangladesh. About one fourth of all mangoes of the country that are marketed, are produced in the greater Rajshahi area. The bulk of this is composed of *Fazli* variety, with others being *Langra, Gopalbhog, Ashina* and *Khirshapat*. A large portion is also constituted by 'Gutee' (seed propagated) mangoes which are of seedling origin and are of many kinds.

In Chapai Nawabganj district, the approximate production of mangoes is about *Fazli*-30%, *Langra*-15%, *Gopalbhog* and *Khirshapat* combined-15%, *Ashina*-10%, 'Gutee' or unnamed seedling mangoes-20% and all others-10% (Amzad, 1994). Other prominent mango producing areas are Dinajpur, Jessore and Kustia have a good part of their production in elite varieties. The eastern part of the Jamuna River, however, raises mangoes borne by seedling trees, whose fruits are not systematically marketed than those in the western Bangladesh.

1.7 Mango Cultivars- Nomenclature and Registration

The lack of systematic approach in naming of mango cultivars in the past has resulted in a great confusion in their nomenclature due to many synonyms and duplication of names in the absence of any rules governing nomenclature. The originator or finder of a mango cultivar was free to allot any name at his will. Mango (*Mangifera indica* L.) has a great variation resulting into more than one thousand cultivars (Pandey, 1985). The International Plant Genetic Resources Institute (IPGRI), formerly known as the International Board for Plant Genetic Resources (IBPGR), commissioned an eco-geographical study of known *Mangifera* genetic resources (Mukherjee, 1985). Based upon that documentation, a joint IBPGR-International Union for the Conservation of Nature (IUCN)- World Wildlife Fund (WWF) project was initiated to collect wild mangoes on the island of Borneo and in the Malay Peninsula (Bompard, 1989), the regions that held the highest concentrations of *Mangifera* species. Kostermans and Bompard (1993), in the latest revision of the taxonomy of *Mangifera*, recognized 69 species, many of which were collected during the course of that project. A partial list of the principal mango cultivars has been provided in Table 1.3 (Litz, 1997) which includes many cultivars that were identified in a survey of world mango production compiled by Watson and Winston (1984).

In mango orchards, multiple cultivars are often grown together to improve cross-pollination. This practice also promotes origin of new types by genetic mixing when seed propagation is used. Realizing the situation, the International Society for Horticultural Science has recognized the Division of Fruit and Horticultural Technology of the Indian Agricultural Research Institute, New Delhi (India) as the International Registration Authority for Mango Cultivars. This Authority (IRA- Mango) follows the rules of the International Code of Nomenclature of Cultivated Plants for the nomenclature of a new cultivar. It makes specific consideration that every cultivar worthy recognition should have a name and the same name should not be given to any other cultivar. IRA-Mango has prepared an international directory of mango cultivars entitled “International Check List of Mango Cultivars” (Pandey, 1984) comprising chief characteristics of 793 cultivars from different countries of the world which also includes the synonyms.

Table 1.3 Most important mango cultivars in major producing countries

Continent	Country	Cultivars
Africa	Cote d'Ivoire	'Amelie', 'Kent'
	Egypt	'Alphanso', 'Bullock's Heart', 'Hindi be Sennara, 'Langra', 'Mabrouka', 'Pairie', 'Taimour', 'Zebda'
	Kenya	'Boubo', 'Ngowe', 'Batawi'
	Mali	'Amelie', 'Kent'
	South Africa	'Fascell', 'Haden', 'Keitt', 'Kent', 'Sensation', 'Tommy Atkins', 'Zill'
Asia	Bangladesh	'Aswina', 'Fazli', 'Gopal Bhog', 'Himsagar', 'Khirshapati', 'Langra'
	China	'Gui Fei', 'Tainong No.1', 'Keitt', 'Sensation', 'Zill', 'Zihua', 'Jin Huang'
	India	'Alphanso', 'Banganapalli', 'Bombay', 'Bombay Green', 'Chausa', 'Dashehari', 'Fazli', 'Fernandian', 'Himsagar', 'Kesar', 'Kishen Bhog', 'Langra', 'Mallika', 'Mankurad', 'Mulgoa', 'Neelum', 'Pairi', 'Samar Behisht', 'Suvarnarekha', 'Totapuri', 'Vanraj', 'Zardalu'
	Indonesia	'Arumanis', 'Dodol', 'Gedong', 'Golek', 'Madu', 'Manalagi'
	Israel	'Haden', 'Tommy Atkins', 'Keitt', 'Maya', 'Nimrod', 'Kent', 'Palmer'
	Malaysia	'Apple Rumani', 'Arumanis', 'Golek', 'Kuala Selangor 2', 'Malgoa'
	Myanmar	'Aug Din', 'Ma Chit Su', 'Sein Ta Lone', 'Shwe Hin Tha'
	Pakistan	'Anwar Ratol', 'Began Pali', 'Chausa', 'Dashehari', 'Gulab Khas', 'Langra', 'Siroli', 'Sindhri', 'Suvarnarekha', 'Zafran'
	The Philippines	'Carabao', 'Manila Super', 'Pico'
	Taiwan	'Irwin','Jin-hwung','Keitt','Tommy Atkins','Tainong No.1','Tsar-swain'
	Thailand	'Nam Doc Mai','Ngar Charn','Ok Rong','Keow Savoey','Pimsen Mum'
Australia		'Calypso', 'Kensington Pride'
North and Central America	Costa Rica	'Haden', 'Irwin', 'Keitt', 'Mora', 'Tommy Atkins'
	Dominican Republic	'Haden', 'Keitt', 'Kent', 'Tommy Atkins'
	Guatemala	'Haden', 'Keitt', 'Kent', 'Tommy Atkins'
	Haiti	'Francine', ' Madame Francis'
	Mexico	'Ataulfo', 'Haden', 'Keitt', 'Kent', 'Manila', 'Palmer', 'Sensation', 'Tommy Atkins', 'Van Dyke'
	USA	'Keitt', 'Kent', 'Tommy Atkins'
South America	Brazil	'Bourbon', 'Coite', Coquinho', 'Coracao', 'Espada', 'Haden', 'Itamaraca', 'Keitt','Mamao','Palmer', 'Rosa', 'Tommy Atkins', 'Uba', 'Van Dyke'
	Colombia	'Vallenato'
	Ecuador	'Haden', 'Keitt', 'Kent', 'Tommy Atkins'
	Peru	'Haden', 'Keitt', 'Kent', 'Tommy Atkins'
	Venezuela	Haden', 'Keitt', 'Kent', 'Tommy Atkins'

[Adopted from The Mango: Botany, Production and Uses by Litz, R. E. (ed.), 1997]

Breeders, nurserymen, growers and organizations engaged in the evolution of mango cultivars should check up with IRA (mango) whether the proposed name is available for use or not. Registration of newly evolved cultivars at the international level will go a long way in removing further confusion in the names of mango cultivars and enabling growers for getting true to the type planting material. Any person or organization can register names of cultivars with IRA-Mango. IRA-Mango issues a certificate to the originator of that mango cultivar (Brickell *et. al.,* 2009). The cultivars offered for registration must be described by the originator in a form to be supplied by this authority free upon request.

1.8 International Association for Cultivated Plant Taxonomy

Plants have been cultivated for millennia for agricultural, forestry and horticultural purposes, yet it is becoming increasingly difficult to maintain clarity and understanding in the science of naming of cultivated plants. The value of knowing plant's precise name and understanding its origin, development, description, classification and performance potential is steadily increasing; though it is often underestimated. Stability and harmonization in cultivated plant names can be achieved only with clear and widely accessible information. This will facilitate communication about the plants and improve their introduction, breeding, production and conservation; which are all crucial to human well being. To provide leadership in this area, a new organization, the *International Association for Cultivated Plant Taxonomy (IACPT)*, has been launched in Wageningen, The Netherlands on 18 October 2007 during the 5th International Symposium on the Taxonomy of Cultivated Plants (IACPT, 2009). This association seeks to promote the field of taxonomy and nomenclature of cultivated plants and to encourage international relations among individuals and institutions interested in this field and related disciplines. Its members will include taxonomists who work on cultivated plants, international cultivar registration authorities, representatives of plant breeder's rights authorities, plant breeders, crop scientists, agriculturists, foresters and horticulturists, plant physiologists and others. To achieve its goals, the *IACPT* is expected to sponsor symposia, publish a journal dedicated to cultivated plant taxonomy, develop databases and on-line resources for improving stability in the nomenclature of cultivated plants and to be a vehicle for discussion of the *International Code of Nomenclature for Cultivated Plants (ICNCP*) and provide advice to queries on its implementation (Brickell *et. al.*, 2009).

An *International Cultivation Registration Authority* (ICRA) is an organization responsible for ensuring that each plant cultivar receives a unique, authoritative botanical name (ICRAs, 2009). The ICRA system was established more 50 years ago, and operates under the *International Code of Nomenclature for Cultivated Plants* (ICNCP). Its main aim is to prevent duplicated uses of cultivar and Group epithets within a defined denomination class (usually a genus), and to ensure that name is in accord with the latest edition of the ICNCP. Each name designation must be formally established by being published in hard copy, with a description in a dated publication. The *International Society for Horticultural Science* appoints and monitors all ICRAs. At present it recognizes over 70 ICRAs, ranging from societies focused on a specific genus (such as *clivia, oak*, or *saxifrage)*, through organizations with broader sets of interests (including the Singapore Botanic Gardens and the United States National Arboretum).

A cultivar is a group of individual plants which collectively is distinct from any other, uniform in its overall appearance and which remains stable in its attributes. A single plant is not a cultivar. There are different sorts of cultivars ranging from clones, which should be genetically identical to tightly controlled seed raised cultivars such as F_1 hybrids. Article-II of ICNCP describes some of the different kinds of cultivar. The only way to check a cultivar as new or distinct is by comparing with its existing cultivars. A cultivar name is made up of a botanical name in Latin (or its common name equivalent) for a genus or species followed by a cultivar epithet which is the last part of the entire name and which renders the name unique. Cultivar epithets are always written within single quotation marks (never double quotation marks) so that they stand out from the rest of the name and so that their status is obvious.

Coining new and original cultivar name is not easy, especially in groups which historically have had hundreds or even thousands of cultivars. Luckily many of these groups have *International Cultivar Registration Authority* (ICRAs) who publish Checklists and registers of names which are in use or which have been used in the past. One can search in the alphabetic list of genera in these pages to see if the genus of that cultivar is covered by an ICRA and then consult the ICRA's Publication or contact the particular ICRA Registrar directly. Registrars will advice about the proposed name. There have been many other lists of cultivar epithets produced in the past and a fairly comprehensive list of those is given in Appendix XI of the 1995 edition of the code. This list of Checklists is kept up to date at Delaware State University (USA). Good horticultural and botanical libraries are likely to have copies of many Checklists, registers and other publications through which one can check a proposed name before publishing (Brickell *et. al*, 2009).

1.9 The Mango Cultivars in Bangladesh

As mentioned earlier, the mango is commonly propagated by seeds and thus gives rise to innumerable varieties. The numbers of quality mango varieties cultivated in Bangladesh are not many and many of them are maintained at household level. The vegetative and reproductive characters of all these cultivated varieties have not been recorded systematically so far except that fruit characters of some of the varieties have been described sporadically here and there (Hossain and Ahmed, 1994). Scientific approach for the collection of mango germplasm was made after the establishment of Mango Research Station at Chapai Nawabganj in 1985 and considerable variability was conserved in field gene bank. Subsequently another project entitled “Mango Improvement and Development” funded by FAO/UNDP came into being with its head quarter at Chapai Nawabganj and with three sub-stations in different region of the country for attainment of self-sufficiency in mango production. In 1994 “A Monograph on Mango Varieties of Bangladesh” was published by the Horticulture Research Institute, Joydebpur, Gazipur. In that monograph 72 cultivated varieties have been described (Hossain and Ahmed, 1994). The keys for description were taken from both ‘The Mango’ by Gangolly *et al.* (1957) and ‘Descriptors for Mango’ published by IBPGR in 1989. The name of the varieties published and described in that monograph are as follows: *Agmamashu, Agni, Amrita bhog, Anaras, Aswina, Baishaki, Batasa, Bhabani, Bhuto bombai, Bira, Bodruddoza, Bombai, Bombai gopalbhog, Bombai ketulla, Chandan khos, Chakchakia, Chinipata, Darbhanga, Daud Bhog, Dilsad, Fazli, Fonia, Golap bash, Golla, Gopalbhog, Gourjit, Himsagar, Hoskos, Ilsapeti, Jalibum, Jamrut, Kala pahar, Kali bhog, Kalomegha, Kancha mitha, Kanchan khosal, Khejur kant, Khirshapat, Khir* *bombai, Khudi khirshapat, Kishanbhog, Kohitur, Krishnachura, Kuapahari, Ladua, Lakhan bhog, Langra, Lata Bombai, Love-e-moshgul, Malda, Mirza pasand, Misri bhog, Misrikanta, Mohan bhog, Motichur, Mulgova, Narkel faki, Panja, Piar phuli, Rajbhog, Ranipasand, Rasun taki, Romali, Satiarkara, Shah pasand, Shyam lata, Surjapuri, Tikka farash, Trifala, Viswanath and Zarda.*

Fifty five mango germplasm were selected from the field gene bank of Mango Research Station at Chapai Nawabganj and had been characterized as per IPGRI Descriptor utilizing 56 characters. In 2003 this piece of work was published by Horticulture Research Centre of the Bangladesh Agriculture Research Institute, Gazipur as a catalogue named "Catalogue on Mango Germplasm" (Bhuyan *et. al.,* 2003). The names of the mango varieties described in that catalogue are as follows: *Alfaz Bombai, Amina, Ashwina, Badshah, Badshabhog, Baishakhi, BARI Mango-1, BARI Mango-2, BARI Mango-4, Baromashi, Baunilata, Bharoti, Bilu pasand, Bogla, Bombai, Borobabu, Boubhulani, Chandankhos, Chhatapara, Choucha, Dadbhog, Deobhog, Dillir Larua, Dilsad, Fazli, Golap bash, Golapkhas, Golla, Goote Maldah, Gopalbhog, Gourjit, Himsagar, Kalia, Kalibhog, Karalla, Kazi Pasand, Khirshapat, Kohitoor, Kuapahari, Langra, Lata Bombai, Mishridagi, Mishrikanta, Modhumoni, Monohora, Nabi Bombai, Pathuria, Pukurpar, Rajbhog, Rani Pasand, Shayam lata, Surjapuri, Tiakathi, Zalibum and Zitubhog.*

These two publications act as a catalyst to increase the level of scientific research on mango as well as became useful to the scientists who are involved and interested in the improvement and development of mango industry in the country.

1.10 Production and Plant Genetic Resources of Mango

The production of mango per unit land in Bangladesh is very low compared to other mango growing countries of the world namely India, Pakistan, Philippines, Indonesia, Mexico and China. Bangladesh has 51000 hectares of mango in 2005 (FAO, 2006), total of 1,72,000 metric tons of mango was produced on 22,500 hectares of land in Chapainawabganj district in 2010 [http:// bangladesheconomy.wordpress.com/2011/02/21/ bumper-mango-production-likely-in-cnawabganj/]. During 1970's there was a general decline in mango production for various reasons like the shoot gall disease. Soon after independence of Bangladesh in 1971, there was a heavy demand of timber which was met by felling mature, fruit bearing mango trees. According to Banglapedia (2006), "Bangladesh produced about 1,86,760 m tons of mango during 1997-98 from an area of about 1,24,520 acres. The annual production, however, fluctuates, depending upon various factors. The present production is not very high compared to that of other mango growing countries. According to FAO, mango production in this country amounted to, on average, about 4,24,000 m tons during 1969-71. This indicates that the production has declined considerably during the last three decades. The factors that are considered responsible for the decline of production include: (i) old trees which are no longer productive; (ii) a general lack of interest and attention amongst owners; (iii) lack of management and care of trees; (iv) absence of plant protection measures against insect pests and diseases; (v) growing trees from seedlings; (vi) apathy towards use of improved techniques of production and (vii) indiscriminate felling of productive trees for fuel wood, road construction, house-building." [http://www.banglapedia.org/httpdocs/HT/M_0126.HTM].

However, it is much to the credit of the FAO Mango Improvement and Development Program that decline in mango production has been reversed. The momentum created by this program through its country-wide training, demonstration, mass propaganda, advisory services, distribution of printed materials, field days and mango exhibitions should be continued in the interest of mango industry of the country (FAO, 2011)

Plant genetic resources are the raw materials which the farmers and plant breeders use to improve the quality and productivity of the crops. The future of agriculture depends on conservation, sustainable use and the open exchange of crops, trees and their genes that are present in the farmer's fields and lands. There is a world wide concern over the ever increasing loss of the diversity of the plant genetic resources as it plays a critical role on global agriculture and environment. The sustainable use of this resource and its conservation is very necessary for attaining food security sustainable development.

Mango trees grow widely throughout Bangladesh and are raised mostly as homestead plantations. Although there are a number of varieties of mango available in Bangladesh and numerous orchards scattered all over the greater Rajshahi and Dinajpur districts and other areas of the country; most of these are not documented and classified. This research argues that whether there exists any diversity among the mango cultivars in the study area or not. If diversity exists to what extent it remains.

A high intra-specific diversity of mango and detailed knowledge about the characteristics of each of the existing trees/varieties are essential to ensure stable and high production. For this, the documentation and conservation of this resource is necessary and characterization is an important aspect for documentation of the performance of the studied cultivars, which subsequently will help to induce, select and improve the existing mango varieties. The study aims at providing the information on the varietal characteristics. So, it might be useful for the growers also in determining the cultivars to be grown. Moreover, it needs to identify and locate the areas of rich genetic diversity and homes of natural populations of mango in the agro-climatic condition of Chapai Nawabganj, the north-western part of Bangladesh, has been emphasized in the present study.

1.11 Purpose of the Present Study

The numbers of quality mango varieties cultivated in Bangladesh have not yet estimated systematically. But there is a little information about the varietal characters of these which have not been recorded systematically in many cases. Moreover, there are many cultivated 'types' which are maintained at household level and in personal orchards remaining undocumented.

Ahmed (1966) and Uddin *et. al.* (1997) described the fruit characteristics of a few commercial varieties in their book. As mentioned earlier "A Monograph on Mango Varieties of Bangladesh" (Hossain and Ahmed 1994) and "Catalogue on Mango Germplasm" (Bhuyan *et. al.*, 2003) these two publications have great importance to the scientist engaged in mango research in Bangladesh. However, the scientific information regarding the morphological and physio-chemical characteristics of mango varieties growing under different regions of Bangladesh is still scanty. Only a few characters of a limited number of cultivars have been studied (Mollah and Siddique, 1973; Hossain and Talukdar 1974; Hossain & Uddin, 1995; Samad and Faruque, 1976; Bhuyan and Islam, 1989; Sardar *et al*., 1998; Uddin *et. al.*, 1995). It is well known that, variations in the characters of the same variety may occur because of differences in environmental condition; or because of root stock used in mango cultivation. Hence, a description of any variety may not be exactly applicable to the same variety when grows at different environment.

Therefore, the present study was undertaken in the six villages of Chapai Nawabganj district to collect data on mango germplasm from the fields, orchards, homesteads to examine and document mango diversity and variations.

The main objectives of this research are:

i. To document and describe the existing (a) vegetatively propagated and (b) sexually propagated mango germplasms systematically.
ii. To examine the present state of mango diversity.
iii. To develop of a suitable key for varietal identification or classification and characterization of the available types, varieties, strains and sexually propagated individuals using taxonomic characters.
iv. To point out the need of conservation for mango germplasm management on a sustainable basis.

Considering the above mentioned objectives, the study was carried out in the aforesaid places of Chapai Nawabganj district.

CHAPTER – II

2. MATERIALS AND METHODS

The present study was carried out in the six villages of Chapai Nawabganj district. The villages were selected randomly and their names were- Bohalabari village of Sattajitpur union under Shibganj upozilla, Komolakantapur of Sattajitpur union under Shibganj upozilla, Mirer Chora village of Sundorpur union under Chapai Nawabganj sadar upozilla, Chondipur village of Noya Lavanga union under Shibganj upozilla, Shaheb gram of Choudala union under Gomostapur upozilla and Noya Lavanga of Noya lavanga union under Shibganj upozilla (Fig. 2.1).

2.1 Materials

A large number of mango varieties of varying age and quality were being included in the study. The plants from commercial varieties, local cultivars and 'gutee' trees (seed propagated) had been investigated. The names of most common commercial varieties which had been observed for this study were *Fazli, Ashina, Langra, Gopal bhog, Khirshapat, Boglaguti, Bombai, Lakhxan bhog, Kohinoor, Himsagar and Gourjeet*. The name of the local cultivars are *Narkelphaki, Khudi khirsha, Kali bhog, Mohon Bhog, Alamshahi, Poichchha, Dilshad, Kancha Mitha, Shantu, Chock Choke, Batasha, Kalimeghi, Dad bhog, Chosha, Champa, Bira, Larua, Boishakhi, Pherdous pasand, Nazim pasand, Sipia, Lamba guti, Mirabhog, Golapbas, Lugnee, Shathiarer kera, Chal guti, Kalua, Kumapahari. Jhurki, Khejura, Hayati, RI, Totapuri, Dofola* and *Danadar*. Plants originated from seeds ('gutee') also had been included in the study. The names of the 'gutee' were *Khatash*, *Nokkani* and many trees without any name. The 'gutee' trees were mostly seed propagated and there were not enough information yet about these cultivars.

2.1.1 Survey on Mango

The information on mango had been collected from the inhabitants of the villages of Chapai Nawabgang district. At first, observations were made and the interviews were taken to collect knowledge and perceptions of the local people. The villagers were asked about the plantation and history of the individual mango tree, about the plants of their homestead, neighborhood and the orchards. People were also asked about the age and characteristics of the tree, fruit size, quality, taste, *etc*. A number of visits were made for this study to assess the distribution and availability of different types and varieties of mango trees. As the Chapai Nawabganj district is the home district of the author; it proved convenient to survey and to assess the distribution and availability of different types and variants of mango.

2.1.2 Sampling of Materials

In the selected areas, villagers were asked about the mango varieties, their age, type and quality. After the intensive observation of twelve hundred and fifty six trees; three hundred fifty seven trees were selected for the systematic study of both qualitative and quantitative characters. The mango trees were grouped into three categories (commercial varieties, cultivated varieties or local cultivars and 'gutee') according to Subedi *et. al.*, 2005.

The selected mango trees and plant parts were observed and measured. For statistical analysis, different plant parts were collected. During the field work it was perceived, that a number of mango germplasm had been cultivating at a large scale since long time for commercial issues and the local people were giving emphasis on those varieties for economic benefit. During the survey a number of locally cultivated variety or cultivars were found which were not well known to all but some collectors are conserving those to keep wider variations of their collection and those cultivars have a little selection pressure but there are a number of 'gutee' trees which developed naturally and have not get commercial importance. Most of the graft propagated trees were commercial varieties whereas the 'gutee' trees were mainly seed propagated. The trees were collected from different places including mango orchards, homesteads, crop fields, fallow lands and road sides from the study area.

2.1.3 Characters Measured

Both qualitative and quantitative characters were measured. IBPGR Descriptor 1989 and IPGRI Descriptor 2006 were followed to select the characters. The qualitative characters including tree and different plant parts were grouped into different classes following the 'Descriptors'. The quantitative characters like Panicle length, Panicle breadth, fruit weight, fruit length and fruit width were measured. For qualitative characters, observations were made and questions were asked but for the quantitative characters measurement scales were used for data collection as discussed in the section 2.2.

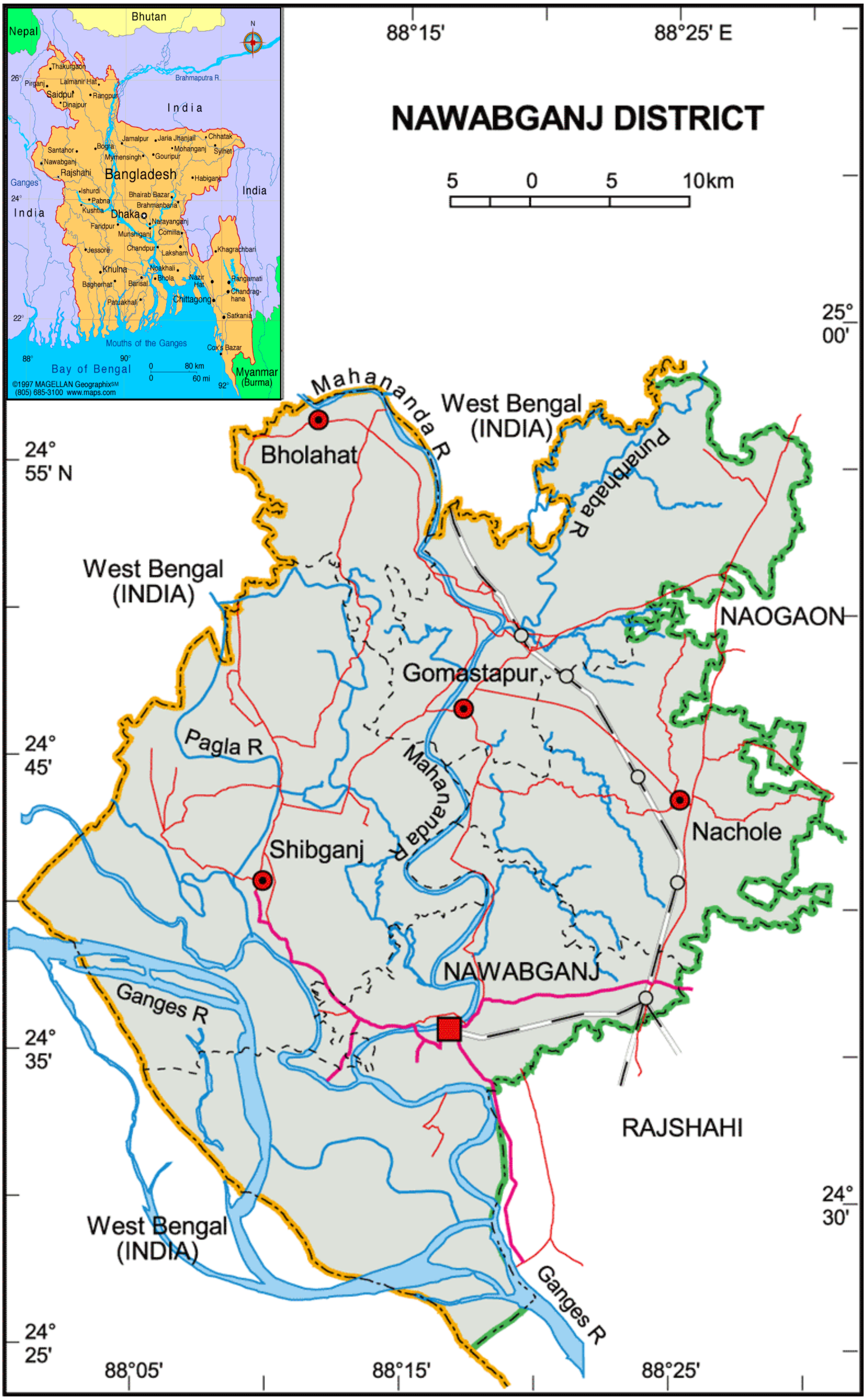


Fig. 2.1 Map of Chapai Nawabganj district showing upozillas

2.2 Methods

The methods which have been followed to conduct the experiment are described below.

2.2.1 Methods for Survey on Mango

Villagers both male and female were selected randomly during the field visits and had been asked several questions. The visits and surveys were made from February to the end of July from 2006 to 20012. The villagers were consulted regarding their knowledge and experiences about the plantation and the age of the mango trees, their productivity, morphological characters and this information had been recorded for further analysis. Especially, the villagers were asked about the source of origin of the mango trees to determine the pressure of human selection. The information was collected by using formal and informal interviews and field observations. Some information was also gathered by group discussion with the farmers.

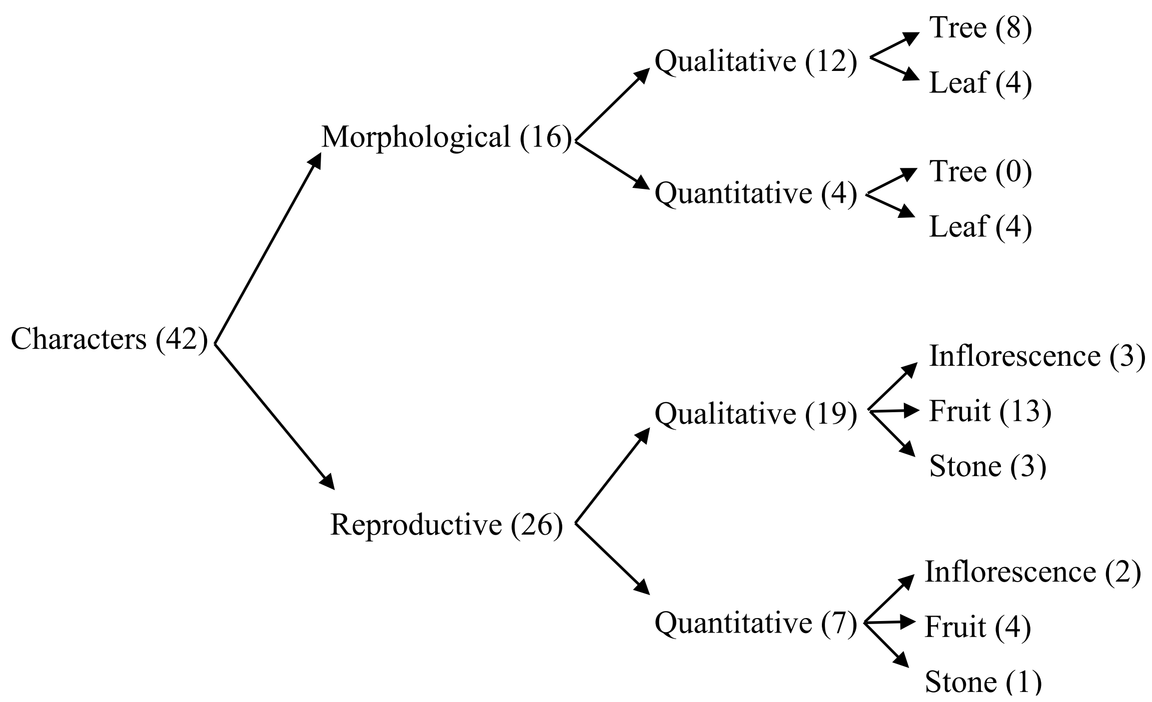
2.2.2 Methods of Sampling

Different sites of the villages had been selected. This is because it was not possible for one person to document all germplasms of Chapai Nawabganj district. The other important factor was the permission of the orchard owners to collect plant parts from their orchards had been taken into consideration. The mango trees had been observed identified and data had been recorded for further study.

2.2.3 Methods of Measurement

The different characters of mango tree, leaf, inflorescence, fruit and stone had been selected, measurement had been made and all data were recorded for analysis afterward. For standard description the help of IBPGR descriptor book 1989 and IPGRI descriptor book 2006 were followed (IBPGR 1989 & IPGRI 2006).

The aim of the study was to determine the range of diversity of mango, to document the mango varieties, to find out the causes of erosion of mango germplasm if any and so as to put emphasis on their conservation. As the morphological characters are very important for taxonomic studies of any plant, the qualitative and quantitative characters of different plant parts of mango were observed, measured and recorded for statistical analysis. The following characters of different plant parts of mango were selected from IBPGR Descriptor book 1989, IPGRI Descriptor book 2006 and from observations of preliminary survey and were used into different parts of the research as required.



2.2.3.1 Characters selected for tree

The following qualitative characters of tree had been selected for the present study:

i) Age of tree

ii) Tree shape

iii) Branching type

iv) Canopy structure

v) Timber of the main trunk

vi) Productivity

vii) Time of fruit maturity

viii) Fruit bearing habit

(i) Age of trees was measured in years following the four point scale from observation and with the help of the knowledge of local inhabitants according to IBPGR descriptor 1989 and IPGRI descriptor 2006.

Age of tree				
Age (years)	10^+	20^+	30^+	40^+
Name	Young	Medium	Old	Mature

(ii) Tree shape was noted following the five point scale from observation and IBPGR descriptor 1989 and IPGRI descriptor 2006 (Fig. 2.2).

Tree shape				
Symmetrical	Round	Irregular	Very irregular	Tall

(iii) Branching type was recorded by visual examination; the scale followed is given below (Fig. 2.3).

Serial no.	**Branching Type**
1	Main trunk slender, few branches at top.
2	Main trunk medium, several branches at top.
3	Main trunk short, branches from the base.

(iv) Canopy structure was recorded following the five point scale from observation and with the help of local people as given below (Fig. 2.4).

Serial no.	**Canopy structure**
1	Conical.
2	Globose
3	Spreading
4	Tall slender
5	Irregular

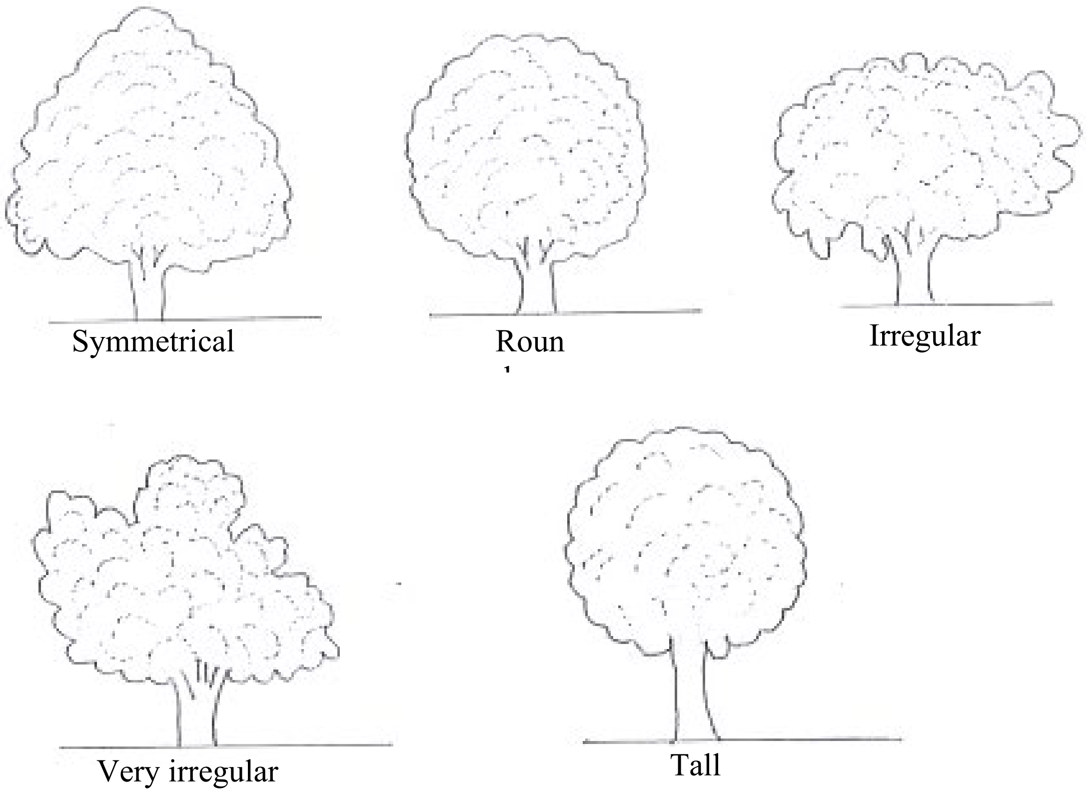


Fig. 2.2 Different tree shapes of mango

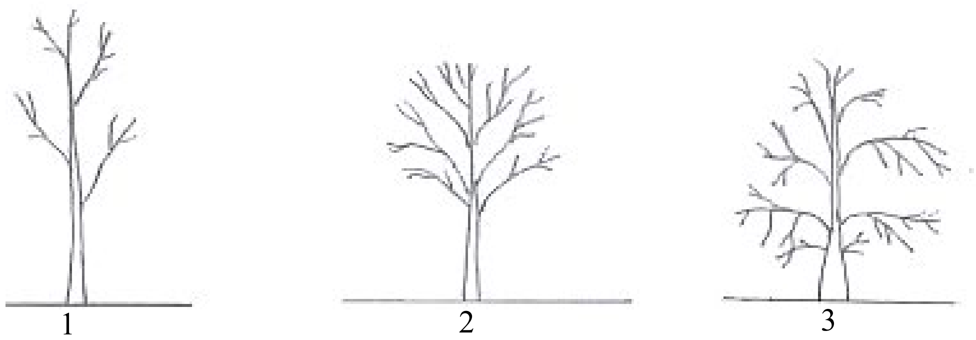


Fig. 2.3 Branching types of mango trees

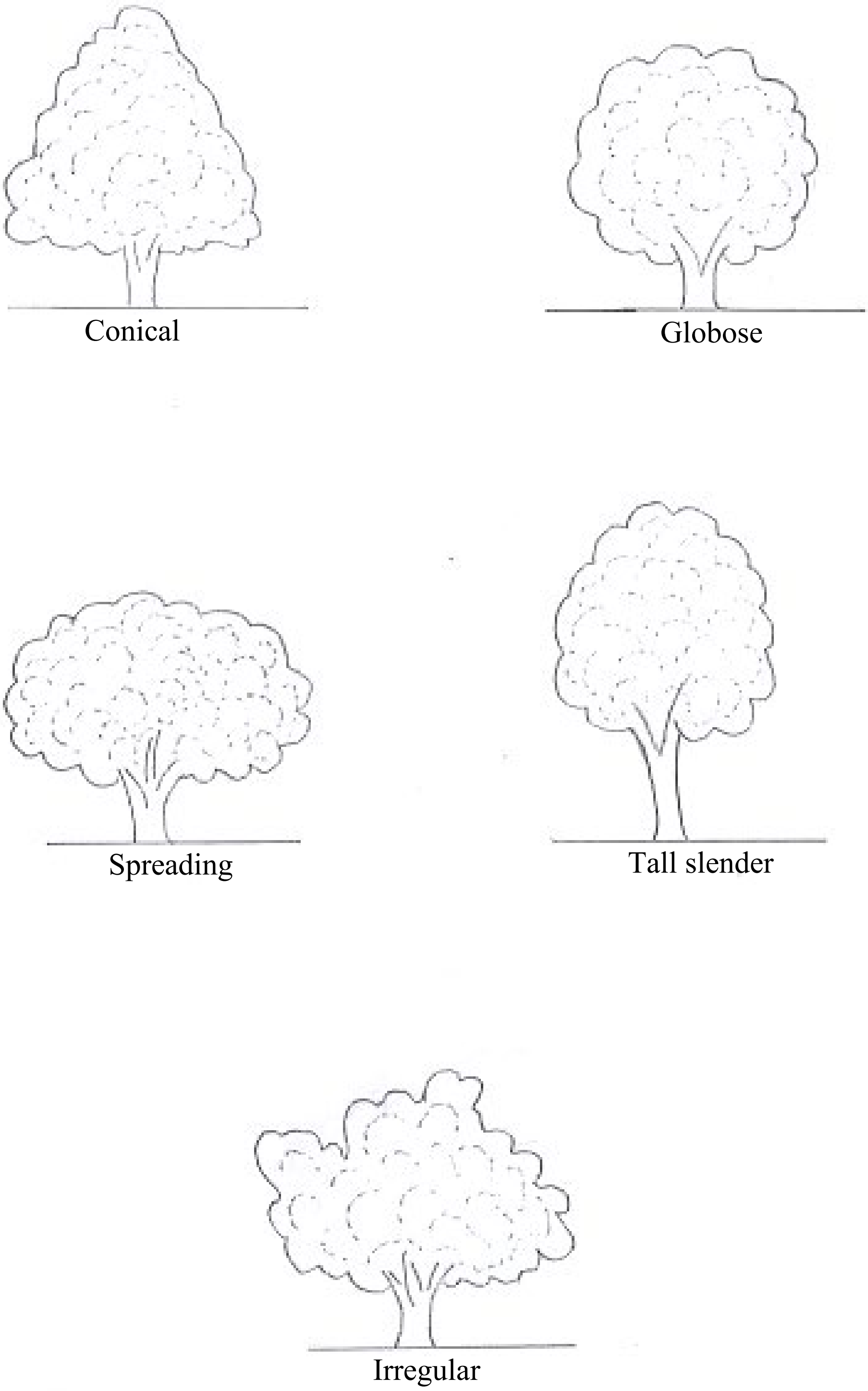


Fig. 2.4 Different types of canopy structure of mango trees

(v) The quantity of timber of the main trunk was recorded by visual examination; the scale which was followed is given below.

Timber of the main trunk				
Very poor	Poor	Medium	Good	Very good

(vi) Fruit production of tree was recorded following the three point scale from observation of the local people in accordance with IBPGR descriptor 1989 and IPGRI descriptor 2006.

Productivity		
Low	Intermediate	High

(vii) Time of fruit maturity was divided into three time scale on the basis of harvesting time of mature fruits.

Time of fruit maturity		
Early season	Mid season	Late season
Harvest time of fruit is from late May to early June.	Harvest time of fruit is from mid June to late June.	Harvest time of fruit is from early July to late July.

(vii) The fruit bearing habit was recorded by visual examination following the two point scale.

Fruit bearing habit	
Regular	Alternative

2.2.3.2 Characters selected for leaf

Both qualitative and quantitative characters had been selected for the leaf. Leaves were collected from each village. Total three thousand five hundred seventy leaves, ten mature leaves from each tree were randomly selected.

A. Qualitative characters

i) Leaf orientation

ii) Leaf shape

iii) Shape of leaf tip

iv) Leaf margin

B. Quantitative characters

i) Petiole length

ii) Lamina length

iii) Lamina width

iv) Width of half leaf

A. Qualitative characters

i) The angle of leaf with the main axis was divided into two point of scale as follows (Fig. 2.5).

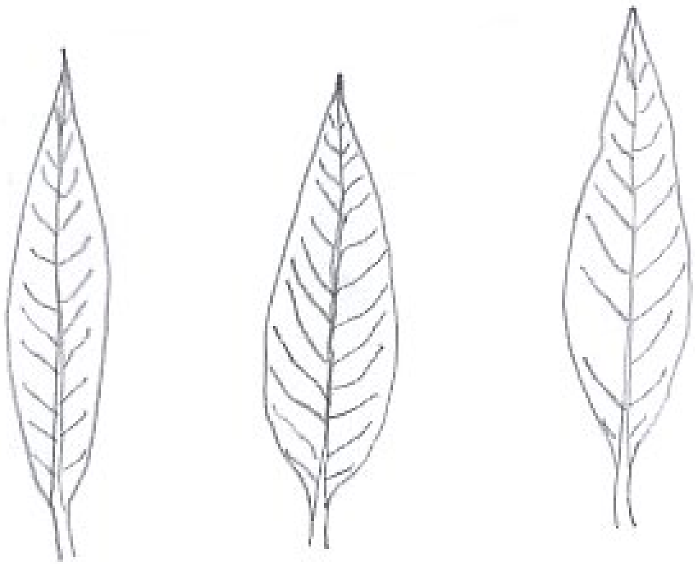
Leaf orientation	
Erect	**Spreading**
Angle of lamina with main axis is (0-45)°	Angle of lamina with main axis is (50-90)°

(ii) Leaf shape was recorded according three point of scale of IBPGR Descriptor 1989 and IPGRI Descriptor 2006 (Fig. 2.6).

Leaf shape		
Elliptic lanceolate	Ovate lanceolate	Oval lanceolate

Erect Spreading

Fig. 2.5 Different types of leaf orientation of mango



Elliptic lnceolate Ovate lanceolate Oval lanceolate

Fig. 2.6 Different types of leaf shapes of mango

(iii) Shape of leaf tip was recorded following the three point scale from observation and with the help of local people in accordance with IBPGR descriptor 1989 and IPGRI descriptor 2006 (Fig. 2.7).

Shape of leaf tip		
Acute	Sub- acuminate	Acuminate

(iv) Leaf margin was recorded following the three point scale according to IBPGR Descriptor 1989 and IPGRI Descriptor 2006 (Fig. 2.8).

Leaf margin		
Wavy	Flat	Crinkled

B. Quantitative characters

i) The petiole length of leaves was measured with the help of meter scale and the data were recorded in cm. The petiole length of three thousand five hundred seventy mature leaves (ten from each mango tree) was measured from the stem to the base of leaf blade. The average petiole length of ten leaves was considered as the petiole length for a tree.

ii) The lamina length of three thousand five hundred seventy mature leaves (ten from each mango tree) was measured from the base to the tip of leaf blade with the help of a meter scale and recorded in cm. The average lamina length of ten leaves was considered as the lamina length for a tree.

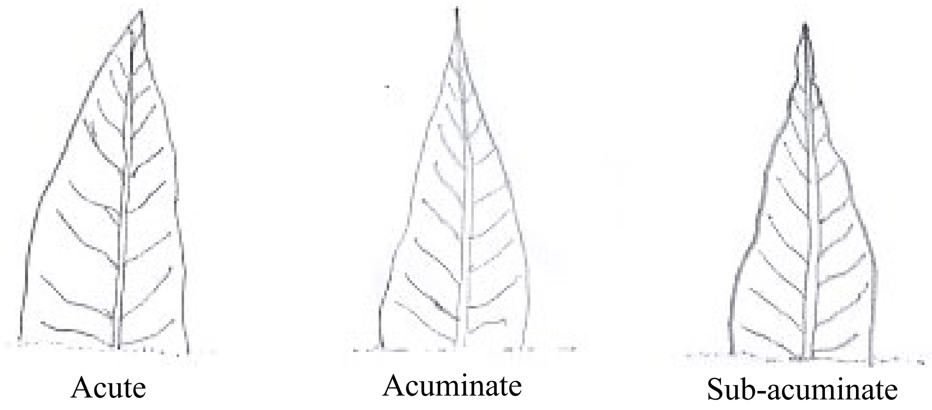


Fig. 2.7 Different types of leaf tips of mango

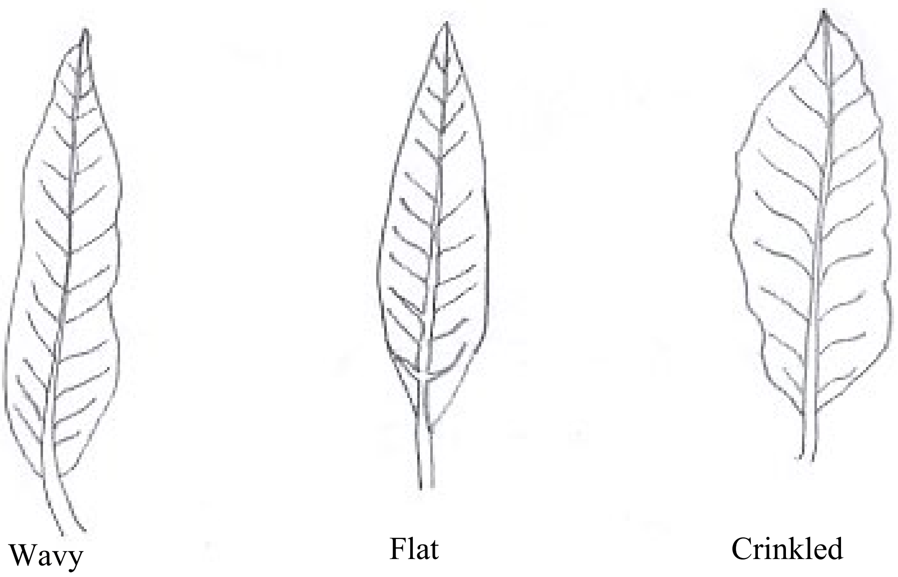


Fig. 2.8 Different types of leaf margins of mango

iii) The average lamina width of three thousand five hundred seventy mature leaves (ten from each mango tree) was measured at the widest point of lamina with the help of a meter scale and data were recorded in cm. The average lamina width of ten leaves was considered as the lamina width for a tree.

iv) The width of half leaf of three thousand five hundred seventy mature leaves (ten from each mango tree) was measured at the middle point of lamina length with the help of a meter scale and data were recorded in cm. For this character the average of ten leaves was considered as the width of half leaf for a tree.

2.2.3.3 Characters selected for inflorescence

Both qualitative and quantitative characters had been selected for the inflorescence.

A. Qualitative characters

i) Inflorescence shape

ii) Floral density

iii) Flower color

B. Quantitative characters

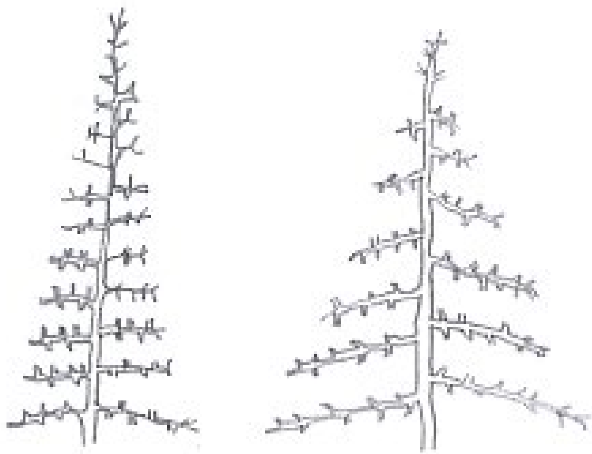
i) Panicle length

ii) Panicle breadth

A. Qualitative characters

(i) Inflorescence shape was noted following the three point scale from observation and IBPGR Descriptor 1989 and IPGRI Descriptor 2006 (Fig. 2.9).

Inflorescence shape		
Conical	Pyramidal	Broadly pyramidal



Conical Pyramidal Broadly pyramidal

Fig. 2.9 Different types of inflorescence shapes of mango

(ii) Floral density was found two types according to the IBPGR Descriptor 1989 and IPGRI Descriptor 2006.

Floral density	
Densely	Laxly

(iii) Flower color was found four types from observation in accordance with IBPGR descriptor 1989 and IPGRI descriptor 2006.

Flower color			
Light green with yellow slash	Cream with yellow slash	Light green with radish slash	Cream with radish slash

B. Quantitative Characters

(i) Three thousand five hundred seventy panicles were collected (Ten from each tree) and panicle length was measured with cm scale and data were recorded in cm.

(ii) Three thousand five hundred seventy panicles were collected (Ten from each tree) and panicle breadth was measured with cm scale and data were recorded in cm.

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2.2.3.4 Characters selected for fruit

Different parts of fruit were observed (Fig. 2.10). Three thousand five hundred seventy mature fruits were randomly selected and used for measurements. The qualitative and quantitative characters were selected for the study are as follows.

A. Qualitative characters

i) Fruit size

ii) Fruit shape

iii) Skin type

iv) Skin color

v) Pulp color

vi) Flavor

vii) Texture

viii) Taste

ix) Fiber

x) Beak

xi) Sinus

xii) Apex

xiii) Basal cavity

xiv) Storage quality

B. Quantitative characters

i) Fruit weight

ii) Fruit length

iii) Fruit width

iv) Fruit diameter

A. Qualitative character

(i) After maturation three thousand five hundred seventy mature fruits were collected and on the basis of their average weight the fruit size was divided into three major groups as follows.

Fruit size	
Weight (g)	**Category**
Below 150	Small
150-300	Medium
More than 300	Large

(ii) Fruit shape was recorded by visual examination; the scale followed is given below (Fig. 2.11).

a) Mummiform
b) Roundish
c) Ovate
d) Ovate oblique
e) Ovate oblong
f) Oblong
g) Oblong oblique
h) Oblong elliptic
i) Oval
j) Obliquely oval
k) Oblong oval

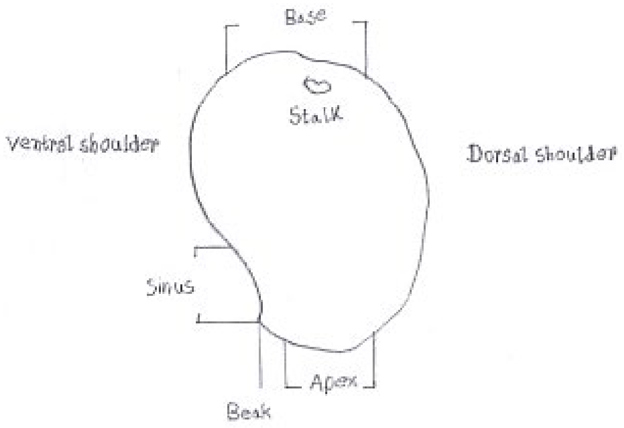

Fig. 2.10 Different parts of a mango fruit

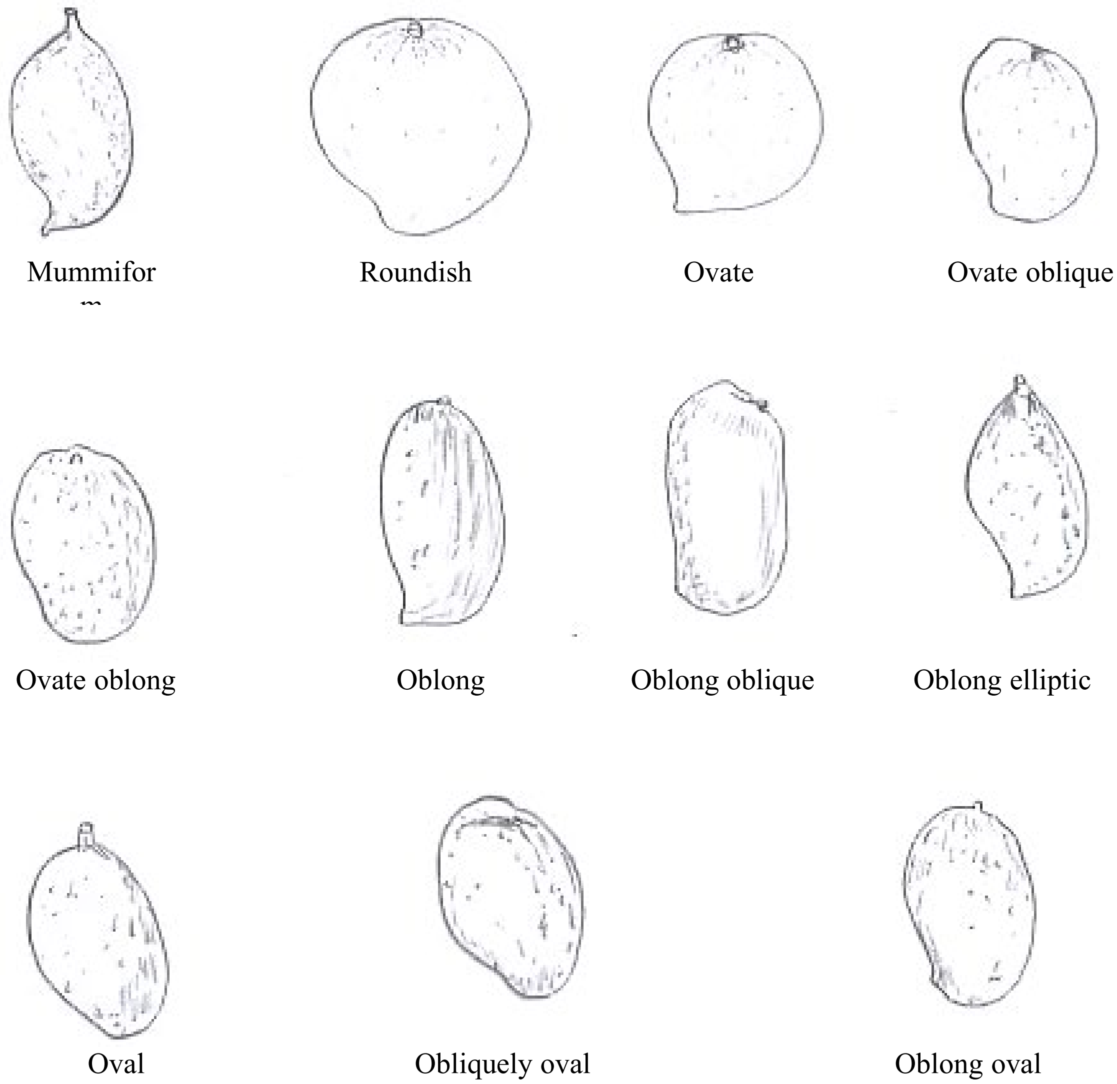

Fig. 2.11 Different shapes of mango fruits

iii) Skin type of mature fruits was divided into two point scale from observation.

Skin type	
Glassy	Non glassy

(iv) Skin color of mature fruits of each mango tree was observed and was recorded followings are the five point scale from observation as follows.

Skin color				
Green	Green with yellow slash	Green with orange slash	Yellow	Yellow with radish slash

(v) Pulp color of ripe fruits was recorded following the five point scale according to IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006.

Pulp color				
Light yellow	Yellow	Deep yellow	Light orange	Deep orange

(vi) Flavor of ripe fruits was recorded following the two point scale

Flavor	
Pleasant	Unpleasant

(vii) Texture of pulp of ripe fruits was found three types in accordance with IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006.

Texture		
Soft	Moderate	Firm

(viii) Taste was recorded following the five point scale after eating and with the help of IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006.

Taste				
Excellent	Good	Fair	Sour	Sour and sweet

ix) Fiber of ripe fruits was divided into three point of scale as follows.

Fiber		
Low	Medium	High

(x) Beak of mature fruits was recorded following the four point of scale according to IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006 as follows (Fig. 2.12).

Beak type			
Mummiform	Prominent	Pointed	Absent

(xi) Fruit sinus type was recorded into two point of scale according to IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006 as follows (Fig. 2.13).

Sinus type	
Present	Absent

(xii) Shape of fruit apex was recorded following the three point of scale according to IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006 as follows (Fig. 2.14).

Type of apex		
Round	Obtuse	Acute

xiii) Basal cavity was found present and absent in different mango varieties (Fig. 2.15).

Basal cavity	
Present	Absent

xiv) After harvesting the storage time of mature fruits at room temperature in days were divided into three categories on the basis of observation as follows.

Storage quality (in days)		
1-7	8-14	15-21

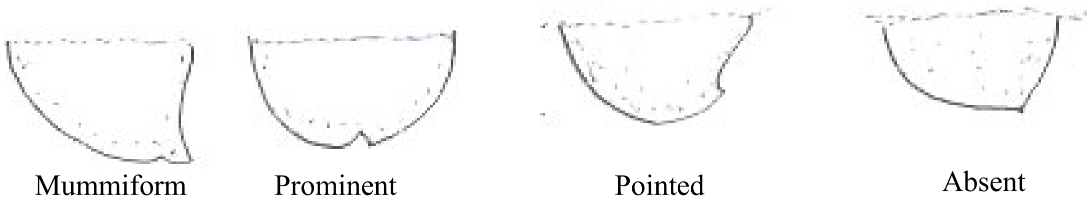

Fig. 2.12 Different types of beak of mango fruits

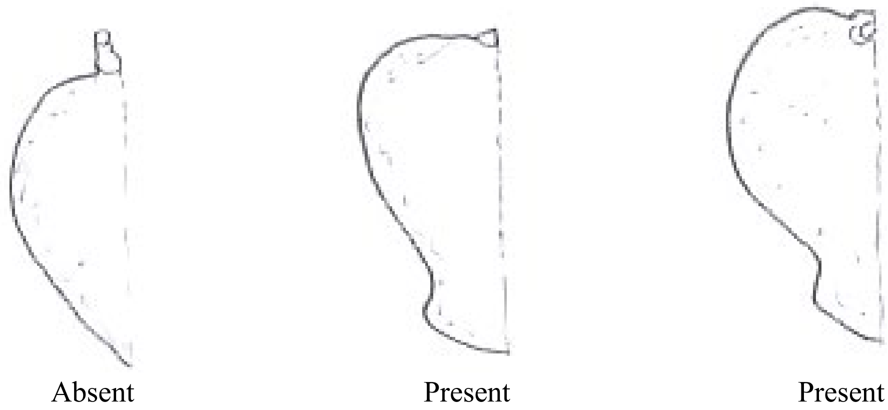

Fig. 2.13 Presence or absence of sinus on mango fruits

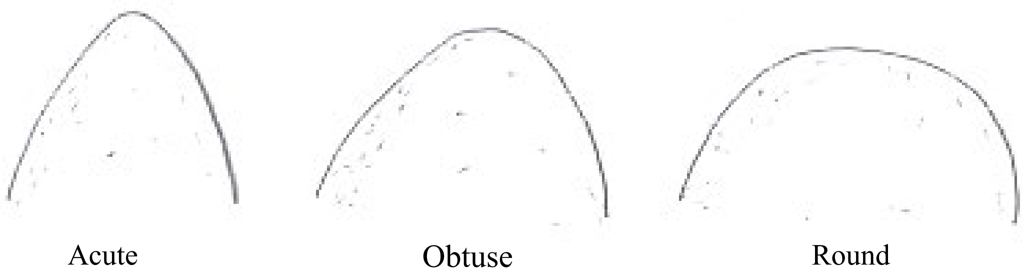

Fig. 2.14 Different types of apex of mango fruits

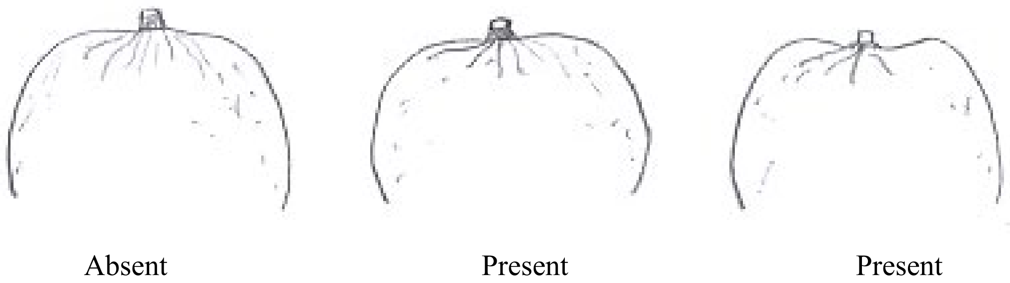

Fig. 2.15 Presence or absence of basal cavity of mango fruits

B. Quantitative characters

i) After ripening fruits were collected from each tree (ten fruits from each tree) and their weight was recorded in grams. The mean value was considered as the value of fruit weight of a tree. These values were grouped into different classes for further study.

ii) Fruits from each tree were collected and fruit length was measured in cm. The mean value of ten fruits was considered as the length of fruit for a tree. The values of all trees were grouped into different classes for further study.

iii) Fruits were collected (ten fruits from each tree) and fruit width was measured in cm. The average width of ten fruits was considered as the width of fruit for a tree. These values were grouped into different classes for further statistical analysis.

iv) The diameter of fruits (ten fruits from each tree) was taken in cm and the average diameter was considered as fruit diameter for a tree. The data were recorded for further statistical assessment.

2.2.3.5 Characters selected for stone

The characters selected for the study are as follows.

A. Qualitative characters

i) Stone size

ii) Presence of fiber

iii) Veins on stone

B. Quantitative characters

i) Stone weight

A. Qualitative characters

i) Stone size was recorded following the three point of scale according to IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006.

Stone size		
Small	Medium	Large

ii) Stone fiber was recorded high or low in different mango varieties according to IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006 as follows.

Presence of fiber	
High	Low

iii) Veins on stones were recorded following the three point of scale according to IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006.

Veins on stone		
Elevated	Labeled	Depressed

B. Quantitative characters

i) Stone weight was measured in gram. The average stone weight of ten fruits from each tree was measured and considered as stone weight of fruit for a tree.

2.2.4 Method of Arrangement

The data of qualitative characters were tabulated according to the scales used from IBPGR Descriptor book 1989 and IPGRI Descriptor book 2006 and quantitative characters were arranged in frequency tables and graphs.

2.2.5 Method of Analysis

The quantitative characters were arranged and analyzed for mean, variance and standard deviation. The analysis of variance was carried out to find out the level of significance. Contingency chi square tests were carried out to assess the level of significance among the categories and between the age groups. T-tests and F tests were also used to compare the means of different parameters (Mishra and Mishra, 1989).

Following the IPGRI descriptors for mangoes as a guide to collect data the above mentioned characters were recorded for further study. Most of the characterizations of the varieties were done in the field where the trees were planted. It is expected that following the above mentioned methods of analysis, the goal of the present research will be achieved.

CHAPTER – III

3. RESULTS: VARIATIONS IN MANGO CHARACTERS OF SIX VILLAGES

The present study was carried out in six different villages of Chapai Nawabganj district named Bohalabari village of Sattajitpur union, Komolakantapur of Sattajitpur union, Mirer chora village of Sundorpur union, Chondipur village of Noya lavanga union, Shaheb gram of Choudala union and Noya lavanga of Noya lavanga union. Data on morphological and reproductive characters of different plant parts were collected and evaluated for statistical analysis. Total three hundred and fifty seven trees were selected from these villages for this part of the study. The results of different qualitative and quantitative characters of mango scored from the villages are given below.

3.1 Sampling for Phenotypic Characters

Data on both morphological and reproductive characters were recorded. For this part of the study the trees were randomly selected from each village and the results are given below.

3.1.1 Qualitative Morphological Characters

Eight tree and four leaf morphological characters of the selected mango trees were evaluated for the six villages. The variation of the collected germplasm which was recorded and measured is given below.

3.1.1.1. Tree characters

Tree to tree variation of different tree characters was observed. The qualitative tree characters evaluated for this study were as follows- age of tree, tree shape, branching type, canopy structure, timber of the main trunk, productivity, time of fruit maturity and fruit bearing habit. These were scored according to scales following IBPGR Descriptor 1989 and IPGRI Descriptor 2006 and the results for six villages are given below.

3.1.1.1.1. Age of mango trees for six villages

The age of the trees for six villages were divided into four different groups. The age groups were- Young (10^+ years), Medium (20^+ years), Old (30^+ years) and Mature (40^+ years). The variation for age groups of mango trees for six different villages was observed (Table 3.1). It was noted mature trees were still the major dominant group and Chondipur village had the maximum number of mature trees. Significant difference in respect of age of trees was observed among the six villages. The contingency χ^2 value was highly significant ($\chi^2 = 223.99$, P>***).

3.1.1.1.2. Tree shape of mango for six villages

The tree shapes were divided into five categories: symmetrical, round, irregular, very irregular and tall (Table 3.2). Irregular tree shape was recorded in the highest number of trees followed by symmetrical while tall tree shape was recorded in the least number of trees. Usually tall shape of tree was the characteristics of relatively young trees. A distinct variation was observed in tree shapes among the six villages. The contingency χ^2 value was found highly significant ($\chi^2 = 66.48$, P>***).

Table 3.1 Ages of mango trees for six villages

Village	Age of tree				
	Young (10^+ years)	Medium (20^+ years)	Old (30^+ years)	Mature (40^+ years)	Total
Bohalabari	20	23	38	38	119
Komolakantapur	1	1	10	8	20
Mirer chora	31	4	0	9	44
Chondipur	6	0	7	76	89
Shaheb gram	8	17	28	3	56
Noya lavanga	3	12	10	4	29
Total	69	57	93	138	357

Contingency $\chi2$=223.99, P>***

Table 3.2 Tree shape of mango trees for six villages

Village	Tree shape					
	Symmetrical	Round	Irregular	Very irregular	Tall	Total
Bohalabari	28	11	55	18	7	119
Komolakantapur	8	3	4	4	1	20
Mirer chora	19	10	11	4	0	44
Chondipur	21	32	20	12	4	89
Shaheb gram	12	10	23	4	7	56
Noya lavanga	12	4	5	1	7	29
Total	100	70	118	43	26	357

Contingency χ^2= 66.48, P>***

3.1.1.1.3. Branching type of mango trees for six villages

Three types of branching were noted among the mango trees for the six villages (Table 3.3). It was noted medium main trunk with several branches at top was the most common type of branching among all villages except Mirer chora. Main trunk slender with few branches at top was noted in the least number of trees. A highly significant variation was observed among the six villages in respect of branching type. The contingency χ^2 value was recorded highly significant (χ^2= 77.15, P>***).

3.1.1.1.4. Canopy structure of mango trees for six villages

Different types of canopy structure were observed ranging from conical, globose, spreading, tall slender and irregular. The irregular canopy structures were found to be most common followed by spreading. Conical shaped canopy structure was found in the least number of trees. It was noted there was a distinct difference among the six villages for canopy structure (Table 3.4). The contingency χ^2 value was highly significant (χ^2= 70.08, P>***).

3.1.1.1.5. Timber of the main trunk of mango trees for six villages

Timber of the main trunk varied from very poor, poor, medium, good and very good respectively. The old and the mature trees had medium to very good timbers. As the quantity of timbers depends upon the age of trees, so medium, good and very good quantity of timber were found in most of the trees. Chondipur village had the highest number of trees containing very good quantity of timber of the main trunk. It was noted that there was significant variations among six villages for this morphological trait (Table 3.5). The contingency χ^2 value was highly significant (χ^2= 134.20, P>***).

Table 3.3 Branching type of mango trees for six villages

Village	Branching type			
	Main trunk slender, few branches at top	Main trunk medium, several branches at top	Main trunk short, branches from the base	Total
Bohalabari	19	58	42	119
Komolakantapur	1	10	9	20
Mirer chora	27	8	9	44
Chondipur	8	41	40	89
Shaheb gram	18	32	6	56
Noya lavanga	9	18	2	29
Total	82	167	108	357

Contingency $\chi^2 = 77.15$, P>***

Table 3.4 Canopy structure of mango trees for six villages

Village	Canopy structure					
	Conical	Globose	Spreading	Tall slender	Irregular	Total
Bohalabari	0	24	36	6	53	119
Komolakantapur	0	2	8	1	9	20
Mirer chora	1	21	10	2	10	44
Chondipur	0	32	22	12	23	89
Shaheb gram	5	9	24	6	12	56
Noya lavanga	2	2	11	7	7	29
Total	8	90	111	34	114	357

Contingency $\chi^2 = 70.08$, P>***

Table 3.5 Timber of the main trunk of mango trees for six villages

Village	Timber of the main trunk					
	Very poor	Poor	Medium	Good	Very good	Total
Bohalabari	5	10	47	43	14	119
Komolakantapur	1	0	2	1	16	20
Mirer chora	7	12	20	4	1	44
Chondipur	3	4	12	26	44	89
Shaheb gram	5	8	24	14	5	56
Noya lavanga	1	3	14	5	6	29
Total	22	37	119	93	86	357

Contingency $\chi^2 = 134.20$, P>***

3.1.1.1.6. Productivity of mango trees for six villages

Productivity of fruits is one of the most important characters for mango as it is directly related with the earning of money for both orchard owners and merchandisers. The productivity of fruits of the trees is of three types- low, intermediate and high (Table 3.6). The productivity of most of the trees in the six villages was intermediate. There was significant difference among six villages for fruit productivity of trees. The contingency χ^2 value was found highly significant for this trait ($\chi^2 =$ 39.58, P>***).

3.1.1.1.7. Time of fruit maturity of mango trees for six villages

The time of fruit maturity of the trees was noted three types- early season, mid season and late season (Table 3.7). For the most of the mango varieties the maturation time of fruits was mid season. Time of fruit maturation was noted early season in the least number of trees. There was significant difference among six villages for the time of fruit maturity. The contingency χ^2 value was highly significant ($\chi^2 =$ 74.08, P>***).

3.1.1.1.8. Fruit bearing habit of mango trees for six villages

The fruit bearing habit of mango trees was divided into two categories- regular fruit bearing and alternative fruit bearing (Table 3.8). In most of the mango trees fruit bearing habit was found alternative. Significant difference was obtained among six villages for this character. Data were evaluated for the statistical analysis and the contingency χ^2 value was found highly significant ($\chi^2 =$ 46.1, P>***).

Table 3.6 Productivity of mango trees for six villages

Village	Productivity			
	Low	Intermediate	High	Total
Bohalabari	25	44	50	119
Komolakantapur	0	6	14	20
Mirer chora	5	32	7	44
Chondipur	6	43	40	89
Shaheb gram	5	36	15	56
Noya lavanga	4	15	10	29
Total	45	176	136	357

Contingency $\chi^2 = 39.58$, P>***

Table 3.7 Time of fruit maturity of mango trees for six villages

Village	Time of fruit maturity			
	Early season	Mid season	Late season	Total
Bohalabari	17	37	65	119
Komolakantapur	2	15	3	20
Mirer chora	1	31	12	44
Chondipur	6	30	53	89
Shaheb gram	6	46	4	56
Noya lavanga	2	23	4	29
Total	34	182	141	357

Contingency $\chi^2 = 74.08$, P>***

Table 3.8 Fruit bearing habit of mango trees for six villages

Village	Fruit bearing habit		
	Regular	Alternative	Total
Bohalabari	40	79	119
Komolakantapur	7	13	20
Mirer chora	34	10	44
Chondipur	45	44	89
Shaheb gram	12	44	56
Noya lavanga	5	24	29
Total	143	214	357

Contingency $\chi^2 = 46.1$ P>***

3.1.1.2. Leaf characters

The qualitative leaf characters were observed and measured for the study. Four qualitative leaf characters were scored and were grouped into suitable scales following IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. These were leaf orientation, shape of leaf, shape of leaf tip and leaf margin. The variation of different leaf characters are described below.

3.1.1.2.1. Leaf orientation of mango trees for six villages

The leaf orientations are of two types on the basis of angle with midrib- erect (angle with midrib 0-45°) and spreading (angle with midrib 50-90°). Variation among the trees of six villages was observed for this trait (Table 3.9). The spreading leaf orientation was more common for the six villages. The contingency χ^2 value was highly significant (χ^2= 44.82, P= ***).

3.1.1.2.2. Shape of leaf of mango trees for six villages

The shapes of leaves varied from elliptic lanceolate, ovate lanceolate and oval lanceolate respectively (Table 3.10). It was observed in several cases when the leaf shape was elliptic lanceolate and the leaf blade was not much wide, the fruits were found to be small. Oval lanceolate leaf shape was most common among all villages. Variation in leaf shape among the six villages was observed. The contingency χ^2 value was very significant (χ^2= 27.70, P= **).

Table 3.9 Leaf orientation of mango trees for six villages

Village	Leaf orientation		
	Erect	Spreading	Total
Bohalabari	34	85	119
Komolakantapur	13	7	20
Mirer chora	19	25	44
Chondipur	58	31	89
Shaheb gram	11	45	56
Noya lavanga	14	15	29
Total	149	208	357

Contingency $\chi^2 = 44.82$, P>***

Table 3.10 Shape of leaf of mango trees for six villages

Village	Shape of leaf			
	Elliptic lanceolate	Ovate lanceolate	Oval lanceolate	Total
Bohalabari	34	32	53	119
Komolakantapur	1	9	10	20
Mirer chora	13	7	24	44
Chondipur	35	14	40	89
Shaheb gram	5	16	35	56
Noya lavanga	7	6	16	29
Total	95	84	178	357

Contingency $\chi^2 = 27.70$, P>**

3.1.1.2.3. Shape of leaf tip of mango trees for six villages

The shapes of leaf tip varied from acute, acuminate and sub-acuminate (Table 3.11). Acute shape of leaf tip was found in the maximum number of trees in the six villages whereas sub-acuminate shape of leaf tip was least common type in those villages. There was significant difference among the six villages regarding the shape of leaf tip. The contingency χ^2 value was highly significant (χ^2= 36. 93, P>***).

3.1.1.2.4. Leaf margin of mango trees for six villages

Variation in leaf margin of different mango trees among the six villages was noticed (Table 3.12). Wavy leaf margin was most common than other two types among the six villages. Crinkled leaf margin was found in the least number of trees among all villages. There was no significant difference for this trait among the six villages. The contingency χ^2 value was non significant (χ^2= 9.04, P= N. S.).

Table 3.11 Shape of leaf tip of mango trees for six villages

Village	Shape of leaf tip			
	Acute	Acuminate	Sub-acuminate	Total
Bohalabari	61	39	19	119
Komolakantapur	2	13	5	20
Mirer chora	23	18	3	44
Chondipur	49	36	4	89
Shaheb gram	18	34	4	56
Noya lavanga	12	17	0	29
Total	165	157	35	357

Contingency $\chi^2 = 36.93$, P>***

Table 3.12 Leaf margin of mango for six villages

Village	Leaf margin			
	Wavy	Flat	Crinkled	Total
Bohalabari	83	25	11	119
Komolakantapur	9	8	3	20
Mirer chora	34	8	2	44
Chondipur	59	21	9	89
Shaheb gram	37	16	3	56
Noya lavanga	19	8	2	29
Total	241	86	30	357

Contingency $\chi^2 = 9.04$, P=N. S.

3.1.2. Qualitative Reproductive Characters

The characteristics of following reproductive plant parts- inflorescence, fruit and stone were observed for the study.

3.1.2.1. Inflorescence characters

The qualitative inflorescence characters observed for the study were inflorescence shape, floral density and flower color. The data were recorded for these characters and were evaluated for the statistical analysis. The variations among the villages are described below.

3.1.2.1.1. Inflorescence shape of mango trees for six villages

The variation in inflorescence shapes of mango trees among six villages was noticed (Table 3.13). The shapes of inflorescence varied from conical, pyramidal and broadly pyramidal respectively. Conical shaped inflorescence was found in the highest number of trees among the villages but it was most common only in Bohalabari and Mirer chora village. The least common inflorescence shape was pyramidal among villages. The contingency χ^2 value was highly significant for this character ($\chi^2 = 42.43$, P>***).

3.1.2.1.2. Floral density of mango trees for six villages

Floral density of mango trees among six villages was observed (Table 3.14) and noted that the laxly type was more common among all villages. No significant variation was observed among the villages in respect of floral density. The contingency χ^2 value was non significant ($\chi^2 = 9.13$, P= N. S.).

Table 3.13 Inflorescence shape of mango trees for six villages

Village	Inflorescence shape			
	Conical	Pyramidal	Broadly pyramidal	Total
Bohalabari	58	35	26	119
Komolakantapur	0	5	15	20
Mirer chora	21	9	14	44
Chondipur	28	25	36	89
Shaheb gram	15	27	14	56
Noya lavanga	8	11	10	29
Total	130	112	115	357

Contingency $\chi^2 = 42.43$, P>***

Table 3.14 Floral density of mango trees for six villages

Village	Floral density		
	Densely	Laxly	Total
Bohalabari	34	85	119
Komolakantapur	9	11	20
Mirer chora	15	29	44
Chondipur	23	66	89
Shaheb gram	23	33	56
Noya lavanga	14	15	29
Total	118	239	357

Contingency $\chi^2 = 9.13$, P= N. S.

3.1.2.1.3. Flower color of mango trees for six villages

The flower colors were divided into four categories- light green with yellow slash, cream with yellow slash, light green with radish slash and cream with radish slash (Table 3.15). Light green with yellow slash color of flower was most common in Bohalabari, Komolakantapur and Shaheb gram whereas cream with yellow slash color of flower was most common in Mirer chora, Chondipur and Noya lavanga. Cream with radish was least common flower color among the six villages. The difference of flower colors was highly significant. The variation in flower color was evaluated for statistical analysis. The contingency χ^2 value was highly significant for this character ($\chi^2 = 66.17$, P>***).

3.1.2.2. Fruit characters

Different qualitative fruit characters were observed for the study. The quality of fruit is very important for both orchard owners and consumers. The qualitative characters of fruits studied for this part of the study were fruit size, skin type, skin color, pulp color, texture, taste, fibrousness, beak type, sinus, apex, basal cavity and storage quality. The variations of these qualitative reproductive traits among the villages are discussed below.

3.1.2.2.1. Fruit size of mango for six villages

The fruit size was divided into three categories based on their weight as follows- small (below 150), medium (150-300 g) and large (more than 300 g). Medium sized fruits were found in the highest number of trees followed by large size (Table 3.16). There was significant variation among the six villages in respect of fruit size. The contingency χ^2 value was highly significant ($\chi^2 = 84.48$, P>***).

Table 3.15 Flower color of mango trees for six villages

Village	Flower color				
	Light green with yellow slash	Cream with yellow slash	Light green with radish slash	Cream with radish slash	Total
Bohalabari	84	25	9	1	119
Komolakantapur	11	9	0	0	20
Mirer chora	15	29	0	0	44
Chondipur	27	59	3	0	89
Shaheb gram	29	22	5	0	56
Noya lavanga	13	15	1	0	29
Total	179	159	18	1	357

Contingency $\chi^2 = 66.17$, P>***

Table 3.16 Fruit size of mango trees for six villages

Village	Fruit size			
	Small	Medium	Large	Total
Bohalabari	13	41	65	119
Komolakantapur	3	16	1	20
Mirer chora	3	32	9	44
Chondipur	5	30	54	89
Shaheb gram	17	31	8	56
Noya lavanga	10	14	5	29
Total	51	164	142	357

Contingency $\chi^2 = 84.48$, P>***

3.1.2.2.2. Skin type of mango for six villages

Skin types of mature fruits were of two types- glassy and non glassy (Table 3.17). In most of the trees among the six villages the skin of mature fruits was non glassy type. The glassy skin was found only in a few numbers of trees among the six villages. Significant variation regarding skin type of mature fruits was recorded among the villages. The contingency χ^2 value was found significant ($\chi^2 = 11.78$, P>*).

3.1.2.2.3. Skin color of ripe mango for six villages

The fruit color at ripening stage was either green, green with yellow slash, green with orange slash, yellow or yellow with radish slash (Table 3.18). The green skin color of ripe fruits was observed in the highest number of trees among all villages while yellow skin color with radish slash was observed in the least number of trees. The green skin color with yellow slash was also frequently common in those villages. The variation in skin color of fruit of different mango germplasm was noticed. The contingency χ^2 value was obtained highly significant ($\chi^2 = 65.18$, P>***)

3.1.2.2.4. Pulp color of ripe mango for six villages

The pulp color of ripe fruits was found to vary from tree to tree. The pulp color of ripe fruits was divided into five categories- light yellow, yellow, deep yellow, light orange and deep orange (Table 3.19). The deep yellow pulp color was found in the highest number of trees while light orange color of pulp was found in the least number of trees. The variation was prominent among the villages for this character. The contingency χ^2 value was highly significant ($\chi^2 = 81.16$, P>***).

Table 3.17 Skin type of mango trees for six villages

Village	Skin type		
	Glassy	Non glassy	Total
Bohalabari	21	98	119
Komolakantapur	0	20	20
Mirer chora	3	41	44
Chondipur	11	78	89
Shaheb gram	2	54	56
Noya lavanga	3	26	29
Total	40	317	357

Contingency $\chi^2 = 11.78$, P>*

Table 3.18 Skin color of ripe mango fruits for six villages

Village	Skin color					
	Green	Green with yellow slash	Green with orange slash	Yellow	Yellow with radish slash	Total
Bohalabari	77	28	2	9	3	119
Komolakantapur	10	7	2	1	0	20
Mirer chora	21	10	11	2	0	44
Chondipur	60	25	0	4	0	89
Shaheb gram	32	20	1	2	1	56
Noya lavanga	18	7	0	4	0	29
Total	218	97	16	22	4	357

Contingency $\chi^2 = 65.18$, P>***

Table 3.19 Pulp color of ripe mango fruits for six villages

Village	Pulp color					
	Light yellow	Yellow	Deep yellow	Light orange	Deep orange	Total
Bohalabari	24	37	36	9	13	119
Komolakantapur	2	0	4	6	8	20
Mirer chora	10	4	16	2	12	44
Chondipur	18	18	40	6	7	89
Shaheb gram	8	6	11	15	16	56
Noya lavanga	5	6	6	10	2	29
Total	67	71	113	48	58	357

Contingency $\chi^2 = 81.16$, P>***

3.1.2.2.5. Flavor of ripe mango for six villages

The flavor of ripe fruits was assessed as pleasant or unpleasant (Table 3.20). The flavor of most of the trees among the six villages was pleasant. There was no significant variation for this character. The contingency χ^2 value was non significant for this character (χ^2= 3.34, P= N. S.).

3.1.2.2.6. Texture of ripe mango for six villages

The texture of ripe fruits was assessed as soft, moderate and firm (Table 3.21). Distinct difference was found among the collected germplasm of the six villages. The moderate texture was found in the highest number of trees whereas the firm texture was found in the least number of trees. The contingency χ^2 value was highly significant (χ^2= 60.78, P>***).

3.1.2.2.7. Taste of ripe mango for six villages

The taste of fruits was divided into five categories: excellent, good, fair, sour and sour and sweet (Table 3.22). Distinct variation was observed regarding taste of ripe fruits among the mango trees of six villages. The taste of most of the varieties was excellent among the six villages but there were a few varieties the taste of which was sour. The contingency χ^2 value was obtained highly significant for this character of mango (χ^2= 110.21, P>***).

Table 3.20 Flavor of ripe mango for six villages

Village	Flavor		
	Pleasant	Unpleasant	Total
Bohalabari	118	1	119
Komolakantapur	20	0	20
Mirer chora	42	2	44
Chondipur	86	3	89
Shaheb gram	55	1	56
Noya lavanga	28	1	20
Total	349	8	357

Contingency $\chi^2 = 3.34$, P= N. S.

Table 3.21 Texture of ripe mango fruits for six villages

Village	Texture			
	Soft	Moderate	Firm	Total
Bohalabari	39	72	8	119
Komolakantapur	16	1	3	20
Mirer chora	34	9	1	44
Chondipur	28	58	3	89
Shaheb gram	36	15	5	56
Noya lavanga	9	17	3	29
Total	162	172	23	357

Contingency $\chi^2 = 60.78$, P>***

Table 3.22 Taste of ripe mango fruits for six villages

Village	Taste					
	Excellent	Good	Fair	Sour	Sour and sweet	Total
Bohalabari	53	47	9	2	8	119
Komolakantapur	5	4	11	0	0	20
Mirer chora	34	5	5	0	0	44
Chondipur	29	23	13	2	22	89
Shaheb gram	12	15	22	4	3	56
Noya lavanga	8	13	5	1	2	29
Total	141	107	65	9	35	357

Contingency $\chi^2 = 110.21$, P>***

3.1.2.2.8. Fibrousness of ripe mango for six villages

The fibrousness of ripe fruits varied from low, medium and high (Table 3.23). The variation was recorded for this character among the mango trees of six villages. The most of the mango fruits among the six villages was found to contain low fiber followed by medium fiber. The contingency χ^2 value was highly significant for this character (χ^2= 32.09, P>***).

3.1.2.2.9. Beak type of mango for six villages

The type of beak was mummiform, prominent and pointed but in most of the mango varieties the beak was absent (Table 3.24). Variation was found in regard to type of beak among the collected germplasm of six villages. The pointed beak was the most common type of beak while mummiform beak was the least common type. The contingency χ^2 value was found highly significant for this reproductive trait of mango (χ^2= 40.15, P>***).

3.1.2.2.10. Presence of sinus on mango for six villages

The presence or absence of sinus on mango for six villages was observed and data were recorded for statistical evaluation (Table 3.25). In most of the varieties the sinus was absent. Significance difference was found in regard to presence or absence of sinus on mango among the six villages. The contingency χ^2 value was highly significant (χ^2= 45.89, P>***).

Table 3.23 Fibrousness of ripe mango fruits for six villages

Village	Fibrousness			
	Low	Medium	High	Total
Bohalabari	63	55	1	119
Komolakantapur	14	5	1	20
Mirer chora	38	6	0	44
Chondipur	42	43	4	89
Shaheb gram	31	20	5	56
Noya lavanga	14	14	1	29
Total	202	143	12	357

Contingency $\chi^2 = 32.09$, P>***

Table 3.24 Beak type of mango for six villages

Village	Beak type				
	Mummiform	Prominent	Pointed	Absent	Total
Bohalabari	1	10	50	58	119
Komolakantapur	0	0	4	16	20
Mirer chora	0	3	7	34	44
Chondipur	0	9	32	48	89
Shaheb gram	0	4	11	41	56
Noya lavanga	0	1	0	28	29
Total	1	27	104	225	357

Contingency $\chi^2 = 40.15$, P>***

Table 3.25 Presence of sinus on mango for six villages

Village	Sinus		
	Present	Absent	Total
Bohalabari	58	61	119
Komolakantapur	2	18	20
Mirer chora	5	39	44
Chondipur	27	62	89
Shaheb gram	8	48	56
Noya lavanga	2	27	20
Total	102	255	357

Contingency $\chi^2 = 45.89$, P>***

3.1.2.2.11. Type of apex on mango for six villages

The type of apex varied from round, obtuse and acute (Table 3.26). The obtuse apex was most common type among all villages except Mirer chora. The acute apex was found in the least number of trees among the villages. Tree to tree variation in type of apex among the mango varieties of six villages was observed. The contingency χ^2 value was highly significant for this trait of mango ($\chi^2 = 42.42$, P>***).

3.1.2.2.12. Presence of basal cavity on mango for six villages

The basal cavity was present in most of the mango varieties among the six villages (Table 3.27). Distinct variation was observed for this character of mango among the villages. The contingency χ^2 value was highly significant ($\chi^2 = 40.59$, P>***).

3.1.2.2.13. Storage quality of mango for six villages

The storage quality of fruit was different in different mango varieties (Table 3.28). The storage quality of mature fruits was divided into three categories based on storage days- 1-7 days, 8-14 days and 15-21 days. The storage quality of fruits in maximum number of trees among the six villages was 8-14 days. The contingency χ^2 value was highly significant ($\chi^2 = 67.31$, P>***).

Table 3.26 Type of apex on mango for six villages

Village	Apex			
	Round	Obtuse	Acute	Total
Bohalabari	29	87	3	119
Komolakantapur	3	14	3	20
Mirer chora	23	21	0	44
Chondipur	22	67	0	89
Shaheb gram	18	33	5	56
Noya lavanga	1	26	2	29
Total	96	248	13	357

Contingency $\chi^2 = 42.42$, P>***

Table 3.27 Basal cavity on mango for six villages

Village	Basal cavity		
	Present	Absent	Total
Bohalabari	92	27	119
Komolakantapur	10	10	20
Mirer chora	31	13	44
Chondipur	75	14	89
Shaheb gram	24	32	56
Noya lavanga	14	15	29
Total	246	111	357

Contingency $\chi^2 = 40.59$, P>***

Table 3.28 Storage quality of mango for six villages

Village	Storage quality			
	1-7 days	8-14 days	15-21 days	Total
Bohalabari	14	103	2	119
Komolakantapur	0	13	7	20
Mirer chora	3	40	1	44
Chondipur	10	77	2	89
Shaheb gram	6	48	2	56
Noya lavanga	0	18	11	29
Total	33	299	25	357

Contingency $\chi^2 = 67.31$, P>***

3.1.2.3. Stone characters

The qualitative stone characters recorded for this study were- stone size, presence of fiber and the type of veins on stone. The variation of different stone characters among the six villages was observed and discussed below.

3.1.2.3.1. Stone size of mango for six villages

The stone size was found three types- small, medium and large (Table 3.29). Large sized stone was found most common among the villages followed by medium sized. The variation for this character was recorded. The contingency χ^2 value was found highly significant for this character ($\chi^2 = 56.02$, P>***).

3.1.2.3.2. Presence of fiber on stone of mango for six villages

The presence of fiber on stone of mango trees for six villages was noted (Table 3.30). In most of the varieties the stone fiber was high. The variation was prominent among the villages for this character. The contingency χ^2 value was found highly significant ($\chi^2 = 21.89$, P>***).

3.1.2.3.3. Veins on stone of mango for six villages

The veins on stone were of three kinds- elevated, labeled and depressed (Table 3.31). Elevated veins on stone were most common among the villages followed by labeled veins on stone. The contingency χ^2 value was highly significant for this character among six villages ($\chi^2 = 43.73$, P>***).

Table 3.29 Stone size of mango for six villages

Village	Stone size			
	Small	Medium	Large	Total
Bohalabari	14	42	63	119
Komolakantapur	1	10	9	20
Mirer chora	2	34	8	44
Chondipur	5	29	55	89
Shaheb gram	14	24	18	56
Noya lavanga	8	15	6	29
Total	44	154	159	357

Contingency $\chi^2 = 56.02$ P>***

Table 3.30 Presence of fiber on stone of mango for six villages

Village	Presence of fiber		
	High	Low	Total
Bohalabari	91	28	119
Komolakantapur	11	9	20
Mirer chora	28	16	44
Chondipur	65	24	89
Shaheb gram	29	27	56
Noya lavanga	12	17	29
Total	236	121	357

Contingency $\chi^2 = 21.89$, P>***

Table 3.31 Veins on stone of mango for six villages

Village	Veins on stone			
	Elevated	Labeled	Depressed	Total
Bohalabari	59	27	33	119
Komolakantapur	8	7	5	20
Mirer chora	13	13	18	44
Chondipur	51	15	23	89
Shaheb gram	13	29	14	56
Noya lavanga	9	17	3	29
Total	153	108	96	357

Contingency $\chi^2 = 43.73$, P>***

3.1.3. Quantitative Morphological Characters

The quantitative traits are as important as qualitative traits as these are directly related with fruit production. Four quantitative morphological characters of leaf were scored in six villages, the results are given below.

3.1.3.1. Leaf characters

In the present study four quantitative leaf characters were scored and were grouped into suitable scales following IBPGR Descriptor 1989 and IPGRI Descriptor, 2006. These were petiole length, lamina length, lamina breadth and width of half leaf. The variation of different leaf characters of six villages are described below.

3.1.3.1.1. Petiole length of mango trees for six villages

The data on petiole length were grouped into three classes and the frequency is shown in Fig. 3.1. The mean value, mode, standard deviation (Table 3.32) and the results of analysis of variance of petiole length of mango trees for six villages are shown in Table 3.33.

The frequency bars showed that 1-3 cm was the most common range for petiole length in all villages except in Mirer chora village. For Mirer chora, the most common range of petiole length was 3-5 cm. However, 5-7 cm petiole length was found only in a few mango trees of Bohalabari and Chondipur village.

The mean value of petiole length showed a narrow range of variation among the six villages. The mean values of Bohalabari, Mirer chora and Chondipur for petiole length were 3.09 cm, 3.37 cm and 3.01 cm respectively which were very similar. The mean values of Komolakanatpur, Shaheb gram and Noya lavanga were 2.5 cm, 2.85 cm and 2.63 cm respectively which were also very similar. The highest mean value of petiole length was found in Mirer chora and lowest in Komolakantapur. The values for mode of petiole length of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 2.71, 2.2, 3.70, 2.81, 2.6 and 2.29 respectively. The highest mode was found in Mirer chora village whereas the lowest mode was found in Komolakantapur village. There was difference in standard deviation; the highest standard deviation was found 1.21 in Bohalabari and the lowest standard deviation was found 0.88 in Komolakantapur village.

The analysis of variance was carried out for petiole length among the six villages (Table 3.33). F value between villages was highly significant and within villages also showed highly significant difference which confirmed the significant variation for this character (P>***).

3.1.3.1.2. Lamina length of mango trees for six villages

The lengths of laminas were divided into four classes and their frequency is shown in Fig. 3.2. The mean value, mode, standard deviation and analysis of variance of lamina length of mango trees for six villages were carried out for statistical analysis.

The most common range for lamina length was 14-19 cm in all villages except Bohalabari and Chondipur. For Bohalabari and Chondipur the most common range of lamina length was 19-24 cm which was frequently common among the other villages. Only in a few mango trees of these villages the lamina length ranged from 9-14 cm and 24-29 cm.

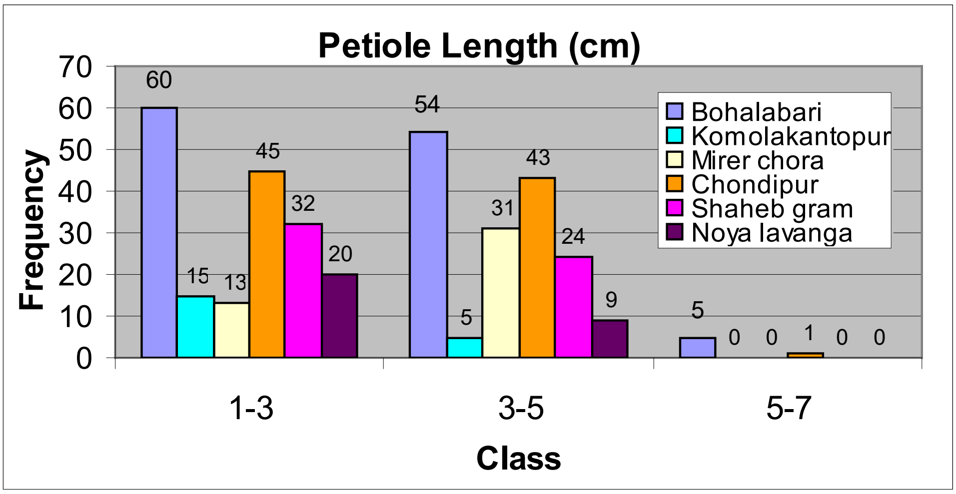

Fig. 3.1 Frequency bars for petiole length of six villages

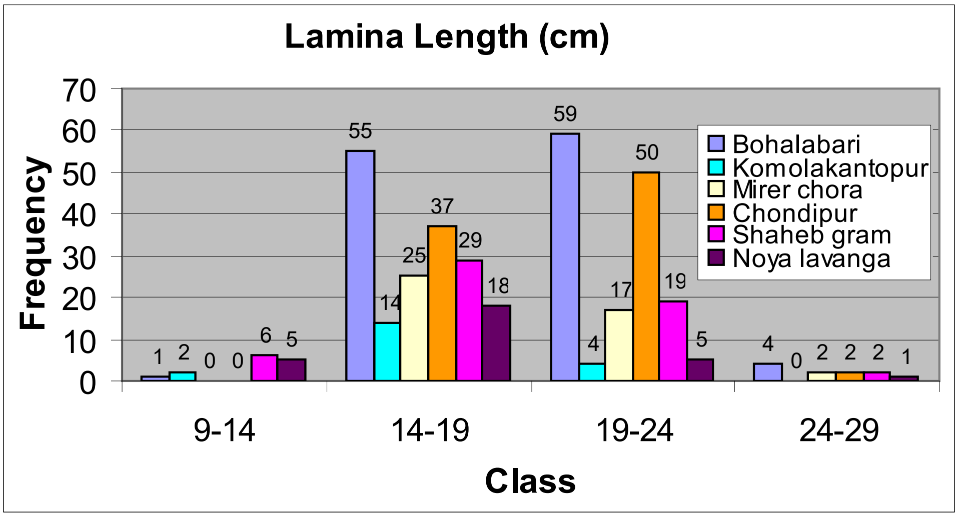

Fig. 3.2 Frequency bars for lamina length of six villages

Table 3.32 Mean, mode and standard deviation of petiole length of mango trees for six villages

Village	Item		
	Mean	Mode	Standard deviation
Bohalabari	3.09	2.71	1.21
Komolakantapur	2.50	2.20	0.88
Mirer chora	3.37	3.70	0.94
Chondipur	3.01	2.81	1.10
Shaheb gram	2.85	2.60	0.99
Noya lavanga	2.63	2.29	0.93

Table 3.33 Analysis of variance of petiole length of mango trees for six villages

Item	SS	df	MS	F	P
Between villages	9.2948	5	1.8589	5.91	***
Within villages	59.4643	58.5	1.0164	3.23	***
Residual	92.0818	292.5	0.3148		
Total	160.841	356			

Variation was observed among the six villages for the mean values (Table 3.34) of lamina length. The mean values of lamina length for Bohalabari, Mirer chora and Chondipur were 19.14 cm, 19.35 cm and 19.42 cm respectively which were very similar. The mean values for Komolakanatpur, Shaheb gram and Noya lavanga were 17.00 cm, 17.93 cm and 16.85 cm. The highest mean value of lamina length was found in Chondipur village and the lowest in Noya lavanga. The mode values for lamina length of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 18.84, 16.72, 19.00, 19.81, 17.50 and 16.50 respectively. Variation was observed for mode among six villages; the highest mode was found in Chondipur village whereas the lowest mode value was found in Noya lavanga village.

The standard deviation values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 2.89, 2.76, 2.94, 2.69, 3.66 and 3.52 respectively. The highest value of standard deviation was found in Shaheb gram and the lowest value was found in Chondipur village.

The data were evaluated for two way analysis of variance (Table 3.35) and F value for between villages and within villages were highly significant which confirmed that there was highly significant difference for this character among six villages (P>***).

Table 3.34 Mean, mode and standard deviation of lamina length of mango trees for six villages

Village	Item		
	Mean	Mode	Standard deviation
Bohalabari	19.14	18.84	2.89
Komolakantapur	17.00	16.72	2.76
Mirer chora	19.35	19.00	2.94
Chondipur	19.42	19.81	2.69
Shaheb gram	17.93	17.50	3.66
Noya lavanga	16.85	16.50	3.52

Table 3.35 Analysis of variance of lamina length of mango trees for six villages

Item	SS	df	MS	F	P
Between villages	236.4689	5	47.2937	9.674	***
Within villages	747.3163	58.5	12.7746	2.613	***
Residual	1429.9644	292.5	4.8887		
Total	2413.7496	356			

3.1.3.1.3. Lamina breadth of mango trees for six villages

Lamina breadths of mango trees for six villages were observed and data were evaluated for statistical analysis. The mean value, mode, standard deviation are shown and the results of analysis of variance are presented in Table 3.37.

Among all villages 5-7 cm was found the most common range for lamina breadth whereas 7-9 cm range of lamina breadth was the least common range (Fig. 3.3). The variation for this quantitative trait was noticeable.

Variation was observed among six villages for the mean values of lamina breadth. The mean value of lamina breadth for Bohalabari and Mirer chora were 5.98 cm and 6.04 cm respectively while the mean values for Komolakanatpur, Chondipur, Shaheb gram and Noya lavanga were 5.0 cm, 5.94 cm, 5.21 cm and 5.10 cm respectively. The highest mean value of lamina breadth was found in Mirer chora village and the lowest in Komolakanatpur. The mode values for leaf breadth of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 6.0, 5.0, 6.02, 5.97, 5.21 and 5.0 respectively. The highest mode was found in Mirer chora village whereas the lowest mode was found in Komolakantapur and Noya lavanga. The values of standard deviation for lamina breadth for Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 1.20, 1.03, 1.18, 1.18, 1.18 and 1.15 respectively.

The analysis of variance was carried out (Table 3.37) and the result of F test was highly significant (P>***). F value for between villages and within villages being very significant confirmed the significant difference among the villages for this character.

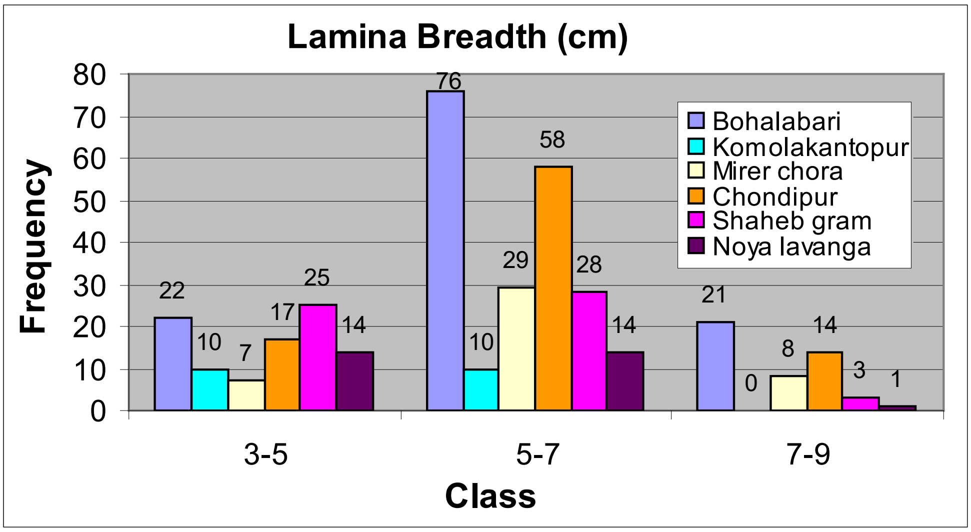

Fig. 3.3 Frequency bars for lamina breadth of six villages

Table 3.36 Mean, mode and standard deviation of lamina breadth of mango trees for six villages

Village	Item		
	Mean	Mode	Standard deviation
Bohalabari	5.98	6.00	1.20
Komolakantapur	5.00	5.00	1.03
Mirer chora	6.04	6.02	1.18
Chondipur	5.94	5.97	1.18
Shaheb gram	5.21	5.21	1.18
Noya lavanga	5.10	5.00	1.15

Table 3.37 Analysis of variance of lamina breadth of mango trees for six villages

Item	SS	df	MS	F	P
Between villages	34.0836	5	6.8167	9.1819	***
Within villages	120.6942	58.5	2.0631	2.7789	***
Residual	217.1592	292.5	0.7424		
Total	371.9371	356			

3.1.3.1.4. Width of half leaf of mango trees for six villages

The width of half leaves was measured and was divided into three classes (Fig. 3.4). The mean value, mode, standard deviation (Table 3.38) and the analysis of variance for width of half leaf of mango trees for six villages were analyzed.

In the maximum number of trees in all the six villages the width of half leaf was found 5-7 cm except in Komolakantapur and Noya lavanga. The least common range for width of half leaf in all villages was recorded 7-9 cm.

Variation was observed among the six villages for the mean values of width of half leaf. The mean values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noyalavangta for width of half leaf were 5.75 cm, 4.80 cm, 5.90 cm, 5.52 cm, 5.15 cm and 5.03 cm respectively. The lowest mean value for width of half leaf was found in Komolakanatpur while the highest mean value was found in Mirer chora village. The mode values for width of half leaf of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 5.86, 4.50, 5.96, 5.73, 5.15 and 4.77 respectively. The highest mode was found in Mirer chora village whereas the lowest mode was found in Komolakantapur village. The standard deviation values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga for width of half leaf were 1.18, 1.00, 1.13, 1.12, 1.13 and 1.15 respectively.

The analysis of variance was carried out (Table 3.39) and F value was found highly significant for both between villages and within villages (P>***).

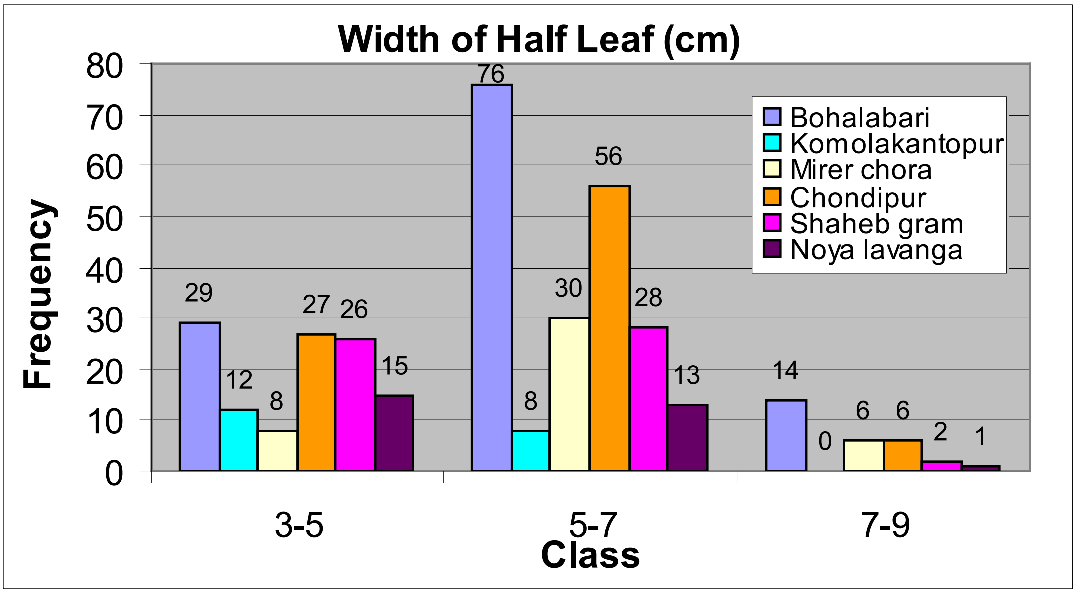

Fig. 3.4 Frequency bars for width of half leaf of six villages

Table 3.38 Mean, mode and standard deviation of width of half leaf of mango trees for six villages

Village	Item		
	Mean	Mode	Standard deviation
Bohalabari	5.75	5.86	1.18
Komolakantapur	4.80	4.50	1.00
Mirer chora	5.90	5.96	1.13
Chondipur	5.52	5.73	1.12
Shaheb gram	5.15	5.15	1.13
Noya lavanga	5.03	4.77	1.15

Table 3.39 Analysis of variance of width of half leaf of mango trees for six villages

Item	SS	df	MS	F	P
Between villages	31.1017	5	6.2203	8.4791	***
Within villages	111.0672	58.5	1.8985	2.5879	***
Residual	214.6028	292.5	0.7336		
Total	356.7718	356			

3.1.4. Quantitative Reproductive Characters

The quantitative reproductive characters of panicle, fruit and stone were observed, measured and the results are given below.

3.1.4.1. Panicle characters

Two quantitative panicle characters were scored and grouped into suitable scales following IBPGR Descriptor, 1989 & IPGRI Descriptor, 2006. These were panicle length and panicle breadth. The results on the variation of these characters of six villages are described below.

3.1.4.1.1. Panicle length of mango tees for six villages

The data on panicle length were evaluated for mean, mode, standard deviation and analysis of variance. The variation for this character was observed.

Panicle lengths were divided into four classes (Fig. 3.5). The most common range for panicle length in Bohalabari, Komolakantapur, Mirer chora and Chondipur village was 20-30 cm was while 10-20 cm was the most common range in Shaheb gram and Noya lavanga village; 10-20 cm range was also the next common range for Bohalabari, Komolakantapur, Mirer chora and Chondipur village. However, 30-40 cm range for panicle length was also found in all villages; 40-50 cm range for panicle length was found only in a few mango trees of Komolakantapur, Shaheb gram and Noya lavanga village.

The mean values of panicle length showed a wide range of variation among the six villages (Table 3.40). The mean values of panicle length of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 22.73 cm, 28.50 cm, 24.54 cm, 23.32 cm, 24.65 cm and 23.97 cm respectively. The highest mean was found 28.50 cm in Komolakantapur village and the lowest mean was found 22.73 cm in Bohalabari village. The mode values for panicle length of Bohalabari, Komolakantapur, Mirer chora, chondipur, Shaheb gram and Noya lavanga were 23.76, 24.54, 24.75, 24.18, 26.25 and 18.0 respectively. There was considerable variation for mode of panicle length among six villages. The highest mode for panicle length was found in Shaheb gram village whereas the lowest mode value was found in Noya lavanga village. There was a remarkable difference in standard deviation; the highest standard deviation was found 10.40 in Komolakantapur and the lowest standard deviation was found 5.44 in Chondipur village.

The analysis of variance was carried out and the F value (Table 3.41) for between villages and within villages was found highly significant that confirmed the significant difference in panicle length among the six villages (P>***).

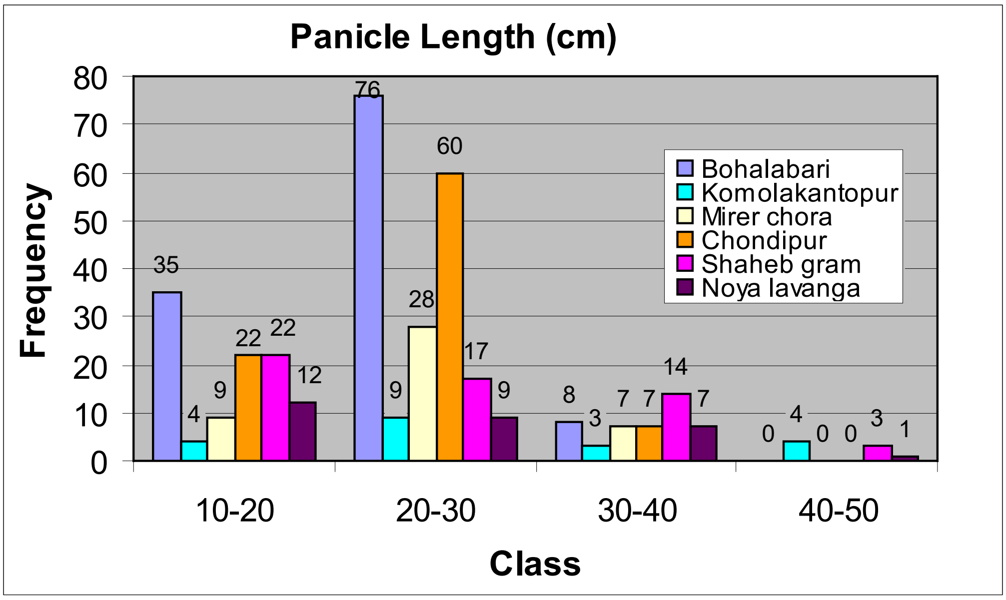

Fig. 3.5 Frequency bars for panicle length of six villages

Table 3.40 Mean, mode and standard deviation of panicle length of mango trees for six villages

Village	Item		
	Mean	**Mode**	**Standard deviation**
Bohalabari	22.73	23.76	5.59
Komolakantapur	28.50	24.54	10.40
Mirer chora	24.54	24.75	6.09
Chondipur	23.32	24.18	5.44
Shaheb gram	24.65	26.25	9.33
Noya lavanga	23.97	18.00	9.01

Table 3.41 Analysis of variance of panicle length of mango trees for six villages

Item	SS	df	MS	F	P
Between Villages	906.6958	5	181.3392	5.3168	***
Within Villages	4747.141	58.5	81.1477	2.3792	***
Residual	9976.1328	292.5	34.1064		
Total	15629.9696	356			

3.1.4.1.2. Panicle breadth of mango tees for six villages

The frequency of panicle breadth for six villages was divided into six classes (Fig. 3.6). The mean value, mode, standard deviation are shown in Table 3.42 and the results of analysis of variance of lamina breadth of mango trees for six villages are shown in Table 3.43.

The most common range for panicle breadth among the villages was 10-16 cm followed by 4-10 cm whereas 16-22 cm range of panicle breadth was also found in all villages but higher range for panicle breadth was found only in some mango trees among these villages.

Variation was observed among the six villages for mean values of panicle breadth. The mean values of Bohalabari and Noya lavanga for panicle breadth were 11.90 cm and 11.97 cm respectively which were similar whereas for Mirer chora, Shaheb gram and Chondipur the mean values were very similar. The highest mean value of panicle breadth was found 16.30 cm in Komolakanatpur village and the lowest 11.9 cm in Bohalabari village. The mode values for panicle breadth of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 11.84, 16.00, 13.00, 13.29, 8.60 and 10.85 respectively. The highest mode was found in Komolakantapur village whereas the lowest mode was found in Shaheb gram village.

The standard deviation values of panicle breadth for Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 4.20, 6.88, 4.55, 4.88, 6.53 and 4.55 respectively. Variation was observed for standard deviation among the villages. The highest standard deviation was found in Komolakantapur and the lowest standard deviation was found in Bohalabari village.

The F value of between villages and within villages was found highly significant for this quantitative trait (Table 3.43) which indicated a distinct variation for panicle breadth among the six villages (P>***).

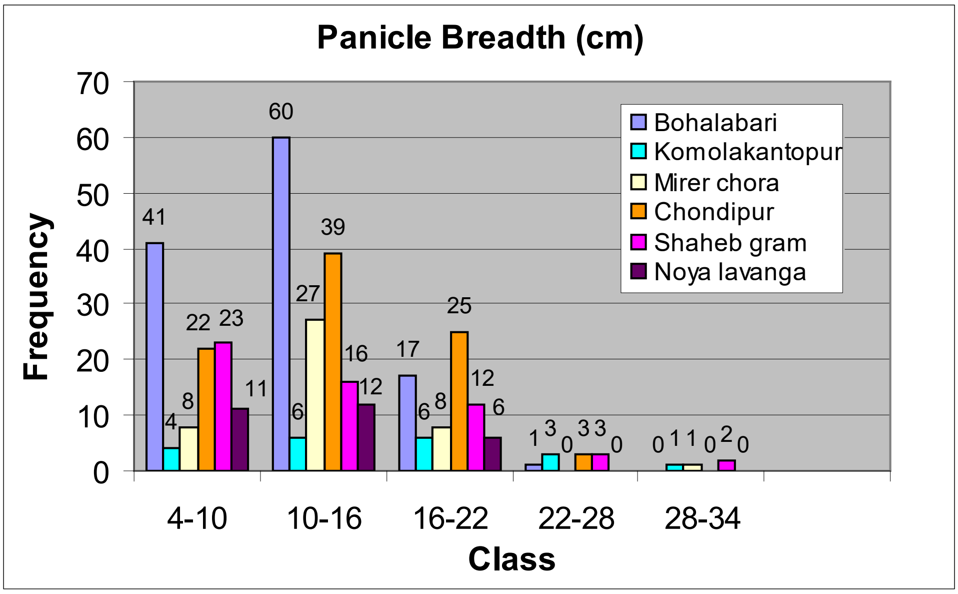

Fig. 3.6 Frequency bars for panicle breadth of six villages

Table 3.42 Mean, mode and standard deviation of panicle breadth of mango trees for six villages

Village	Item		
	Mean	**Mode**	**Standard deviation**
Bohalabari	11.90	11.84	4.20
Komolakantapur	16.30	16.00	6.88
Mirer chora	13.40	13.00	4.55
Chondipur	13.61	13.29	4.88
Shaheb gram	13.1	8.60	6.53
Noya lavanga	11.97	10.85	4.55

Table 3.43 Analysis of variance of panicle breadth of mango trees for six villages

Item	SS	df	MS	F	P
Between villages	569.2462	5	113.8492	5.9379	***
Within villages	2596.1883	58.5	44.3792	2.3146	***
Residual	5608.2053	292.5	19.1733		
Total	8773.6399	356			

3.1.4.2. Fruit characters

The fruit is the most important part of mango tree for its economic value. Four quantitative fruit characters - fruit weight, fruit length, fruit width and fruit diameter were observed and measured for the study. The quantitative fruit characters were scored and were grouped into suitable scales following IBPGR Descriptor, 1989 & IPGRI Descriptor, 2006.

3.1.4.2.1. Fruit weight of mango tees for six villages

The fruit weight varied from tree to tree. The data on fruit weight were recorded and were divided into five classes (Fig. 3.7). The mean value, mode, standard deviation and the analysis of variance of fruit weight of mango trees for six villages were carried out.

The most common range for fruit weight was 151-300 g in all villages. The range of fruit weight from 1-150 g and from 301-450 g was also frequently common among the villages. Large fruit size (451-600 g range) was observed less common while very large size of fruits (601-750 g range) were the least common in the six villages.

Variation was observed among six villages for the mean values (Table 3.44) of fruit weight. The mean values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga for fruit weight were 320.04 g, 210.50 g, 266.40 g, 350.21 g, 201.40 g and 194.47 g respectively. The highest mean for fruit weight was found 350.21 g in Chondipur village and the lowest mean for fruit weight was found 194.47 g in Noya lavanga village. The mode values for fruit weight of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were

263.50, 220.65, 231.35, 290.29, 190.13 and 197.87 respectively. Variation was also observed in mode among six villages. The highest mode was found in Chondipur village whereas the lowest mode was found in Shaheb gram village.

The standard deviation values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 147.27, 67.08, 104.15, 141.65, 113.62 and 101.25 respectively. A wide range of variation was also observed for standard deviation among the six villages. The highest standard deviation was found in Bohalabari and the lowest standard deviation was found in Kamalakantapur village.

The analysis of variance was carried out and the F value (Table 3.45) for both between villages and within villages were highly significant indicated major variation in this trait among the six villages (P>***).

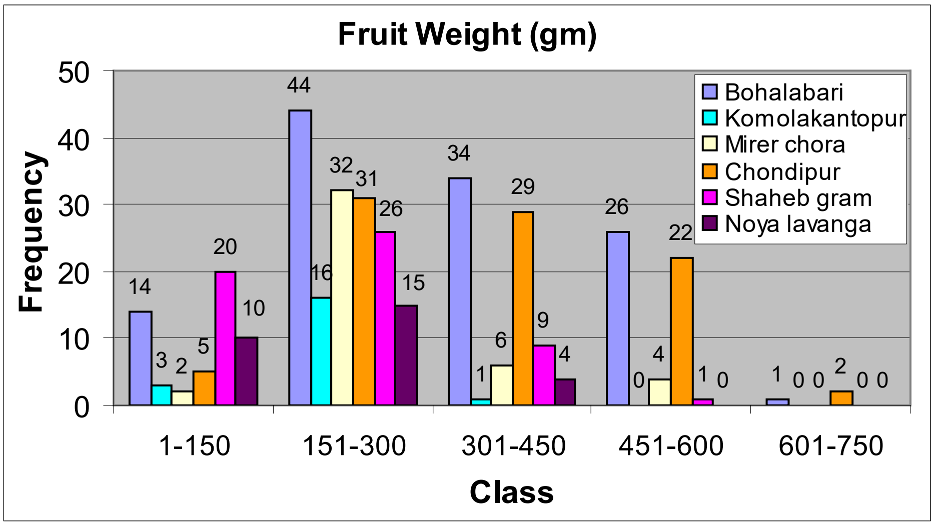

Fig. 3.7 Frequency bars for fruit weight of six villages

Table 3.44 Mean, mode and standard deviation of fruit weight of mango for six villages

Village	Item		
	Mean	Mode	Standard deviation
Bohalabari	320.04	263.50	147.27
Komolakantapur	210.50	220.65	67.08
Mirer chora	266.40	231.35	104.15
Chondipur	350.21	290.29	141.65
Shaheb gram	201.40	190.13	113.62
Noya lavanga	194.47	197.87	101.25

Table 3.45 Analysis of variance of fruit weight of mango for six villages

Item	SS	df	MS	F	P
Between villages	1511933.5	5	302386.7	26.2890	***
Within villages	1771497.7	58.5	30282.01	2.6326	***
Residual	3364446.6	292.5	11502.38		
Total	6647877.8	356			

3.1.4.2.2. Fruit length of mango tees for six villages

The data on fruit length were grouped into four classes and the frequency is shown in Fig. 3.8. The mean value, mode, standard deviation and the analysis of variance of fruit length of mango trees for six villages were calculated.

The highest frequency was found in 8-11 cm range in all villages; 5-8 cm and 11-14 cm ranges were also frequently common among the six villages whereas 14-17 cm range for fruit length was found only in a few mango trees of Bohalabari, Mirer chora and Chondipur village.

The mean value of fruit length (Table 3.46) showed variation among the six villages. The mean values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga for fruit length were 10.38 cm, 9.05 cm, 9.90 cm, 11.32 cm, 9.29 cm and 9.29 cm respectively. The highest mean value was found 11.32 cm in Chondipur village and the lowest mean value was found 9.05 cm in Kamalakantapur village. The mode values of fruit length for Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 10.37 cm, 9.26 cm, 9.50 cm, 10.29 cm, 9.29 cm and 9.42 cm respectively. The highest mode for fruit length was found in Bohalabari village whereas the lowest mode was found in Kamalakantapur village. There was a remarkable difference in standard deviation among six villages; the highest standard deviation was found 2.55 in Bohalabari and the lowest standard deviation was found 1.58 in Noya lavanga village.

The F value (Table 3.47) being highly significant for between and within villages confirmed the significant variation for fruit length among the six villages (P>***).

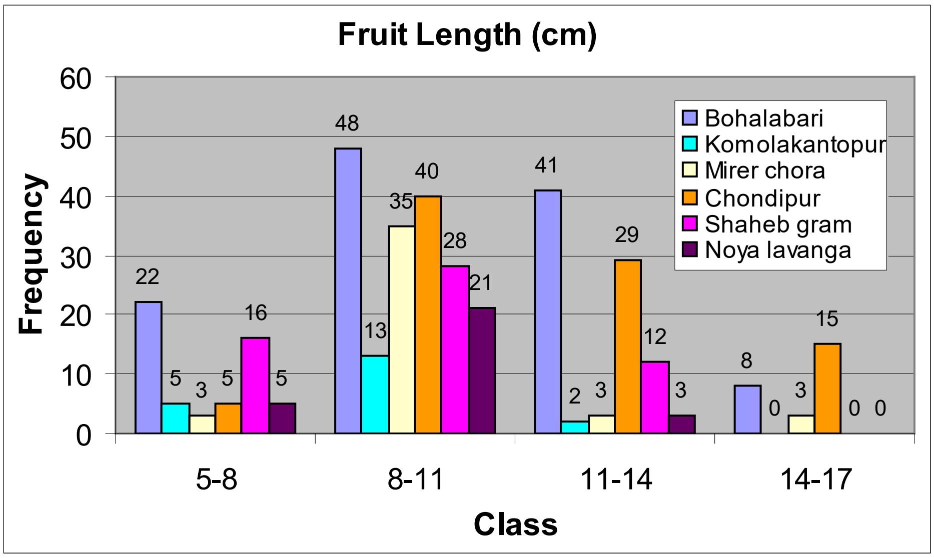

Fig. 3.8 Frequency bars for fruit length of six villages

Table 3.46 Mean, mode and standard deviation of fruit length of mango for six villages

Village	Item		
	Mean	**Mode**	**Standard deviation**
Bohalabari	10.38	10.37	2.55
Komolakantapur	9.05	9.26	1.76
Mirer chora	9.90	9.50	1.90
Chondipur	11.32	10.29	2.51
Shaheb gram	9.29	9.29	2.13
Noya lavanga	9.29	9.42	1.58

Table 3.47 Analysis of variance of fruit length of mango for six villages

Item	SS	df	MS	F	P
Between villages	254.3222	5	50.8644	14.21	***
Within villages	487.0814	58.5	8.3261	2.32	***
Residual	1049.2454	292.5	3.5871		
Total	1790.649	356			

3.1.4.2.3. Fruit width of mango tees for six villages

The width of fruits among the six villages was noted and was divided into three classes (Fig. 3.9). The data were evaluated for statistical analysis.

In all villages except Chondipur 6-8 cm was the most common range for fruit width while in Chondipur village 8-10 cm range was the most common range for fruit width.

Variation was observed among the six villages for the mean values (Table 3.48) of fruit width. The mean values for fruit width of Komolakantapur, Shaheb gram and Noya lavanga were 6.60 cm, 6.40 cm and 6.31 cm which were very similar. The mean values for fruit width of Bohalabari, Mirer chora and Chondipur village were 7.37 cm, 7.31 cm and 7.95 cm respectively which were also similar. The highest mean for fruit width was found in Chondipur village and the lowest mean was found in Noya lavanga. The mode values for fruit width of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 7.35, 6.81, 7.15, 8.26, 6.32 and 6.38 respectively. The highest mode was found in Chondipur village whereas the lowest mode was found in Shaheb gram village. The standard deviation values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 1.35, 1.05, 1.06, 1.17, 1.32 and 1.29 respectively.

The analysis of variance was carried out (Table 3.49) and F value for both between villages and within villages were found highly significant which indicated the significant difference regarding this quantitative trait among the six villages (P>***).

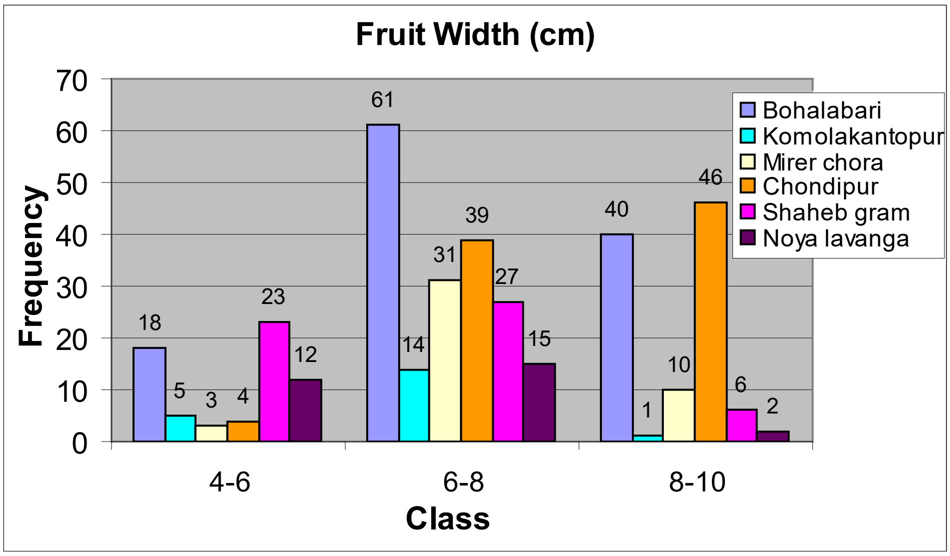

Fig. 3.9 Frequency bars for fruit width of six villages

Table 3.48 Mean, mode and standard deviation of fruit width of mango for six villages

Village	Item		
	Mean	Mode	Standard deviation
Bohalabari	7.37	7.35	1.35
Komolakantapur	6.60	6.81	1.05
Mirer chora	7.31	7.15	1.06
Chondipur	7.95	8.26	1.17
Shaheb gram	6.40	6.32	1.32
Noya lavanga	6.31	6.38	1.29

Table 3.49 Analysis of variance of fruit width of mango for six villages

Item	SS	df	MS	F	P
Between villages	119.1515	5	23.8303	24.3715	***
Within villages	136.9053	58.5	2.3402	2.3934	***
Residual	286.0043	292.5	0.9777		
Total	542.0612	356			

3.1.4.2.4. Fruit diameter of mango tees for six villages

The diameters of fruits were measured and were grouped into four classes (Fig. 3.10). The mean, mode, standard deviation and the analysis of variance of fruit diameter of mango trees for six villages were calculated.

For fruit diameter 17-21 cm and 21-25 cm were frequently common ranges among all villages; 13-17 cm and 25-29 cm ranges for fruit diameter were also found in some mango trees among the villages.

Variation for fruit diameter among six villages was observed. The mean values (Table 3.50) of fruit diameter for Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 23.16 cm, 19.80 cm, 22.69 cm, 23.62 cm, 20.15 cm and 23.56 cm. The highest mean for fruit diameter was found in Chondipur village and the lowest mean was found in Komolakantapur. The mode values for fruit diameter of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 25.53, 19.29, 22.86, 24.20, 19.58 and 19.29 respectively. The highest mode was found in Bohalabari village whereas the lowest mode was found in Komolakantapur and Noya lavanga village. The standard deviation values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 3.40, 1.65, 2.72, 3.13, 3.03 and 2.33 respectively. Variations were observed for the values of standard deviation among the villages.

The results of analysis of variance (Table 3.51) confirmed significant difference between villages and within villages for this character among the six villages as F value was highly significant for fruit diameter (P>***).

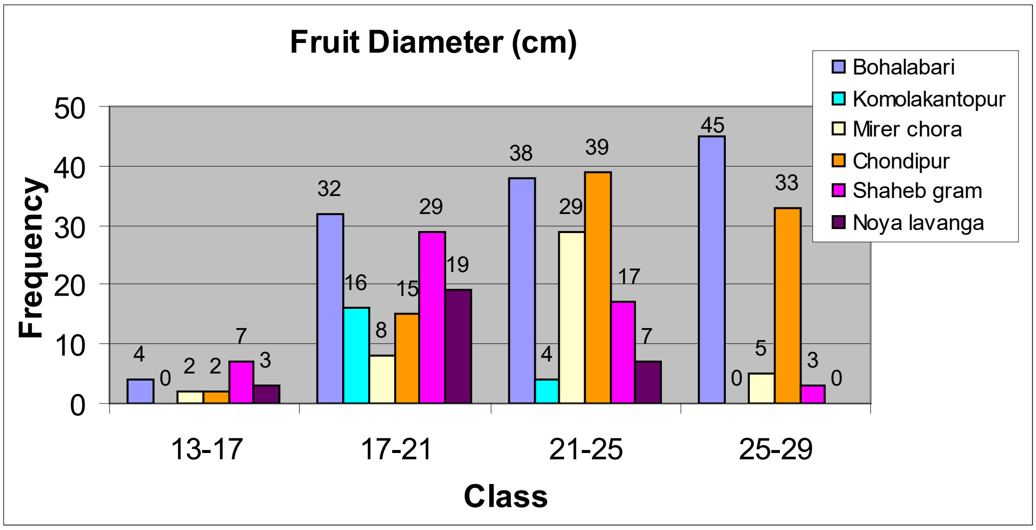

Fig. 3.10 Frequency bars for fruit diameter of six villages

Table 3.50 Mean, mode and standard deviation of fruit diameter of mango for six villages

Village	Item		
	Mean	**Mode**	**Standard deviation**
Bohalabari	23.16	25.53	3.40
Komolakantapur	19.80	19.29	1.65
Mirer chora	22.69	22.86	2.72
Chondipur	23.62	24.20	3.13
Shaheb gram	20.15	19.58	3.03
Noya lavanga	23.56	19.29	2.33

Table 3.51 Analysis of variance of fruit diameter of mango for six villages

Item	SS	df	MS	F	P
Between villages	938.8022	5	187.7604	27.0561	***
Within villages	982.0644	58.5	16.7874	2.4190	***
Residual	2029.8483	292.5	6.9396		
Total	3950.7149	356			

3.1.4.3. Stone characters

Stone weight was measured and recorded for the study. The stone weight was grouped into suitable scales following IBPGR Descriptor, 1989 & IPGRI Descriptor, 2006. The results on the variation of this character among six villages are described below.

3.1.4.3.1. Stone weight of mango tees for six villages

The data of stone weight were grouped into four classes and the frequency is shown in Fig. 3.11. The mean, mode, standard deviation and the analysis of variance of stone weight of mango trees for six villages were calculated.

The frequency bars showed that 25-40 g and 40-55 g were common ranges for stone weight in all villages whereas 10-25 g range for stone weight was also often found in all villages but 55-70 g range was least common range for stone weight.

Tree to tree variation for stone weight among the six villages were observed and evaluated for statistical analysis. The mean values of stone weight (Table 3.52) for Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 44.48 g, 28.75 g, 36.60 g, 41.10 g, 27.15 g and 26.29 g respectively. The highest mean for stone weight was 44.48 g in Bohalabari village and the lowest mean was found 26.29 g in Noya lavanga village. The mode values for stone weight of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 45.54, 27.15, 33.93, 36.64, 22.65 and 21.84 respectively. Appreciable variation was observed in mode among six villages. The highest mode was found in Bohalabari village whereas the lowest mode was found in Noya lavanga village.

The standard deviation values of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga were 12.29, 10.74, 9.89, 11.73, 10.49 and 10.23 respectively. A wide range of variation was also observed for standard deviation among the six villages. The highest standard deviation was found in Bohalabari and the lowest standard deviation was found in Mirer chora village.

The data were evaluated for analysis of variance and F value (Table 3.53) was highly significant for this character among the six villages (P>***).

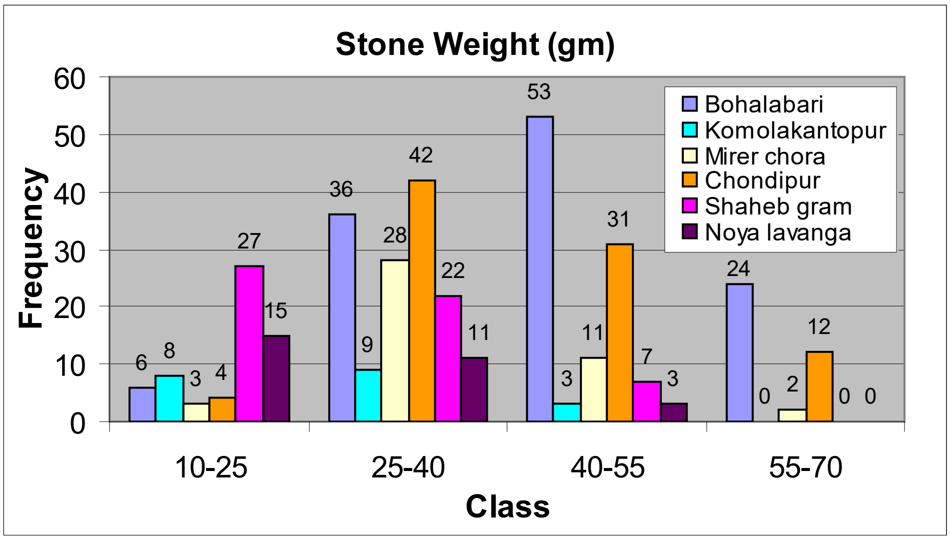

Fig. 3.11 Frequency bars for stone weight of six villages

Table 3.52 Mean, mode and standard deviation of stone weight of mango for six villages

Village	Item		
	Mean	Mode	Standard deviation
Bohalabari	44.48	45.54	12.29
Komolakantapur	28.75	27.15	10.74
Mirer chora	36.60	33.93	9.89
Chondipur	41.10	36.64	11.73
Shaheb gram	27.15	22.65	10.49
Noya lavanga	26.29	21.84	10.23

Table 3.53 Analysis of variance of stone weight of mango for six villages

Item	SS	df	MS	F	P
Between villages	17636.04	5	3527.208	38.1946	***
Within villages	13303.585	58.5	227.4117	2.4625	***
Residual	27011.894	292.5	92.3483		
Total	57951.518	356			

3.2. The Range and Pattern of Variations in Phenotypic Characters of Mango for Six Villages

To identify and asses the range and pattern of changes in the phenotypic characters of both morphological and reproductive plant parts for the six villages, the results of observations and statistical analysis have been summarized in the tables below.

The results strongly indicated distinct pattern of variations in both qualitative and quantitative characters among the six villages because of habitat differences which have been summarized in the tables (Tables 3.54 and 3.55).

Most of the qualitative characters showed highly significant difference among the six villages. The characters which showed non significant or low significant difference due to habitat differences still had variations within the villages. The ranges of variations for the qualitative characters were mostly highly significant different.

The ranges of variations in quantitative characters were much prominent for the six villages. All the quantitative characters showed highly significant difference for both within the villages and among the villages.

Table 3.54 Summery table for qualitative characters performance among the six villages on the basis of chi square tests

Characters	Range of variations among the six villages
A. Tree characters	
Age of trees	***
Tree shapes	***
Type of branching	***
Canopy structure	***
Quantity of timber of the main trunk	***
Productivity of fruits	***
Time of fruit maturity	***
Fruit bearing type	***
B. Leaf characters	
Leaf orientation	***
Shape of leaf	**
Shape of leaf tip	***
Leaf margin	N. S.
C. Inflorescence characters	
Inflorescence Shape	***
Floral density	N. S.
Flower color	***
D. Fruit characters	
Fruit size	***
Skin type	*
Skin color	***
Pulp color	***
Flavor	N. S.
Fruit texture	***
Taste	***
Quantity of fiber	***
Type of beak	***
Presence of sinus	***
Type of apex	***
Presence of basal cavity	***
Storage quality in days	***
E. Stone characters	
Stone size	***
Presence of fiber	***
Veins on stone	***

N. S. = Non significant
* = Low significant
** = Medium significant
*** = Highly significant

3.55 Summery table for pattern of range of variations in quantitative characters for the six villages on the basis of F tests

Characters	Range of variations for the six villages	
	Within six villages	**Between six villages**
A. Leaf characters		
Petiole length	***	***
Lamina length	***	***
Lamina width	***	***
Width of half leaf	***	***
B. Inflorescence characters	***	***
Panicle length	***	***
Panicle width	***	***
C. Fruit characters	***	***
Fruit weight	***	***
Fruit length	***	***
Fruit width	***	***
Fruit Diameter	***	***
D. Stone character	***	***
Stone weight	***	***

* = Low significant
** = Medium significant
*** = Highly significant

CHAPTER – IV

4. RESULTS: VARIATIONS AMONG TYPES OF TREES

The mango trees studied from Chapai Nawabganj district was grouped into three categories as follows- commercial varieties, cultivated varieties and 'gutee' trees according to the findings of survey. Data on morphological and reproductive characters of different plant parts were collected from each type for the study. For this part of the study a total of two hundred seventy trees, ninety from each category were selected from study sites. The results on morphological and reproductive characters of three categories of mango trees are described below.

4.1. Sampling for Phenotypic Characters

Data on different morphological and reproductive characters for three categories of mango trees were collected and the results are given below.

4.1.1. Qualitative Morphological Characters

Eight tree and four leaf morphological characters from each category of mango trees were recorded and the results are given below.

4.1.1.1. Tree characters

The eight qualitative tree characters recorded for evaluation were age of tree, tree shape, branching type, canopy structure, timber of the main trunk, productivity of fruits, time of fruit maturity and fruit bearing habit. These characters were scored according to scales of IBPGR Descriptor (1989) & IPGRI Descriptor (2006) for three categories of mango trees.

4.1.1.1.1. Age of trees for three categories of mango trees

The ages of the trees were divided into four different groups, young (10^+ years), medium (20^+ years), old (30^+ years) and mature (40^+ years) respectively. The highest number of trees was observed in mature age group for the three categories. It was also observed that 'gutee' trees were much less in number in the mature group than other two categories. There was significant variation among the three categories of mango trees in respect of age groups (Table 4.1). The contingency χ^2 value was found highly significant ($\chi^2 = 67.77$, P>***).

4.1.1.1.2. Tree shape for three categories of mango trees

The tree shapes were symmetrical, round, irregular, very irregular and tall (Table 4.2). The most common type of tree shape for each category was irregular. The least common type of tree shape was found tall in commercial and cultivated varieties whereas in 'gutee' trees the least common type was very irregular. Variation in tree shape for the three categories was noticed. The contingency χ^2 value was highly significant ($\chi^2 = 23.34$, P>**).

4.1.1.1.3. Branching type for three categories of mango trees

Three types of branching were found among the mango trees. Variation in branching type was recorded (Table 4.3). In commercial varieties the most of the trees had short main trunk with branches from the base while in cultivated varieties and 'gutee' trees the highest number of trees had medium sized main trunk with several branches at top. Slender main trunk with few branches at top was the least common type in commercial and cultivated varieties whereas short main trunk with branches from the base was found least common in 'gutee' trees. The contingency χ^2 value was highly significant ($\chi^2 = 58.12$, P>***).

Table 4.1 Age of tree for three categories of mango trees

Category	Age of tree				
	Young (10^+ years)	Medium (20^+ years)	Old (30^+ years)	Mature (40^+ years)	Total
Commercial varieties	5	9	18	58	90
Cultivated varieties	17	19	14	40	90
Gutee trees	9	25	45	11	90
Total	31	53	77	109	270

Contingency $\chi^2 = 67.77$, P>***

Table 4.2 Tree shape for three categories of mango trees

Category	Tree Shape					
	Symmetrical	Round	Irregular	Very irregular	Tall	Total
Commercial varieties	16	23	30	19	2	90
Cultivated varieties	26	18	32	8	6	90
Gutee trees	25	16	29	6	14	90
Total	67	57	91	33	22	270

Contingency $\chi^2 = 23.34$, P>**

Table 4.3 Branching type for three categories of mango trees

Category	Branching Type			
	Main trunk slender, few branches at top	Main trunk medium, several branches at top	Main trunk short, branches from the base	Total
Commercial varieties	4	27	59	90
Cultivated varieties	20	47	23	90
Gutee trees	25	51	14	90
Total	49	125	96	270

Contingency $\chi^2 = 58.12$, P>***

4.1.1.1.4. Canopy structure for three categories of mango trees

Different types of canopy structure were observed varied from conical, globose, spreading, tall slender and irregular (Table 4.4). There was significant variation among the three categories of mango trees in respect of canopy structure. The spreading canopy structures were found in the highest number of trees among the three categories. The least common type canopy structure was conical shape for the three categories. The contingency χ^2 value was highly significant (χ^2= 37.53, P>***).

4.1.1.1.5. Timber of the main trunk for three categories of mango trees

The quantity of timber of the main trunk was observed ranging from very poor, poor, medium, good and very good. The old and the mature trees were observed to have medium to very good quantity of timbers. Medium to good quantity of timber was found in most of the trees. There was no significant variation among the three categories for this character (Table 4.5). The contingency χ^2 value was found non-significant (χ^2= 12.52, P=N. S.).

4.1.1.1.6. Productivity for three categories of mango trees

The productivity of fruits was low, intermediate or high. In cultivated varieties and 'gutee' trees the productivity of fruits in most of the trees was intermediate whereas in commercial varieties the productivity of fruits in most of the trees was high. There was significant difference among three categories of mango trees in respect of fruit production (Table 4.6). The contingency χ^2 value was highly significant (χ^2= 23.17, P>***).

Table 4.4 Canopy structure for three categories of mango trees

Category	Canopy structure					
	Conical	Globose	Spreading	Tall slender	Irregular	Total
Commercial varieties	0	29	27	2	32	90
Cultivated varieties	0	20	25	7	38	90
Gutee trees	7	13	39	12	19	90
Total	7	62	91	21	89	270

Contingency $\chi^2 = 37.53$, P>***

Table 4.5 Timber of the main trunk for three categories of mango trees

Category	Timber of the main trunk					
	Very poor	Poor	Medium	Good	Very good	Total
Commercial varieties	2	3	25	31	29	90
Cultivated varieties	5	9	34	21	21	90
Gutee trees	5	10	35	21	19	90
Total	12	22	94	73	69	270

Contingency $\chi^2 = 12.52$, P=N. S.

Table 4.6 Productivity for three categories of mango trees

Category	Productivity			
	Low	Intermediate	High	Total
Commercial varieties	7	36	47	90
Cultivated varieties	24	38	28	90
Gutee trees	9	52	29	90
Total	40	126	104	270

Contingency $\chi^2 = 23.17$, P>***

4.1.1.1.7. Time of fruit maturity for three categories of mango trees

The time of fruit maturity of the trees was found three types- early season, mid season and late season (Table 4.7). In cultivated varieties and 'gutee' trees most of the mango fruits matured in the mid season whereas in commercial varieties most of the mango fruits matured in the late season. In each category the least number of fruits matured in early season. A distinct variation was observed among three categories of mango trees for the time of fruit maturity. The contingency χ^2 value was highly significant (χ^2= 77.70, P>***).

4.1.1.1.8. Fruit bearing habit for three categories of mango trees

The fruit bearing habit of mango trees was observed two types- regular fruit bearing and alternative fruit bearing (Table 4.8). In most of the mango trees of the three categories fruit bearing habit was alternative. There was significant difference among three categories of mango trees for this character. The contingency χ^2 value was significant (χ^2= 7.72, P>*).

4.1.1.2. Leaf characters

Four qualitative leaf characters were scored and were grouped into suitable scales following IBPGR Descriptor, 1989 & IPGRI Descriptor, 2006. These were leaf orientation, shape of leaf, shape of leaf tip and leaf margin. The variation of different leaf characters among three categories are described below.

Table 4.7 Time of fruit maturity for three categories of mango trees

Category	Time of fruit maturity			
	Early season	Mid season	Late season	Total
Commercial varieties	6	27	57	90
Cultivated varieties	15	45	30	90
Gutee trees	8	78	4	90
Total	29	150	91	270

Contingency $\chi^2 = 77.70$, P>***

Table 4.8 Fruit bearing habit for three categories of mango trees

Category	Fruit bearing habit		
	Regular	Alternative	Total
Commercial varieties	39	51	90
Cultivated varieties	27	63	90
Gutee trees	22	68	90
Total	88	182	270

Contingency $\chi^2 = 7.72$, P>*

4.1.1.2.1. Leaf orientation for three categories of mango trees

The orientations of leaves were noticed two types- erect and spreading (Table 4.9). It was observed that the spreading leaf orientation was more common among the three categories of mango trees. There was no significant variation for this character among the three categories. Contingency χ^2 value was 4.54 which was non significant (χ^2= 4.54, P= N. S.).

4.1.1.2.2. Shape of leaf for three categories of mango trees

The shapes of leaves were of three types- elliptic lanceolate, ovate lanceolate and oval lanceolate (Table 4.10). Oval lanceolate shape was the most common type of leaf shape in all the categories of mango trees. The least common type shape of leaf was elliptic lanceolate in commercial and 'gutee' trees whereas in cultivated varieties the least common type leaf shape was noted ovate lanceolate. The variation regarding leaf shape was distinct among three categories of mango trees. The contingency χ^2 value was highly significant (χ^2= 22.95, P= ***).

4.1.1.2.3. Shape of leaf tip for three categories of mango trees

The shapes of leaf tip were acute, acuminate and sub-acuminate respectively (Table 4.11). Acute leaf tips were the most common type in commercial varieties while acuminate leaf tips were found as the most common type of leaf tip in cultivated varieties and 'gutee' trees. Sub-acuminate leaf tip was the least common type among all categories of mango trees. There was distinct difference among three categories of mango trees for shape of leaf tip. The contingency χ^2 value was highly significant (χ^2= 36.02, P>***).

Table 4.9 Leaf orientation for three categories of mango trees

Category	Leaf orientation		
	Erect	Spreading	Total
Commercial varieties	30	60	90
Cultivated varieties	42	48	90
Gutee trees	30	60	90
Total	102	168	270

Contingency $\chi^2 = 4.54$, P=N. S.

Table 4.10 Shape of leaf for three categories of mango trees

Category	Shape of leaf			
	Elliptic lanceolate	Ovate lanceolate	Oval lanceolate	Total
Commercial varieties	24	32	34	90
Cultivated varieties	37	13	40	90
Gutee trees	13	27	50	90
Total	74	72	124	270

Contingency $\chi^2 = 22.95$, P>***

Table 4.11 Shape of leaf tip for three categories of mango trees

Category	Shape of leaf tip			
	Acute	Acuminate	Sub-acuminate	Total
Commercial varieties	62	25	3	90
Cultivated varieties	34	40	16	90
Gutee trees	29	54	7	90
Total	125	119	26	270

Contingency $\chi^2 = 36.02$, P>***

4.1.1.2.4. Leaf margin for three categories of mango trees

The leaf margins were divided into three categories: wavy, flat and crinkled. It was noted that wavy leaf margin was the most common type in all categories of mango trees. Crinkled leaf margin was recorded as the least common type leaf margin among all categories of mango trees. No significant difference was found in regard to leaf margin among three categories (Table 4.12). The contingency χ^2 was non significant (χ^2= 8.29, P=N. S.).

4.1.2. Qualitative Reproductive Characters

The characteristics of reproductive plant parts- inflorescence, fruit and stone were observed. Tree to tree variations for these traits were recorded and data were evaluated for the chi square test.

4.1.2..1. Inflorescence characters

The qualitative inflorescence characters observed for the study were inflorescence shape, floral density and flower color. The variation of different inflorescence characters among the three categories are described below.

4.1.2.1.1. Inflorescence shape for three categories of mango trees

Three types of inflorescence shapes were recorded among the categories of mango trees- conical, pyramidal and broadly pyramidal (Table 4.13). In commercial and cultivated varieties the most common inflorescence shape was conical while in 'gutee' trees the most common shape was pyramidal. Broadly pyramidal and conical inflorescences were the least common type in commercial varieties and 'gutee' trees respectively while in cultivated varieties the least common type was pyramidal. The contingency χ^2 value was highly significant (χ^2=21.54, P>***).

Table 4.12 Leaf margin for three categories of mango trees

Category	Leaf margin			
	Wavy	Flat	Crinkled	Total
Commercial varieties	64	15	11	90
Cultivated varieties	54	29	7	90
Gutee trees	53	30	7	90
Total	171	74	25	270

Contingency $\chi^2 = 8.29$, P=N. S.

Table 4.13 Inflorescence shape for three categories of mango trees

Category	Inflorescence shape			
	Conical	Pyramidal	Broadly pyramidal	Total
Commercial varieties	40	26	24	90
Cultivated varieties	45	13	32	90
Gutee trees	23	39	28	90
Total	108	78	84	270

Contingency $\chi^2 = 21.54$, P>***

4.1.2.1.2. Floral density for three categories of mango trees

Floral density of three categories of mango trees were observed (Table 4.14) and noted that laxly type was more common among all categories. There was no significant variation for this character among the three categories. The contingency χ^2 value was found non-significant (χ^2= 3.36, P= N. S.).

4.1.2.1.3. Flower color for three categories of mango trees

The colors of flowers were- light green with yellow slash, cream with yellow slash, light green with radish slash and cream with radish slash respectively. Tree to tree variations for this character were recorded. The most common flower color was light green with yellow slash among the three categories of mango trees while the least common flower color was recorded cream with radish slash. The variations in flower colors for the three categories were observed (Table 4.15). The contingency χ^2 value was non significant (χ^2=7.16, P=N. S.).

4.1.2.2. Fruit Characters

Fruit is the most important plant part of mango tree. Different qualitative fruit characters were observed and grouped into suitable scales following the IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. The qualitative characters of fruits studied for this part of the study were fruit size, skin type, skin color, pulp color, flavor, texture, taste, fibrousness, beak type, sinus, apex, basal cavity and storage quality. The variations of different qualitative characters among the three categories of mango trees are discussed below.

Table 4.14 Floral density for three categories of mango trees

Category	Floral density		
	Densely	Laxly	Total
Commercial varieties	27	63	90
Cultivated varieties	29	61	90
Gutee trees	38	52	90
Total	94	176	270

Contingency χ^2= 3.36, P= N. S.

Table 4.15 Flower color for three categories of mango trees

Category	Flower color				
	Light green with yellow slash	Cream with yellow slash	Light green with radish slash	Cream with radish slash	Total
Commercial varieties	58	28	4	0	90
Cultivated varieties	45	36	8	1	90
Gutee trees	47	38	5	0	90
Total	150	102	17	1	270

Contingency χ^2= 7.16, P=N. S.

4.1.2.2.1. Fruit size for three categories of mango trees

Fruit size of mango trees were of three types- small, medium and large. It was observed that medium size of fruits were most common in cultivated varieties and 'gutee' trees. In most of the trees of commercial varieties the fruits were found large in size. Small size fruits were least common in commercial and cultivated varieties while large size fruits were found least common in the 'gutee' trees (Table 4.16). The number of mango trees containing small sized fruits was more in 'gutee' trees than commercial and cultivated varieties. A distinct variation was observed in fruit size among the three categories of mango trees. The contingency χ^2 value found highly significant (χ^2= 89.21, P>***).

4.1.2.2.2. Skin type of fruits for three categories of mango trees

Skin types of mature fruits were found to vary two types- glassy and non glassy (Table 4.17). In most of the trees among the three categories the skin of fruits was non glassy type. The number of trees having glassy type skin of fruits was found more in the category of cultivated varieties than commercial varieties and 'gutee' trees. A highly significant variation in respect of skin type of fruits was recorded among the three categories. The contingency χ^2 value was highly significant (χ^2= 26.25, P>***).

4.1.2.2.3. Skin color of ripe fruits for three categories of mango trees

Fruit pigmentation is a major attribute in fruit marketing. The skin colors of fruits at ripening stage were divided into five groups (Table 4.18). The green skin color was most common among all categories. Green with orange slash and yellow with radish slash skin color was the least common type of skin color among all categories of mango trees. Variation was observed among different categories regarding skin color of fruits. The contingency χ^2 value was recorded highly significant (χ^2=37.21, P>***).

Table 4.16 Fruit size for three categories of mango trees

Category	Fruit size			
	Small	Medium	Large	Total
Commercial varieties	3	22	65	90
Cultivated varieties	16	54	20	90
Gutee trees	28	52	10	90
Total	47	128	95	270

Contingency $\chi^2 = 89.21$, P>***

Table 4.17 Skin type of fruit for three categories of mango trees

Category	Skin type		
	Glassy	Non glassy	Total
Commercial varieties	5	85	90
Cultivated varieties	25	65	90
Gutee trees	5	85	90
Total	35	235	270

Contingency $\chi^2 = 26.25$, P>***

Table 4.18 Skin color of ripe mango fruits for three categories of mango trees

Category	Skin color					
	Green	Green with yellow slash	Green with orange slash	Yellow	Yellow with radish slash	Total
Commercial varieties	72	18	0	0	0	90
Cultivated varieties	36	36	3	12	3	90
Gutee trees	52	30	1	6	1	90
Total	160	84	4	18	4	270

Contingency $\chi^2 = 37.21$, P>***

4.1.2.2.4. Pulp color of ripe fruits for three categories of mango trees

The pulp colors of mango at ripening stage were- light yellow, yellow, deep yellow, light orange and deep orange respectively (Table 4.19). The deep yellow pulp color was found in the highest number of trees in commercial and cultivated varieties whereas light orange pulp color was most common in 'gutee' trees followed by deep orange. The variation in pulp color for the three categories was observed. The contingency χ^2 value was found highly significant (χ^2= 71.39, P>***).

4.1.2.2.5. Flavor of ripe fruits for three categories of mango trees

The flavor of ripe fruits was assessed as pleasant or unpleasant (Table 4.20). The flavor of most of the trees among the three categories was pleasant. There was no significant variation for this character among the three categories. The contingency χ^2 value was non significant for this character (χ^2= 5.59, P=N. S.).

4.1.2.2.6. Texture of ripe fruits for three categories of mango trees

Fruit texture at ripening stage was soft, medium or firm (Table 4.21). The moderate texture of ripe fruits was found in the highest number of trees in commercial and cultivated varieties whereas soft texture was found in most of the 'gutee' trees. Firm texture was found in the least number of trees among all categories. The variation was recorded among the mango trees for this character. The contingency χ^2 value was highly significant (χ^2= 23.38, P>***).

Table 4.19 Pulp color of ripe mango fruits for three categories of mango trees

Category	Pulp color					
	Light yellow	Yellow	Deep yellow	Light orange	Deep orange	Total
Commercial varieties	16	29	39	5	1	90
Cultivated varieties	27	2	28	14	19	90
Gutee trees	13	12	18	24	23	90
Total	56	43	85	43	43	270

Contingency χ^2= 71.39, P>***

Table 4.20 Flavor of ripe mango for three categories of mango trees

Category	Flavor		
	Pleasant	Unpleasant	Total
Commercial varieties	90	0	90
Cultivated varieties	85	5	90
Gutee trees	88	2	90
Total	263	7	270

Contingency χ^2= 5.59, P=N. S.

Table 4.21 Texture of ripe mango for three categories of mango trees

Category	Texture			
	Soft	Moderate	Firm	Total
Commercial varieties	29	58	3	90
Cultivated varieties	39	42	9	90
Gutee trees	54	25	11	90
Total	122	125	23	270

Contingency χ^2= 23.38, P>***

4.1.2.2.7. Taste of ripe fruits for three categories of mango trees

The taste of ripe fruits was assessed as excellent, good, fair, sour and sour and sweet respectively (Table 4.22). The taste of fruits in most of the trees was excellent in commercial varieties and cultivated varieties but in most of the 'gutee' trees the taste of fruits was fair. The variation was noticeable among the three categories of mango trees for this qualitative trait. The contingency χ^2 value was found very highly significant ($\chi^2 = 55.81$, P>***).

4.1.2.2.8. Fibrousness of ripe fruits for three categories of mango trees

The fibrousness of ripe fruits was divided into three categories which were low, medium and high (Table 4.23). The most of the fruits among the three categories was observed to have low fiber. Distinct variation was observed in regard to fibrousness among the mango trees. The contingency χ^2 value was highly significant for this character of fruit ($\chi^2 = 16.60$, P>**).

4.1.2.2.9. Beak type for three categories of mango trees

The type of beak was mummiform, prominent and pointed where present but in most mango varieties among the three categories beak was absent (Table 4.24). There was significant difference for this character of mango. The pointed beak was most common type and mummiform beak was the least common type among the three categories. The contingency χ^2 value was highly significant ($\chi^2 = 75.1$,P>***).

Table 4.22 Taste of ripe fruits for three categories of mango trees

Category	Taste					
	Excellent	Good	Fair	Sour	Sour and sweet	Total
Commercial varieties	42	40	0	0	8	90
Cultivated varieties	41	23	21	3	2	90
Gutee trees	19	27	33	6	4	90
Total	102	90	54	9	15	270

Contingency $\chi^2 = 55.81$, P>***

Table 4.23 Fibrousness of ripe fruits for three categories of mango trees

Category	Fibrousness			
	Low	Medium	High	Total
Commercial varieties	44	46	0	90
Cultivated varieties	61	23	6	90
Gutee trees	49	35	6	90
Total	154	104	12	270

Contingency $\chi^2 = 16.60$, P>**

Table 4.24 Beak type for three categories of mango trees

Category	Beak type				
	Mummiform	Prominent	Pointed	Absent	Total
Commercial varieties	0	0	53	37	90
Cultivated varieties	1	18	14	57	90
Gutee trees	0	4	14	72	90
Total	1	22	81	166	270

Contingency $\chi^2 = 75.1$, P>***

4.1.2.2.10. Presence of sinus for three categories of mango trees

The presence or absence of sinus on fruit among the three categories of mango trees was noted (Table 4.25). In most of the trees of cultivated varieties and 'gutee' trees the sinus was absent but in commercial varieties the sinus was present. The variation was prominent for this character among the three categories of mango trees. The contingency χ^2 value was found highly significant ($\chi^2 =$ 33.71, P>***).

4.1.2.2.11. Type of apex for three categories of mango trees

The type of apex was round, obtuse and acute (Table 4.26). Variation for this character of mango among the three categories was recorded. The obtuse apex was most common type and acute apex was least common type among all the categories. The contingency χ^2 value was significant for this character ($\chi^2 =$ 12.33, P>*).

4.1.2.2.12. Presence of basal cavity for three categories of mango trees

The basal cavity was present in most of the trees (Table 4.27) in commercial and cultivated varieties but absent in 'gutee' trees. The variation for this character among the three categories was prominent. The contingency χ^2 value was found highly significant ($\chi^2 =$ 30.21, P>***).

4.1.2.2.13. Storage quality of fruits for three categories of mango trees

The storage quality of mature fruits was divided into three groups ranged from 1-7 days, 8-14 days and 15-21 days (Table 4.28). In most of the trees among the three categories the storage quality of fruits was observed 8-14 days. There was significant difference for this character among the mango trees of three categories. The contingency χ^2 value was highly significant for this character of fruit ($\chi^2 =$65.14, P>***).

Table 4.25 Presence of sinus for three categories of mango trees

Category	Sinus		
	Present	Absent	Total
Commercial varieties	46	44	90
Cultivated varieties	23	67	90
Gutee trees	11	79	90
Total	80	190	270

Contingency $\chi^2 = 33.71$, P>***

Table 4.26 Type of apex for three categories of mango trees

Category	Apex			
	Round	Obtuse	Acute	Total
Commercial varieties	23	67	0	90
Cultivated varieties	29	57	4	90
Gutee trees	19	62	9	90
Total	71	186	13	270

Contingency $\chi^2 = 12.33$, P>*

Table 4.27 Presence of basal cavity for three categories of mango trees

Category	Basal cavity		
	Present	Absent	Total
Commercial varieties	76	14	90
Cultivated varieties	60	30	90
Gutee trees	37	49	90
Total	177	93	270

Contingency $\chi^2 = 30.21$, P>***

Table 4.28 Storage quality of fruits for three categories of mango trees

Category	Storage quality			
	1-7 days	8-14 days	15-21 days	Total
Commercial varieties	9	81	0	90
Cultivated varieties	14	69	7	90
Gutee trees	1	54	35	90
Total	24	204	42	270

Contingency $\chi^2 = 65.14$, P>***

4.1.2.3. Stone characters

The variation of different qualitative stone characters was observed. Three qualitative characters were considered- stone size, type of fiber and the type of veins on the stone. The variations of different stone characters which were observed among the three categories are described below.

4.1.2.3.1. Stone size for three categories of mango trees

The stone size was divided into three categories- small, medium and large (Table 4.29). Medium size stone was most common in cultivated varieties and 'gutee' trees whereas large size stone was most common in commercial varieties. Small size stone was least common among all categories of mango trees. The contingency χ^2 value was found highly significant for this character ($\chi^2 = 58.62$, P>***).

4.1.2.3.2. Presence of fiber on stone for three categories of mango trees

The presence of fiber on stone among the three categories of mango trees was noted (Table 4.30). In most of the trees the stone fiber was high among all the categories. The variation was observed for this character. The contingency χ^2 value was highly significant ($\chi^2 = 21.23$, P>***).

4.1.2.3.3. Veins on stone for three categories of mango trees

The veins on stone were- elevated, labeled and depressed (Table 4.31). Elevated veins on stone were most common in commercial varieties whereas labeled veins on stone were most common in cultivated varieties and 'gutee' trees. The contingency χ^2 value was highly significant for this character ($\chi^2 = 52.04$, P>***).

Table 4.29 Stone size for three categories of mango trees

Category	Stone size			
	Small	Medium	Large	Total
Commercial varieties	3	24	63	90
Cultivated varieties	15	55	20	90
Gutee trees	24	41	25	90
Total	42	120	108	270

Contingency $\chi^2 = 58.62$, P>***

Table 4.30 Presence of fiber on stone for three categories of mango trees

Category	Presence of fiber		
	High	Low	Total
Commercial varieties	75	15	90
Cultivated varieties	51	39	90
Gutee trees	48	42	90
Total	174	96	270

Contingency $\chi^2 = 21.23$, P>***

Table 4.31 Veins on stone for three categories of mango trees

Category	Veins on stone			
	Elevated	Labeled	Depressed	Total
Commercial varieties	54	5	31	90
Cultivated varieties	25	42	23	90
Gutee trees	26	46	18	90
Total	105	93	72	270

Contingency $\chi^2 = 52.04$, P>***

4.1.3. Quantitative Morphological Characters

The data on quantitative morphological characters of three categories of mango trees were scored and the results of statistical analysis are presented below.

4.1.3.1. Leaf characters

Four quantitative traits of leaf- petiole length, lamina length, lamina breadth and width of half leaf were grouped into relevant scales according to IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. The variations of these characters among three categories were recorded and are given below.

4.1.3.1.1. Petiole length for three categories of mango trees

The data on petiole length for commercial varieties, cultivated varieties and 'gutee' trees were recorded and variations obtained for this quantitative trait were evaluated for statistical analysis. The mean value, mode, standard deviation and the analysis of variance of petiole length for the three categories of mango trees were carried out.

The data on petiole length were grouped into three classes (Fig. 4.1) and the frequency curves showed that 1-3 cm was the most common range for petiole length in both the cultivated varieties and 'gutee' trees but in commercial varieties the highest pick was observed for 3-5 cm petiole length. The least common range of petiole length among the three categories was recorded 5-7 cm. .

The mean value, mode and standard deviation were carried out for the three categories of mango trees (Table 4.32). Variations were observed for the mean values among the three categories. The highest mean value was 3.25 cm found in commercial varieties. The mean values for cultivated varieties and 'gutee' trees were found similar 2.93 cm and 2.73 cm respectively. The mode values for petiole length in commercial varieties, cultivated varieties and 'gutee' trees were 3.49, 2.69 and 2.40 respectively. The highest mode was recorded for commercial varieties. The standard deviation values were 1.14, 1.1 and 0.93 for commercial varieties, cultivated varieties and 'gutee' trees respectively. There was difference in standard deviation among the categories.

Data on petiole length was evaluated for the two way analysis of variance (Table 4.33) and significant variation was found in regard to petiole length among the three categories of mango trees. F value between categories and within categories showed highly significant difference which confirmed the significant variation for this character (P>***).

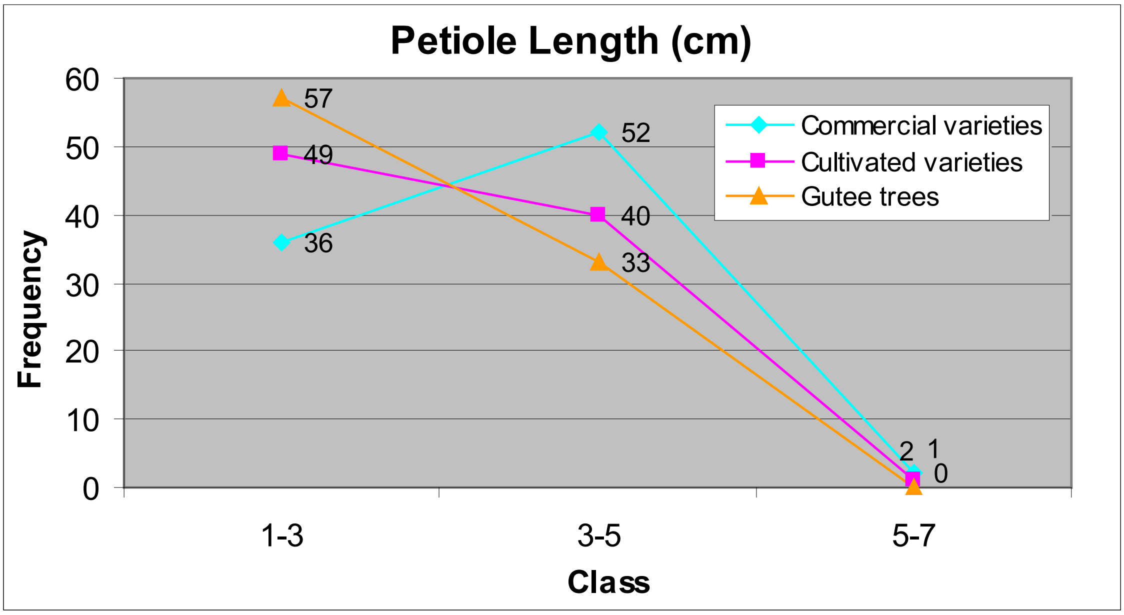

Fig. 4.1 Frequency curves of petiole length for three categories of mango trees

Table 4.32 Mean, mode and standard deviation of petiole length for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	3.25	3.49	1.14
Cultivated varieties	2.93	2.69	1.1
Gutee trees	2.73	2.40	0.93

Table 4.33 Analysis of variance of petiole length for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	6.4092	2	3.2046	9.34	***
Within categories	50.9098	89	0.572	1.67	***
Residual	61.1266	178	0.3434		
Total	118.4456	269			

4.1.3.1.2. Lamina length for three categories of mango trees

The lamina length varied from 9-29 cm and was divided into four classes. The mean value, mode, standard deviation and analysis of variance of lamina length of mango trees for three categories were analyzed for statistical assessment.

Variations were observed for lamina length among the three categories (Fig. 4.2). The most common range for lamina length in ‘gutee’ trees was 14-19 cm while 19-24 cm was the most common range for commercial and cultivated varieties. The next common range for lamina length was 14-19 cm in these two categories. The range for lamina length 9-14 cm was found in a few number of ‘gutee’ trees while this range was rare in cultivated varieties and not found in commercial varieties. The range of lamina length 24-29 cm was also not so frequent among the three categories.

The mean values of lamina lengths for commercial varieties, cultivated varieties and ‘gutee’ trees were 19.06 cm, 19.28 cm and 17.56 cm respectively. The mean for lamina length in ‘gutee’ trees was lower than the commercial and cultivated varieties. Tree to tree variations in lamina length among the three categories were observed (Table 4.34). The mode values for lamina length for commercial varieties, cultivated varieties and ‘gutee’ trees were 19.08 cm, 19.14 cm and 17.08 cm. The mode value was similar in commercial varieties and cultivated varieties. The standard deviation values of commercial varieties, cultivated varieties and ‘gutee’ trees were 2.51, 3.36 and 3.39 respectively.

The results of two way analysis of variance (Table 4.35) for between categories was very highly significant (P>***) and for within categories was also found highly significant (P>**) which indicate that the lamina length among the three categories was significantly different.

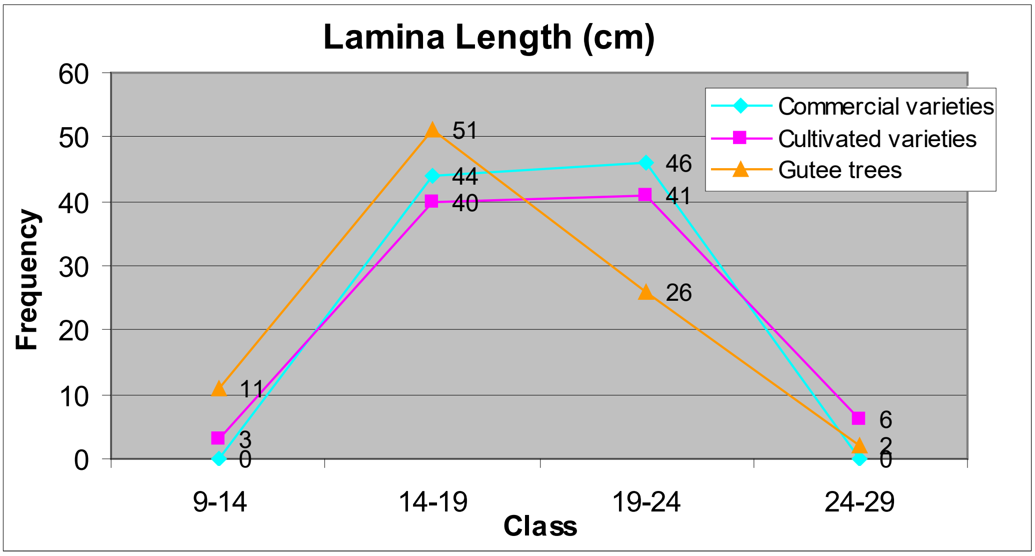

Fig. 4.2 Frequency curves of lamina length for three categories of mango trees

Table 4.34 Mean, mode and standard deviation of lamina length for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	19.06	19.08	2.51
Cultivated varieties	19.28	19.14	3.36
Gutee trees	17.56	17.08	3.39

Table 4.35 Analysis of variance of lamina length for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	178.8174	2	89.4087	14.54	***
Within categories	621.813	89	6.9866	1.14	**
Residual	1094.7751	178	6.1504		
Total	1895.4055	269			

4.1.3.1.3. Lamina breadth for three categories of mango trees

The data on lamina breadth in commercial varieties, cultivated varieties and 'gutee' trees were recorded and the mean value, mode, standard deviation, analysis of vriance were carried out to asses the tree to tree variation of this quantitative trait.

In commercial varieties, cultivated varieties and 'gutee' trees, 5-7 cm was the most common range for lamina breadth (Fig. 4.3). The least common range for lamina breadth in commercial varieties was 3-5 cm whereas in cultivated varieties and 'gutee' trees the least common range was noted 7-9 cm. The variations for this quantitative attribute were noticeable.

There was distinct difference in respect of lamina breadth among the commercial varieties, cultivated varieties and 'gutee' trees (Table 4.36). The mean value of commercial varieties was 6.4 cm while the mean values of cultivated varieties and 'gutee' trees were similar 5.47 cm and 5.16 cm respectively. The mode values of leaf breadth for commercial varieties, cultivated varieties and 'gutee' trees were 6.2, 5.71 and 5.09 respectively. The highest mode was recorded in commercial varieties. The standard deviation values for lamina breadth in commercial varieties, cultivated varieties and 'gutee' trees were recoded 1.08, 1.08 and 1.16 respectively.

The results of two way analysis of variance (Table 4.37) for between categories was found very highly significant (P>***) which confirmed the significant difference among the three categories for this character and the F value for within categories being very significant (P>**) also indicated the distinct variations within the categories for this character.

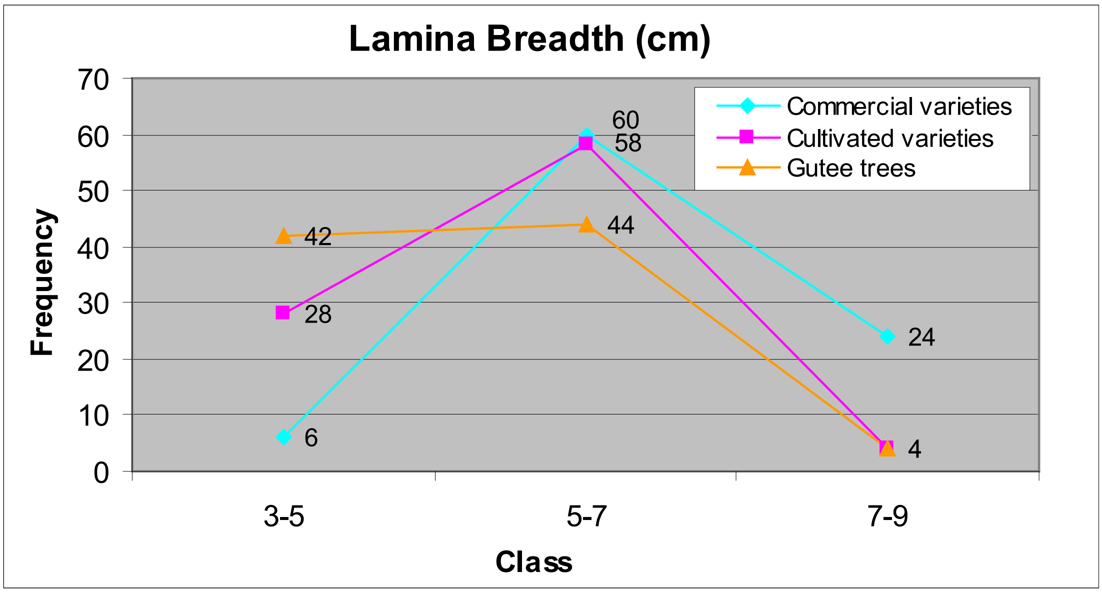

Fig. 4.3 Frequency curves of lamina breadth for three categories of mango trees

Table 4.36 Mean, mode and standard deviation of lamina breadth for three categories of mango trees

Category	Item		
	Mean	Mode	Standard deviation
Commercial varieties	6.4	6.2	1.08
Cultivated varieties	5.47	5.71	1.08
Gutee trees	5.16	5.09	1.16

Table 4.37 Analysis of variance of lamina breadth for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	55.2526	2	27.6263	36.9582	***
Within categories	90.2679	89	1.0142	1.3567	**
Residual	133.0607	178	0.7475		
Total	278.5812	269			

4.1.3.1.4. Width of half leaf for three categories of mango trees

Variations for width of half leaves in commercial varieties, cultivated varieties and 'gutee' trees were measured and recorded. The mean, mode, standard deviation and analysis of variance were carried out for statistical analysis.

The width of half leaves for the three categories of mango trees were divided into three classes (Fig. 4.4). In commercial and cultivated varieties the range of width of half leaf for the maximum number of trees was recorded to have 5-7 cm whereas in 'gutee' trees the highest number of trees was found to have 3-5 cm range for the width of half leaf.

The mean value, mode and standard deviation (Table 4.38) for width of half leaf of mango trees were evaluated. The mean values for this quantitative trait in commercial varieties, cultivated varieties and 'gutee' trees were 5.98 cm, 5.27 cm and 5.02 cm respectively. The mean was highest in commercial varieties while lowest in 'gutee' trees. The mode values regarding width of half leaf in commercial varieties, cultivated varieties and 'gutee' trees were recorded 5.99, 5.47 and 4.75 correspondingly. The standard deviation values in commercial varieties, cultivated varieties and 'gutee' trees showed a narrow range of variations which were 1.06, 1.1 and 1.14 respectively.

The analysis of variance was carried out to find out the significance of difference for this character among the three categories (Table 4.39) and F value was found highly significant for both between categories (P>***) and within categories (P>**) which proved variations present for this trait.

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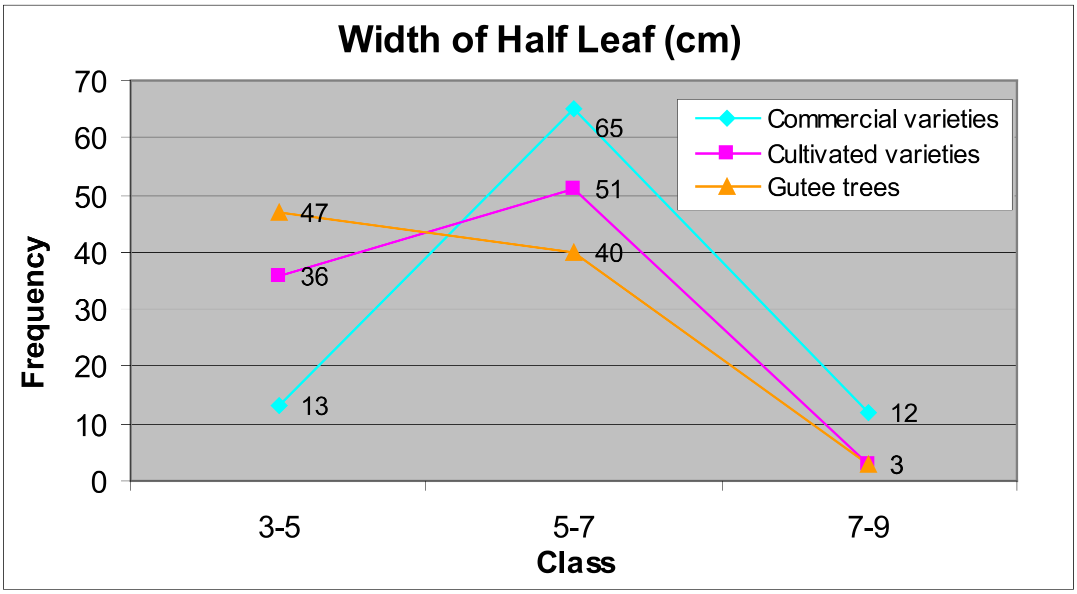


Fig. 4.4 Frequency curves of width of half leaf for three categories of mango trees

Table 4.38 Mean, mode and standard deviation of width of half leaf for three categories of mango trees

Category	Item		
	Mean	Mode	Standard deviation
Commercial varieties	5.98	5.99	1.06
Cultivated varieties	5.27	5.47	1.10
Gutee trees	5.02	4.75	1.14

Table 4.39 Analysis of variance of width of half leaf for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	44.5217	2	22.2608	30.01	***
Within categories	88.417	89	0.9934	1.34	**
Residual	132.0279	178	0.7417		
Total	264.9666	269			

4.1.4. Quantitative Reproductive Characters

The quantitative reproductive characters were recorded according to IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. The data on panicle, fruit and stone characters were assessed for further statistical analysis.

4.1.4.1. Panicle characters

Two quantitative panicle characters- panicle length and panicle breadth were scored and grouped into suitable scales and the results on variations are given below.

4.1.4.1.1. Panicle length for three categories of mango trees

The variations for panicle length among the mango trees of commercial varieties, cultivated varieties and 'gutee' trees were observed and data were calculated for mean, mode, standard deviation and analysis of variance.

Panicle length was divided into four classes (Fig. 4.5). The highest number of trees in commercial and cultivated varieties had 20-30 cm range of panicle length but in 'gutee' tress the maximum number of trees showed 10-20 cm range. Only a few number of mango trees were found to have 40-50 cm range for panicle length in commercial and cultivated varieties. However, 40-50 cm range was absent in 'gutee' trees.

The mean, mode and standard deviation for the three categories of mango trees were evaluated (Table 4.40). The mean values of panicle length showed a narrow range of variation among the three categories whereas the 'gutee' trees showed the highest mean value (24.11 cm) and the commercial varieties had the lowest mean value

(23.22 cm). The mode values for commercial and cultivated varieties were 24.11 cm and 24.07 cm which were similar but lowest mode 18.78 cm was found in ‘gutee’ trees. The standard deviation values for panicle length in commercial varieties, cultivated varieties and ‘gutee’ trees were 5.63, 6.78 and 9.08 respectively. There was a considerable difference in standard deviation for panicle length among the three categories for this quantitative trait.

The analysis of variance was carried out and the F value (Table 4.41) was found non significant for not only between categories but also for within categories which confirmed that there was no significant difference for panicle length (P= N. S.).

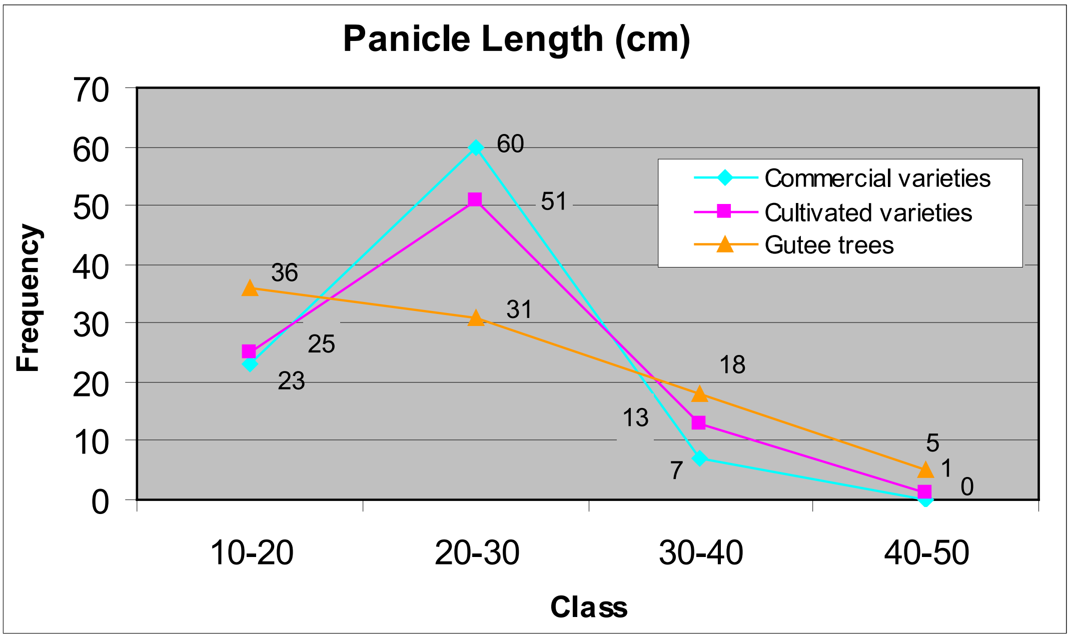


Fig. 4.5 Frequency curves of panicle length for three categories of mango trees

Table 4.40 Mean, mode and standard deviation of panicle length for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	23.22	24.11	5.63
Cultivated varieties	23.89	24.07	6.78
Gutee trees	24.11	18.78	9.08

Table 4.41 Analysis of variance of panicle length for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	69.9043	2	34.9521	0.7453	N. S.
Within categories	3671.908	89	41.2573	0.8798	N. S.
Residual	8346.8624	178	46.8924		
Total	12088.6747	269			

4.1.4.1.2. Panicle breadth for three categories of mango trees

Tree to tree variations for panicle breadth were observed. The data on panicle breadth for commercial varieties, cultivated varieties and 'gutee' trees were evaluated for mean, mode, standard deviation and analysis of variance.

Panicle breadth was grouped into six classes (Fig. 4.6). The most common range was 10-16 cm for panicle breadth in commercial and cultivated varieties followed by 4-10 cm while in 'gutee' trees the most common range for panicle breadth was found 4-10 cm followed by 10-16 cm. Only in a few mango trees in the three categories 22-28 cm, 28-34 cm and 34-40 cm ranges for panicle breadth were found

The mean values of panicle breadth in commercial varieties, cultivated varieties and 'gutee' trees (Table 4.42) were 12.73 cm, 12.6 cm and 13.4 cm respectively. The mode values for commercial varieties, cultivated varieties and 'gutee' trees were 12.75 cm, 12.46 cm and 9.24 cm respectively. The standard deviation values were 4.21, 4.39, and 6.65 respectively. The lowest mode value with highest standard deviation was found in 'gutee' trees. Distinct variation was observed for standard deviation among the categories.

The F value (Table 4.43) of between categories was found non significant (P= N. S.) while within categories was found highly significant (P>**) which indicated a distinct variation for panicle breadth within the categories.

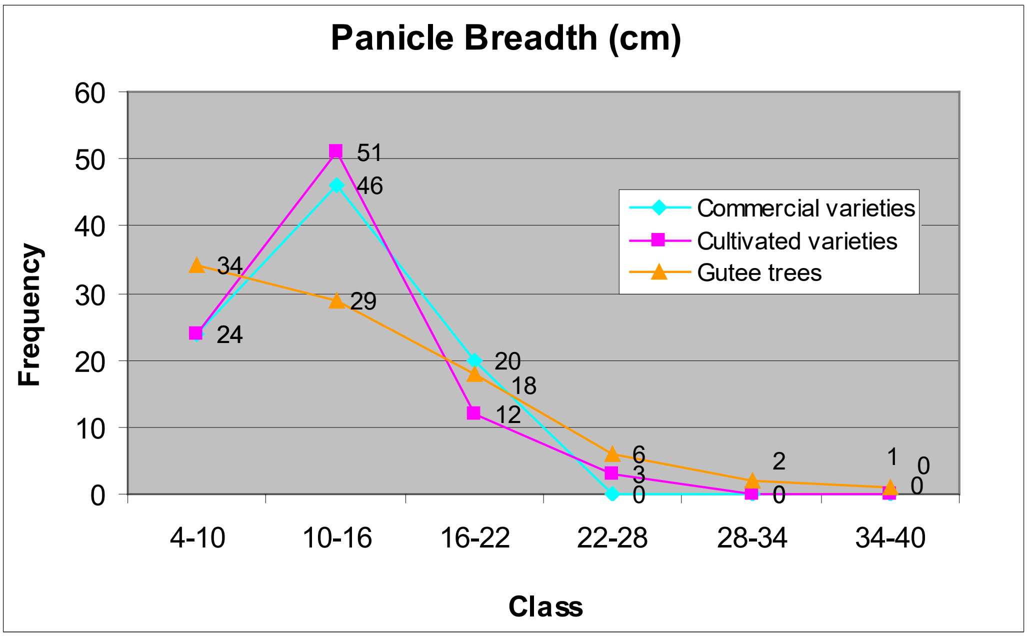


Fig. 4.6 Frequency curves of panicle breadth for three categories of mango trees

Table 4.42 Mean, mode and standard deviation of panicle breadth for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	12.73	12.75	4.21
Cultivated varieties	12.60	12.46	4.39
Gutee trees	13.40	9.24	6.65

Table 4.43 Analysis of variance of panicle breadth for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	39.4503	2	19.7251	0.7763	N. S.
Within categories	2267.4372	89	25.4768	1.0027	**
Residual	4522.2697	178	25.406		
Total	6829.1572	269			

4.1.4.2. Fruit Characters

The quantitative fruit characters were scored and were grouped into suitable scales following IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. Tree to tree variations for fruit weight, fruit length, fruit width and fruit diameter were observed and measured for the study.

4.1.4.2.1. Fruit weight for three categories of mango trees

The weight of fruit varied from tree to tree and variations observed for this quantitative trait were recorded for statistical assessments.

The fruit weight of commercial varieties, cultivated varieties and ‘gutee’ trees were divided into five classes (Fig. 4.7). The frequency curves for cultivated varieties and ‘gutee’ trees showed a shift towards medium sized fruits whereas the curve for the commercial varieties showed a shift to large and very large sized fruits. The range of fruit weight in maximum number of trees for cultivated varieties and ‘gutee’ trees was 151-300 g (medium size). In commercial varieties the most common range for fruit weight was 301- 450 g (large) and the next common range was 451-600 g (very large). In cultivated varieties and ‘gutee’ trees large sized fruits were found only in a few mango trees while in commercial varieties small sized fruits (1-150 g) were found only in a few mango trees followed by medium sized fruits.

The variations in fruit weight among the commercial varieties, cultivated varieties and ‘gutee’ trees were noticeable (Table 4.44). The mean fruit weight for ‘gutee’ trees was 195.5 g while the mean values of fruit weight for commercial and cultivated varieties were 375.5 g and 242.17 g respectively which were much higher than the 'gutee' trees. The mode values for fruit weight in commercial varieties, cultivated varieties and 'gutee' trees were 413.5 g, 220.51 gm and 197.16 g respectively. A wide range of variation was also observed for mode among the three categories. Among the three categories of mango trees the lowest standard deviation was recorded 103.53 in 'gutee' trees while the highest standard deviation was found 129.18 in commercial varieties followed by 128.08 in cultivated varieties.

The result of analysis of variance (Table 4.45) for between categories was found very highly significant (P>***) and within categories was also found highly significant (P>**) which is a sign of major variations for this trait among the three categories of mango trees.

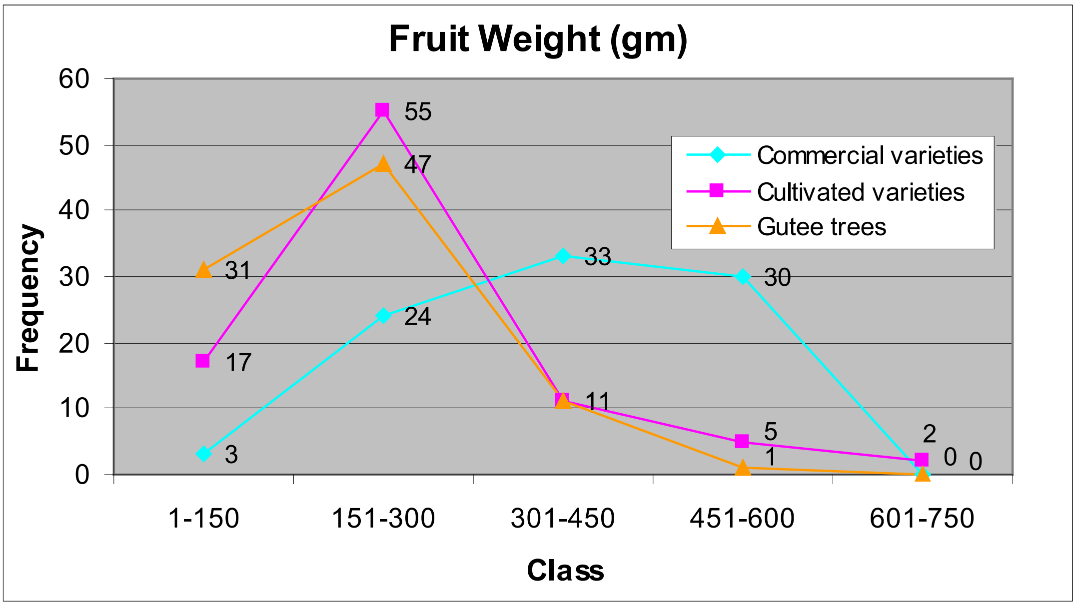


Fig. 4.7 Frequency curves of fruit weight for three categories of mango trees

Table 4.44 Mean, mode and standard deviation of fruit weight for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	375.5	413.5	129.18
Cultivated varieties	242.17	220.51	128.08
Gutee trees	195.5	197.16	103.53

Table 4.45 Analysis of variance of fruit weight for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	1775337.49	2	887668.745	76.89	***
Within categories	1122121.47	89	12608.1064	1.09	**
Residual	2055064.51	178	11545.3062		
Total	4952523.47	269			

4.1.4.2.2. Fruit length for three categories of mango trees

The data on fruit length for commercial varieties, cultivated varieties and 'gutee' trees were observed and the frequency was grouped into different classes. The mean value, mode, standard deviation and the analysis of variance of fruit length for the three categories were assessed for statistical evaluation.

The frequency was grouped into four classes (Fig. 4.8). In commercial varieties, cultivated varieties and 'gutee' trees the highest frequency for fruit length was found in 8-11 cm range. The next common range for fruit length was 5-8 cm found in cultivated varieties and 'gutee' trees while 11-14 cm was the next common range in commercial varieties. The range of fruit length 14-17 cm was found only in a few mango trees of commercial and cultivated varieties which was absent in 'gutee' trees.

The mean values of fruit length (Table 4.46) for commercial varieties, cultivated varieties and 'gutee' trees were 11.53 cm, 9.43 cm and 9.13 cm respectively. The highest mean for fruit length was found in commercial varieties but in cultivated varieties and 'gutee' trees the mean for fruit length was very similar. The highest mode for fruit length was 10.37 cm found in commercial varieties and the lowest was 9.22 cm found in 'gutee' trees. The mode for cultivated varieties was 9.25 cm which was close to 'gutee' trees. The standard deviation values for commercial varieties, cultivated varieties and 'gutee' trees were 2.45, 2.29 and 2.01 respectively. The standard deviation was highest in commercial varieties and lowest in 'gutee' trees.

The analysis of variance was carried out (Table 4.47) and the F value for between categories was recorded very highly significant (P>***) and for within categories was also recorded highly significant (P>**) which indicated there was distinct variation in fruit length for both between categories and within categories.

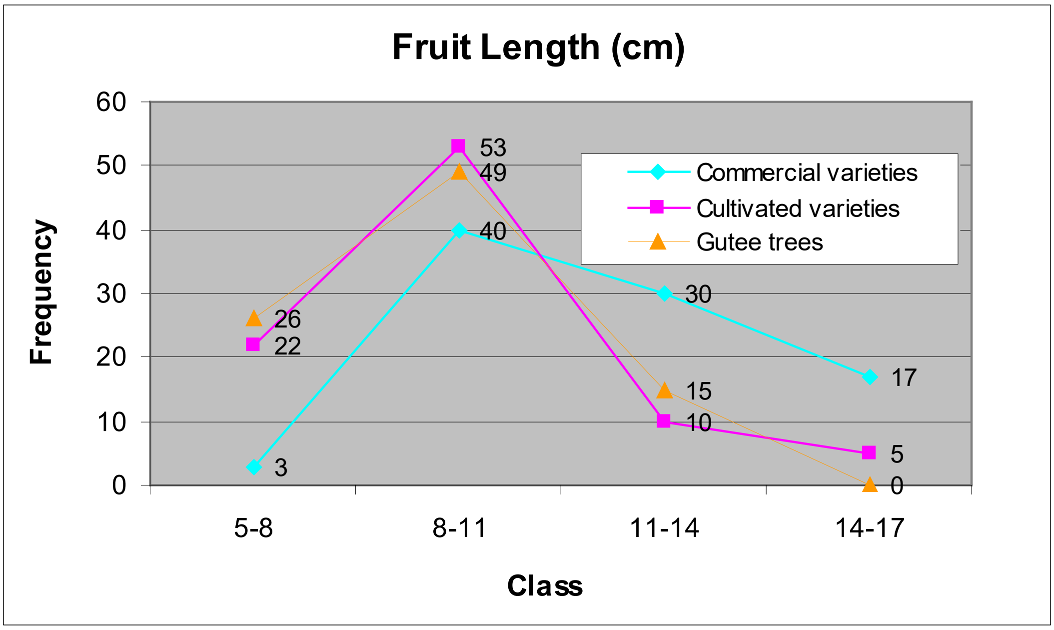


Fig. 4.8 Frequency curves of fruit length for three categories of mango trees

Table 4.46 Mean, mode and standard deviation of fruit length for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	11.53	10.37	2.45
Cultivated varieties	9.43	9.25	2.29
Gutee trees	9.13	9.22	2.01

Table 4.47 Analysis of variance of fruit length for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	296.45	2	148.225	37.43	***
Within categories	408.1356	89	4.5857	1.16	**
Residual	704.8328	178	3.9597		
Total	1409.4185	269			

4.1.4.2.3. Fruit width for three categories of mango trees

The fruit width was observed and measured for commercial varieties, cultivated varieties and ‘gutee’ trees. The variations for this character among the three categories were evaluated for the analysis of mean, mode, standard deviation and analysis of variance.

The most common range for fruit width (Fig. 4.9) was 6-8 cm in cultivated varieties and ‘gutee’ trees while in commercial varieties the range was 8-10 cm. The least common ranges in commercial varieties and ‘gutee’ trees were 4-6 cm and 8-10 cm respectively. In cultivated varieties 4-6 cm and 8-10 cm ranges for fruit width were frequently common.

A wide range of variations was observed among the three categories of mango trees for the mean values of fruit width (Table 4.48). The mean values of fruit width for commercial varieties, cultivated varieties and ‘gutee’ ‘gutee’ trees were 7.91 cm, 7.00 cm and 6.33 cm respectively. The highest mean for fruit width was found in commercial varieties and the lowest mean was found in ‘gutee’ trees. The mode values for fruit width in commercial varieties, cultivated varieties and ‘gutee’ trees were 8.26, 7.07, and 6.29 respectively. The highest mode value was found in commercial varieties whereas the lowest mode value was found in ‘gutee’ trees. The standard deviation values for commercial varieties, cultivated varieties and ‘gutee’ trees were 1.20, 1.16 and 1.28 respectively.

The analysis of variance was carried out (Table 4.49) and F values for both between categories (P>***) and within categories (P>**) were found highly significant which pointed towards the significant difference regarding this quantitative trait.

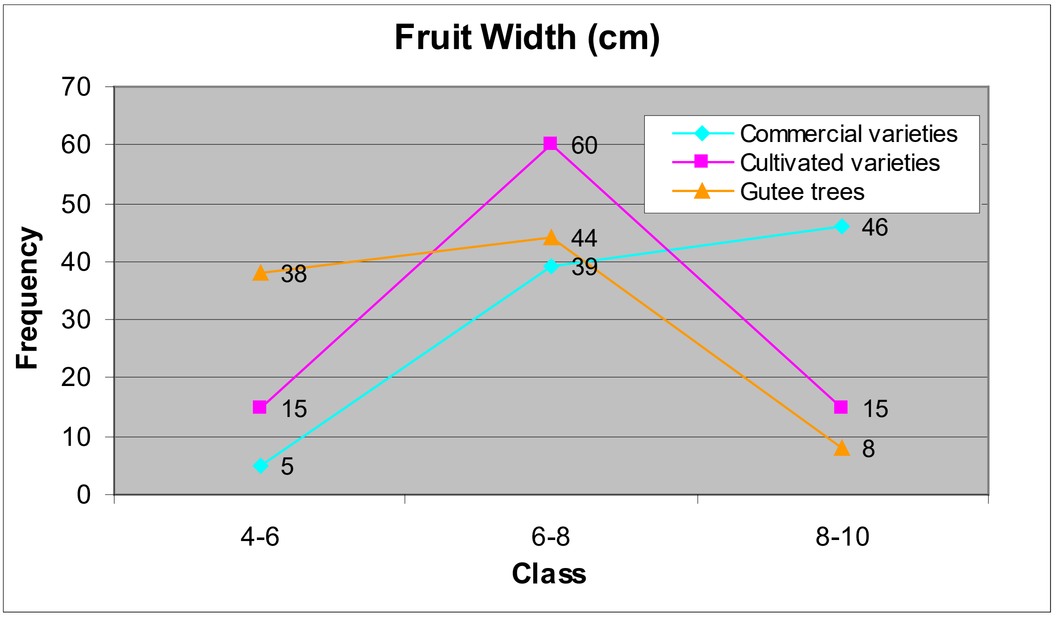


Fig. 4.9 Frequency curves of fruit width for three categories of mango trees

Table 4.48 Mean, mode and standard deviation of fruit width for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	7.91	8.26	1.20
Cultivated varieties	7.00	7.07	1.16
Gutee trees	6.33	6.29	1.28

Table 4.49 Analysis of variance of fruit width for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	127.1045	2	63.5522	61.59	***
Within categories	100.1265	89	1.125	1.09	**
Residual	183.681	178	1.0319		
Total	410.9121	269			

4.1.4.2.4. Fruit diameter for three categories of mango trees

Data on fruit diameter were recorded and the frequencies were divided into four classes. Tree to tree variations for this quantitative trait among the commercial varieties, cultivated varieties and 'gutee' trees were assessed for the calculation of mean, mode, standard deviation and the analysis of variance

In cultivated varieties and 'gutee' trees 17-21 cm fruit diameter (Fig. 4.10) was found in the highest number of trees while in commercial varieties 25-29 cm fruit diameter was found in the highest number of trees followed by 21-25 cm. Only in a few mango trees of commercial varieties 13-17 cm and 17-21 cm ranges for fruit diameter were found. The least common range for fruit diameter in cultivated varieties was 13-17 cm and in 'gutee' trees was 25-29 cm.

The variations for fruit diameter among the categories were apparent (Table 4.50). The mean value for fruit diameter was highest in commercial varieties which was recorded 24.33 cm followed by cultivated varieties which was recorded 20.91 cm. The lowest mean value was found 19.84 cm in 'gutee' trees. The mode values for fruit diameter in cultivated varieties and 'gutee' trees were 19.63 cm and 19.35 cm respectively which were similar. The highest mode was recorded 25.08 cm in commercial varieties. The standard deviation values in the commercial varieties, cultivated varieties and 'gutee' trees were recorded 2.55, 2.95 and 2.72 respectively. The highest standard deviation was recorded in cultivated varieties and the lowest standard deviation was recorded in commercial varieties.

The results of analysis of variance (Table 4.51) were very highly significant for between categories (P>***) and highly significant for within categories (P>**) which pointed out towards the significant difference for this major fruit character.

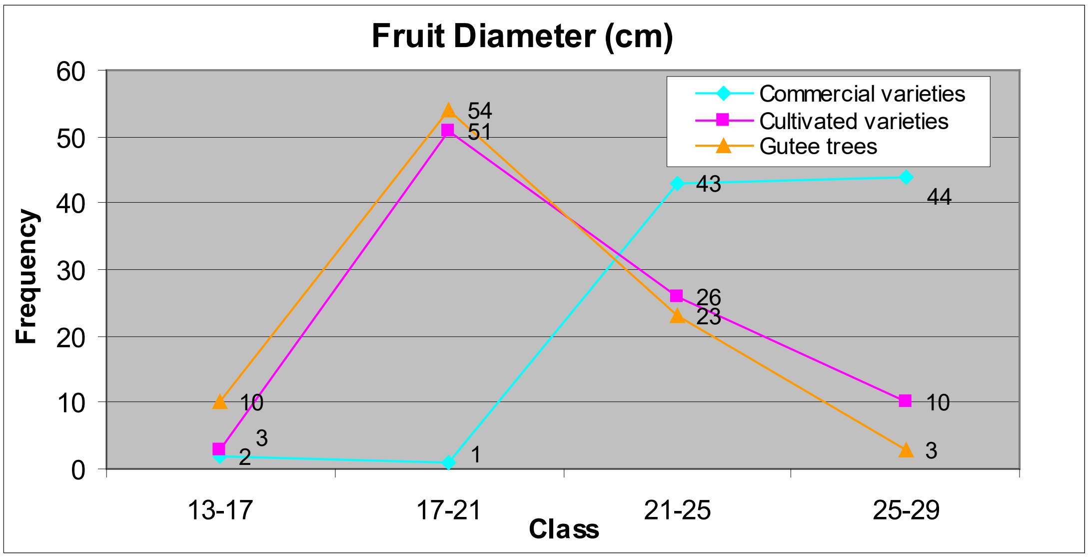


Fig. 4.10 Frequency curves of fruit diameter for three categories of mango trees

Table 4.50 Mean, mode and standard deviation of fruit diameter for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	24.33	25.08	2.55
Cultivated varieties	20.91	19.63	2.95
Gutee trees	19.84	19.35	2.72

Table 4.51 Analysis of variance of fruit diameter for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	1275.5243	2	637.7621	99.20	***
Within categories	628.9530	89	7.0668	1.1	**
Residual	1144.3155	178	6.4287		
Total	3048.7928	269			

4.1.4.3. Stone characters

Stone weight was measured and recorded for the study. The stone weight was grouped into suitable scales following the IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. The results on the variations of this character among the commercial varieties, cultivated varieties and 'gutee' trees are given below.

4.1.4.3.1. Stone weight for three categories of mango trees

The data on stone weight for commercial varieties, cultivated varieties and 'gutee' trees were recorded and the statistical analysis of mean, mode, standard deviation and analysis of variance were carried out to assume the variations for this trait.

In commercial varieties the stone weight of the highest number of trees (Fig. 4.11) was observed 41-55 cm range followed by 56-70 cm range while the stone weight of the lowest number of trees was observed 11-25 cm range. In cultivated varieties the stone weight of the highest number of trees was observed 26-40 cm range and the lowest number of trees was observed 11-25 cm range followed by 56-70 cm range. In 'gutee' trees the most common ranges for stone weight were both 11-25 cm and 26-40 cm while the least common range was 41-55 cm.

The variations for stone weight among the three categories of mango trees were evident (Table 4.52). The mean values of stone weight in commercial varieties, cultivated varieties and 'gutee' trees were 48.17 cm, 38.50 cm and 27.00 cm respectively. The mean was highest in commercial varieties and lowest in 'gutee' trees. In commercial varieties the mode value was highest 49.08 cm and was lowest 25.00 cm in 'gutee' trees. The mode for cultivated varieties was 34.38 cm. There was considerable variation for mode values of stone weight among the three categories of mango trees. The standard deviation for stone weight in commercial varieties, cultivated varieties and ‘gutee’ trees were 11.67, 12.68 and 9.66 respectively. The standard deviation was found highest in cultivated varieties and lowest in ‘gutee’ trees

The data were calculated for analysis of variance and F value (Table 4.53) for stone weight between categories was found very highly significant (P>***) and within categories was also found highly significant (P>**) for this character which was sign of considerable variations that present in this trait among the three categories of mango trees.

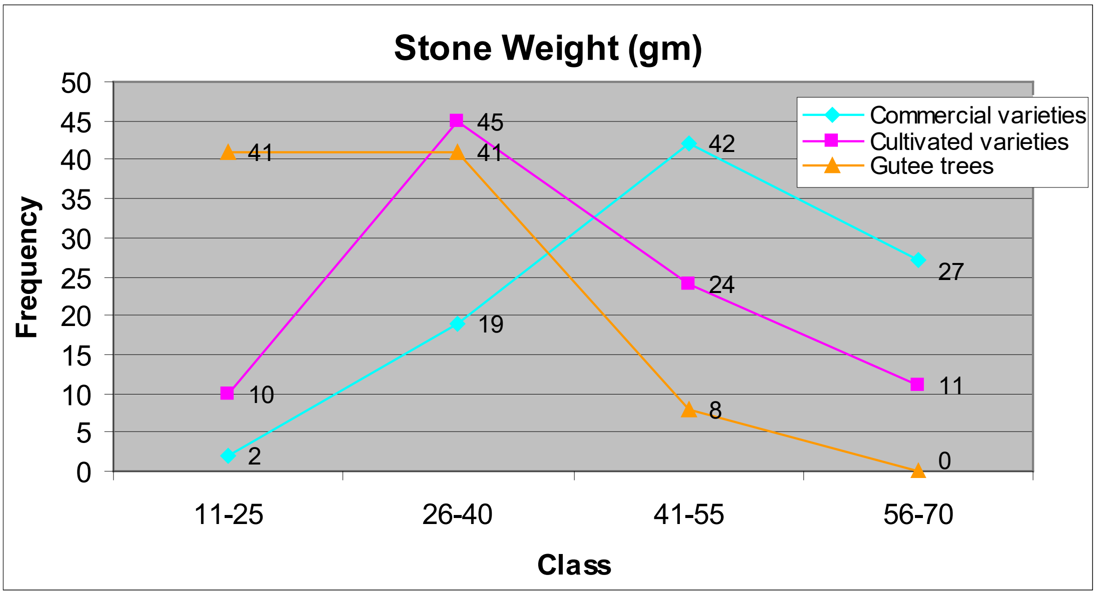


Fig. 4.11 Frequency curves of stone weight for three categories of mango trees

Table 4.52 Mean, mode and standard deviation of stone weight for three categories of mango trees

Category	Item		
	Mean	**Mode**	**Standard deviation**
Commercial varieties	48.17	49.08	11.67
Cultivated varieties	38.50	34.38	12.68
Gutee trees	27.00	25.00	9.66

Table 4.53 Analysis of variance of stone weight for three categories of mango trees

Item	SS	df	MS	F	P
Between categories	19884.1555	2	9942.0777	99.97	***
Within categories	10422.3	89	117.1044	1.18	**
Residual	17702.5112	178	99.4523		
Total	48008.9667	269			

4.2. The Pattern of Character Differentiation Among the Three Categories of Mango

The morphological and reproductive characters showed a pattern of changes in the three categories of mango. Both the qualitative and quantitative characters which were selected to asses the range of variations among the commercial varieties, cultivated varieties and 'gutee' trees are summarized on the basis of majority from chi square table (Table 4.54) and frequency curves (Table 4.55) to identify and describe the pattern of changes in the morphological variations.

The results strongly indicated a distinct pattern of morphological changes among the three categories of mango. The differences for qualitative characters between the commercial varieties with the cultivated varieties and 'gutee' trees were prominent. But the difference between the commercial varieties and cultivated varieties were much less pronounced than the difference between the commercial varieties and 'gutee' trees. Thus the character differentiation among the three categories of mango was clear and the range of variation was wide.

The pattern of changes in quantitative characters was more prominent than in qualitative characters. The commercial varieties showed better performance in respect of leaf, fruit and stone characters than the other two categories. The performance of cultivated varieties in respect of quantitative traits was intermediate-better than 'gutee' trees but not good as commercial varieties which indicated a pattern of changes in the quantitative characters from 'gutee' trees to the commercial varieties.

Table 4.54 Summery table for qualitative characters performance among the three categories of mango

Characters	Range of variations among the categories		
	Commercial varieties	**Cultivated varieties**	***Gutee* trees**
A. Tree characters			
Age of trees	Majority 40+ Yr	Majority 40+ Yr	Majority 30+ Yr
Tree shapes	No pattern	No pattern	No pattern
Type of branching	Main trunk short, branches from the base	Main trunk medium, several branches at top	Main trunk medium, several branches at top
Canopy structure	No pattern	No pattern	No pattern
Quantity of timber of the main trunk	Good-very good	Medium-very good	Medium-good
Productivity of fruits	High	Intermediate	Intermediate
Time of fruit maturity	Majority late season	Majority mid season	Majority mid season
Fruit bearing type	Mostly alternative	Mostly alternative	Mostly alternative
B. Leaf characters			
Leaf orientation	Spreading	Spreading	Spreading
Shape of leaf	Mostly oval lanceolate	Mostly oval lanceolate	Mostly oval lanceolate
Shape of leaf tip	Acute	Acuminate	Acuminate
Leaf margin	Wavy	Wavy	Wavy
C. Inflorescence character			
Inflorescence Shape	Conical	Conical	Pyramidal
Floral density	Laxly	Laxly	Laxly
Flower Color	Mostly light green with yellow slash	Mostly light green with yellow slash	Mostly light green with yellow slash
D. Fruit characters			
Fruit size	Large	Medium	Medium
Skin type	Non Glassy	Non Glassy	Non Glassy
Skin color	Green	Green followed by green with yellow slash	Green followed by green with yellow slash
Pulp color	Deep yellow followed by yellow	Deep yellow followed by light yellow	Light orange followed by deep orange
Flavor	Pleasant	Pleasant	Pleasant
Fruit texture	Mostly moderate	Moderate followed by soft	Soft
Taste	Excellent followed by good	Excellent followed by good and fair	Mostly fair followed by good
Quantity of fiber	Medium-Low	Low	Low-Medium
Type of beak	Majority pointed	Majority absent	Majority absent
Presence of sinus	Present followed by absent	Absent	Absent
Type of apex	Obtuse	Obtuse	Obtuse
Presence of basal cavity	Mostly present	Mostly present	Mostly absent
Storage quality in days	8-14 days	8-14 days	8-14 days
E. Stone characters			
Stone size	Large	Medium	Medium
Presence of fiber	High	High	High-Low
Veins on stone	Elevated	Labeled	Labeled

4.55 Summery table for pattern of differentiation in quantitative characters among the three categories of mango

Characters	Range of variations among the three categories		
	Commercial varieties	**Cultivated varieties**	***Gutee* trees**
A. Leaf characters			
Petiole length	Longer	Medium	Medium
Lamina length	Longer	Longer	Relatively short
Lamina width	Wider	Medium	Relatively low
Width of half leaf	Wider	Medium	Relatively low
B. Inflorescence characters			
Panicle length	Medium	Relatively long	Longer
Panicle width	Relatively low	Relatively low	Wider
C. Fruit characters			
Fruit weight	Greater	Medium	Low
Fruit length	Greater	Medium	Low
Fruit width	Greater	Medium	Low
Fruit Diameter	Greater	Medium	Low
D. Stone character			
Stone weight	Greater	Medium	Low

CHAPTER – V

5. RESULTS: VARIATIONS BETWEEN TWO AGE GROUPS OF MANGO TREES

The results of different qualitative and quantitative traits scored from the two age groups in three categories of mango trees (commercial varieties, cultivated varieties and 'gutee' trees) are described in this section. Two hundred seventy trees; forty five from each age group in each category of mango trees were selected and analyzed for the morphological and reproductive characters. The results regarding to different phenotypic characters are presented below.

5.1. Sampling for Phenotypic Characters

The data on both morphological and reproductive traits were included for variation study between two age groups of mango trees.

5.1.1. Qualitative Morphological Characters

The commercial, cultivated and 'gutee' trees were divided into two groups: trees under 25 years (young) and the trees above 30 years (old). The results of qualitative morphological tree and leaf characters of the two age groups are discussed below.

5.1.1.1. Tree characters

Five qualitative tree characters of young and old age groups evaluated for the study are- tree shape, branching type, timber of the main trunk, productivity and time of fruit maturity which were scored according to the scales following IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006.

5.1.1.1.1. Tree shapes for two age groups

The tree shapes for two age groups varied from symmetrical, round, irregular, very irregular and tall for the three categories of mango trees.

In commercial varieties, the symmetrical tree shape was found most common for young age group whereas round tree shape was most common for old age group followed by irregular. The least number of tree shapes was found very irregular in both age groups (Table 5.1). The variation for tree shapes between the two age groups was recorded highly significant (χ^2= 16.27, P>**).

The most common tree shape for young age group was irregular followed by symmetrical in cultivated varieties whereas the least common type of tree shape was very irregular. For the old age group in cultivated varieties the most common type tree shape was round while the minimum tall tree shape was found for this age group (Table 5.2). The contingency χ^2 value was highly significant (χ^2= 14.26, P>**).

For the young age group in 'gutee' trees the most common type tree shape was recorded irregular followed by tall while for old age group it was symmetrical followed by irregular (Table 5.3). The variation in tree shapes for the two age groups in 'gutee' trees was noticed highly significant (χ^2= 18.83, P>***).

Table 5.1 Tree shape of two age groups in commercial varieties

Age group	Tree shape					
	Symmetrical	Round	Irregular	Very irregular	Tall	Total
Young (below 25 years)	23	7	8	3	4	45
Old (above 30 years)	9	15	14	7	0	45
Total	32	22	22	10	4	90

Contingency χ^2= 16.27, P>**

Table 5.2 Tree shape of two age groups in cultivated varieties

Age group	Tree shape					
	Symmetrical	Round	Irregular	Very irregular	Tall	Total
Young (below 25 years)	16	4	20	1	4	45
Old (above 30 years)	11	14	11	7	2	45
Total	27	18	31	8	6	90

Contingency χ^2= 14.26, P>**

Table 5.3 Tree shape of two age groups in *gutee* trees

Age group	Tree shape					
	Symmetrical	Round	Irregular	Very irregular	Tall	Total
Young (below 25 years)	8	8	16	0	13	45
Old (above 30 years)	18	7	13	5	2	45
Total	26	15	29	5	15	90

Contingency χ^2= 18.83, P>***

5.1.1.1.2. Type of branching for two age groups

The branching types of the trees were divided into three categories. In commercial varieties the branching type of maximum trees for young age group was recorded slender main trunk having few branches at top while the trees for the old age group had short main trunk with branches from the base. The fewest trees of young age group had short main trunk with branches from the base but for the old age group the least trees had slender main trunk with few branches at top. Variation between the two age groups for this character (Table 5.4) was highly significant (χ^2=52.13, P>***).

In cultivated varieties the most common branching type for young and old age group was noted medium main trunk with several branches at top. The least trees of young age group had short main trunk with branches from the base whereas the fewer trees of old age group had slender main trunk with few branches at top. The variation for this character between the two age groups was significant (Table 5.5; Contingency χ^2= 10.57, P>**).

The more trees of young age group in 'gutee' trees had slender main trunk with few branches at top while in old age group the more trees had medium main trunk with several branches at top. Tree to tree variation for this character was noticeable (Table 5.6; Contingency χ^2= 21.88, P>***).

Table 5.4 Branching type of two age groups in commercial varieties

Age group	Branching type			
	Main trunk slender, few branches at top	Main trunk medium, several branches at top	Main trunk short, branches from the base	Total
Young (below 25 years)	33	8	4	45
Old (above 30 years)	1	13	31	45
Total	34	21	35	90

Contingency $\chi^2 = 52.13$, P>***

Table 5.5 Branching type of two age groups in cultivated varieties

Age group	Branching type			
	Main trunk slender, few branches at top	Main trunk medium, several branches at top	Main trunk short, branches from the base	Total
Young (below 25 years)	13	28	4	45
Old (above 30 years)	8	20	17	45
Total	21	48	21	90

Contingency $\chi^2 = 10.57$, P>**

Table 5.6 Branching type of two age groups in *gutee* trees

Age group	Branching type			
	Main trunk slender, few branches at top	Main trunk medium, several branches at top	Main trunk short, branches from the base	Total
Young (below 25 years)	23	16	6	45
Old (above 30 years)	3	33	9	45
Total	26	49	15	90

Contingency $\chi^2 = 21.88$, P>***

5.1.1.1.3. Timber of the main trunk for two age groups

Timber of the main trunk was five types- very poor, poor, medium, good and very good. In commercial varieties the more trees of young age group had poor to medium quantity of timber of the main trunk while the old age group had very good quantity of timber of the main trunk. Considerable variation was observed between the two age groups for this character (Table 5.7; contingency $\chi^2 = 44.30$, P>***).

In cultivated varieties more trees of young age group had medium quantity of timber of the main trunk whereas the old age group had very good quantity of timber of the main trunk in more trees. For young age group fewer trees had good timber of the main trunk while for the old age group fewer trees had poor timber. Significant variation was observed between two age groups for the quantity of timber of the main trunk (Table 5.8; Contingency $\chi^2 = 21.01$, P>***).

In 'gutee' more trees had medium quantity of timber of the main trunk for young age group while for the old age group the highest number of trees had very good quantity of timber of the main trunk. The variation for this character was highly significant (Table 5.9; contingency $\chi^2 = 30.34$, P>***).

Table 5.7 Timber of the main trunk of two age groups in commercial varieties

Age group	Timber of the main trunk					
	Very poor	Poor	Medium	Good	Very good	Total
Young (below 25 years)	11	14	15	4	1	45
Old (above 30 years)	0	1	11	16	17	45
Total	11	15	26	20	18	90

Contingency $\chi^2 = 44.30$, P>***

Table 5.8 Timber of the main trunk of two age groups in cultivated varieties

Age group	Timber of the main trunk					
	Very poor	Poor	Medium	Good	Very good	Total
Young (below 25 years)	3	8	25	5	4	45
Old (above 30 years)	2	2	11	12	18	45
Total	5	10	36	17	22	90

Contingency $\chi^2 = 21.01$, P>***

Table 5.9 Timber of the main trunk of two age groups in *gutee* trees

Age group	Timber of the main trunk					
	Very poor	Poor	Medium	Good	Very good	Total
Young (below 25 years)	6	10	21	5	3	45
Old (above 30 years)	0	0	15	13	17	45
Total	6	10	36	18	20	90

Contingency $\chi^2 = 30.34$, P>***

5.1.1.1.4. Productivity of fruits for two age groups

The fruit production of trees of the two age groups was of three types-low, intermediate and high. In commercial varieties intermediate productivity of fruits was found in most of trees for the young age group while high productivity followed by intermediate productivity was found in the maximum number of trees for the old age group. The variation for this character between the two age groups was noticeable (Table 5.10; contingency $\chi^2 = 22.62$, P>***).

The productivity in cultivated varieties for the young age group was high in most of the trees but for the old age group intermediate production was observed in maximum trees. There was significant variation between the two age groups in respect of fruit production (Table 5.11; contingency $\chi^2 = 6.07$, P>*).

In 'gutee' type the maximum trees had intermediate production for both young and old age groups, distinct variation was observed for this character between the two age groups (Table 5.12; contingency $\chi^2 = 7.59$, P>**).

Table 5.10 Productivity of two age groups in commercial varieties

Age group	Productivity			
	Low	Intermediate	High	Total
Young (below 25 years)	8	34	3	45
Old (above 30 years)	2	20	23	45
Total	10	54	26	90

Contingency $\chi^2 = 22.62$, P>***

Table 5.11 Productivity of two age groups in cultivated varieties

Age group	Productivity			
	Low	Intermediate	High	Total
Young (below 25 years)	12	14	19	45
Old (above 30 years)	10	25	10	45
Total	22	39	29	90

Contingency $\chi^2 = 6.07$, P>*

Table 5.12 Productivity of two age groups in *gutee* trees

Age group	Productivity			
	Low	Intermediate	High	Total
Young (below 25 years)	8	26	11	45
Old (above 30 years)	1	25	19	45
Total	9	51	30	90

Contingency $\chi^2 = 7.59$, P>**

4.1.1.1.5. Time of fruit maturity for two age groups

Time of fruit maturity was of three types- early season, mid season and late season. In commercial varieties the time of fruit maturity of maximum trees was mid season for young age group and late season for old age group. A distinct variation was observed in respect of time of fruit maturity between the two age groups (Table 5.13; contingency $\chi^2 = 7.0$, P>*).

In cultivated varieties the time of fruit maturity of maximum trees for young age group was late season followed by mid season whereas for the old age group the time of fruit maturity of maximum trees was mid season. There was significant variation for this character between the two age groups (Table 5.14; contingency $\chi^2 = 9.44$, P>**).

In 'gutee' trees the time of fruit maturity of the most of trees was mid season for both young and old age groups. Variation for this character between the two age groups was distinct (Table 5.15; contingency $\chi^2 = 6.54$, P> *).

Table 5.13 Time of fruit maturity of two age groups in commercial varieties

Age group	Time of fruit maturity			
	Early season	Mid season	Late season	Total
Young (below 25 years)	3	24	18	45
Old (above 30 years)	3	12	30	45
Total	6	36	48	90

Contingency $\chi^2 =$ 7.0, P>*

Table 5.14 Time of fruit maturity of two age groups in cultivated varieties

Age group	Time of fruit maturity			
	Early season	Mid season	Late season	Total
Young (below 25 years)	3	20	22	45
Old (above 30 years)	11	24	10	45
Total	14	44	32	90

Contingency $\chi^2 =$ 9.44, P>**

Table 5.15 Time of fruit maturity of two age groups in *gutee* trees

Age group	Time of fruit maturity			
	Early season	Mid season	Late season	Total
Young (below 25 years)	4	41	0	45
Old (above 30 years)	5	35	5	45
Total	9	76	5	90

Contingency $\chi^2 =$ 6.54, P>*

5.1.1.2. Leaf characters

The qualitative leaf characters evaluated for the study were leaf orientation, shape of leaf and leaf margin. The variations of different leaf characters between the two age groups were scored and grouped into suitable scales following IBPGR Descriptor 1989 and IPGRI Descriptor 2006.

5.1.1.2.1. Leaf orientation for two age groups

The leaf orientation was of two types- erect (angle with midrib 0-45°) and spreading (angle with midrib 50-90°). For young age group in commercial varieties spreading leaf orientation was more common but for the old age group erect leaf orientation was more common. Distinct variations were recorded for this character between the two age groups (Table 5.16; contingency $\chi^2 = 8.53$, P>**).

In cultivated varieties spreading leaf orientation was more common for the young age group while erect leaf orientation was more common for the old age group. Significant variations were observed (Table 5.17), contingency χ^2 value was found significant ($\chi^2 = 6.42$, P>*).

Spreading leaf orientation was more common for both young and old age groups in 'gutee' trees (Table 5.18). The contingency χ^2 value was significant ($\chi^2 = 5.0$, P>*).

Table 5.16 Leaf orientation of two age groups in commercial varieties

Age group	Leaf orientation		
	Erect	Spreading	Total
Young (below 25 years)	16	29	45
Old (above 30 years)	30	15	45
Total	46	44	90

Contingency $\chi^2 = 8.53$, P>**

Table 5.17 Leaf orientation of two age groups in cultivated varieties

Age group	Leaf orientation		
	Erect	Spreading	Total
Young (below 25 years)	15	30	45
Old (above 30 years)	27	18	45
Total	42	48	90

Contingency $\chi^2 = 6.42$, P>*

Table 5.18 Leaf orientation of two age groups in *gutee* trees

Age group	Leaf orientation		
	Erect	Spreading	Total
Young (below 25 years)	10	35	45
Old (above 30 years)	20	25	45
Total	30	60	90

Contingency $\chi^2 = 5.0$, P>*

5.1.1.2.2. Shape of leaf for two age groups

On the basis of shape leaves were divided into three types- elliptic lanceolate, ovate lanceolate and oval lanceolate. In commercial varieties the most common leaf shape for the two age groups was oval lanceolate whereas the least common leaf shape was elliptic lanceolate. Tree to tree variations for this character between the two age groups was significant (Table 5.19; contingency $\chi^2 = 10.0$, P>**).

The maximum trees of young age group in cultivated varieties had elliptic lanceolate leaf shape while the maximum trees of old age group had oval lanceolate leaf shape (Table 5.20). The least number of trees was recorded to have ovate lanceolate leaf shape for both young and old age groups. The contingency χ^2 value was highly significant ($\chi^2 = 9.25$, P>**).

In both the young and old age groups in 'gutee' trees oval lanceolate leaf shape was observed in the maximum trees. The least number of trees was observed to have elliptic lanceolate leaf shape for both the young and old age groups (Table 5.21); the contingency χ^2 value was significant ($\chi^2 = 8.46$, P>*).

Table 5.19 Shape of leaf of two age groups in commercial varieties

Age group	Shape of leaf			
	Elliptic lanceolate	Ovate lanceolate	Oval lanceolate	Total
Young (below 25 years)	5	7	33	45
Old (above 30 years)	12	15	18	45
Total	17	22	51	90

Contingency $\chi^2 = 10.0$, P>**

Table 5.20 Shape of leaf of two age groups in cultivated varieties

Age group	Shape of leaf			
	Elliptic lanceolate	Ovate lanceolate	Oval lanceolate	Total
Young (below 25 years)	18	12	15	45
Old (above 30 years)	19	2	24	45
Total	37	14	39	90

Contingency $\chi^2 = 9.25$, P>**

Table 5.21 Shape of leaf of two age groups in *gutee* trees

Age group	Shape of leaf			
	Elliptic lanceolate	Ovate lanceolate	Oval lanceolate	Total
Young (below 25 years)	3	10	32	45
Old (above 30 years)	10	16	19	45
Total	13	26	51	90

Contingency $\chi^2 = 8.46$, P>*

5.1.1.2.3. Leaf margin for two age groups

The type of leaf margin of the mango trees was divided into three categories- wavy, flat and crinkled. Maximum trees in commercial varieties were found having wavy leaf margin for both young and old age groups. The variations for this character between the two age groups were significant (Table 5.22; contingency $\chi^2 = 8.30$, P>*).

In cultivated varieties the most common leaf margin was observed wavy for both young and old age groups whereas the least common leaf margin was crinkled (Table 5.23). The contingency χ^2 value was significant ($\chi^2 = 6.86$, P>*).

Also, for both young and old age groups in 'gutee' type maximum trees were found to have wavy leaf margin and crinkled leaf margin was found in the least number of trees (Table 5.24). The contingency χ^2 value was significant ($\chi^2 = 7.37$, P>*).

Table 5.22 Leaf margin of two age groups in commercial varieties

Age group	Leaf margin			
	Wavy	Flat	Crinkled	Total
Young (below 25 years)	38	6	1	45
Old (above 30 years)	27	10	8	45
Total	65	16	9	90

Contingency $\chi^2 = 8.3$, P>*

Table 5.23 Leaf margin of two age groups in cultivated varieties

Age group	Leaf margin			
	Wavy	Flat	Crinkled	Total
Young (below 25 years)	28	10	7	45
Old (above 30 years)	26	18	1	45
Total	54	28	8	90

Contingency $\chi^2 = 6.86$, P>*

Table 5.24 Leaf margin of two age groups in *gutee* trees

Age group	Leaf margin			
	Wavy	Flat	Crinkled	Total
Young (below 25 years)	24	20	1	45
Old (above 30 years)	29	10	6	45
Total	53	27	7	90

Contingency $\chi^2 = 7.37$, P>*

5.1.2. Qualitative Reproductive Characters

Following different qualitative reproductive traits of inflorescence and fruit were evaluated for the young and old age groups.

5.1.2.1. Inflorescence characters

Inflorescence shape, floral density and flower color were noted, analyzed and discussed below.

5.1.2.1.1. Inflorescence shape for two age groups

The inflorescence shape was categorized into conical, pyramidal and broadly pyramidal. The most common inflorescence shape in commercial varieties was broadly pyramidal for young age group and pyramidal for old age group (Table 5.25), the contingency χ^2 value was found significant ($\chi^2 = 8.49$, P>*).

In cultivated varieties the most common inflorescence shape was conical for the young age group and for the old age group the most common inflorescence shape was both conical and broadly pyramidal (Table 5.26), the contingency χ^2 value for this character was significant ($\chi^2 = 8.02$, P>*).

The pyramidal inflorescence shape for both young and old age group in 'gutee' trees was most common. Broadly pyramidal inflorescence shape was least common for young age group but conical inflorescence shape was least common for old age group (Table 5.27), the contingency χ^2 value was observed significant ($\chi^2 = 6.23$, P>*).

Table 5.25 Inflorescence shape of two age groups in commercial varieties

Age group	Inflorescence shape			
	Conical	Pyramidal	Broadly pyramidal	Total
Young (below 25 years)	12	10	23	45
Old (above 30 years)	16	19	10	45
Total	28	29	33	90

Contingency $\chi^2 = 8.49$, P>*

Table 5.26 Inflorescence shape of two age groups in cultivated varieties

Age group	Inflorescence shape			
	Conical	Pyramidal	Broadly pyramidal	Total
Young (below 25 years)	25	10	10	45
Old (above 30 years)	21	3	21	45
Total	46	13	31	90

Contingency $\chi^2 = 8.02$, P>*

Table 5.27 Inflorescence shape of two age groups in *gutee* trees

Age group	Inflorescence shape			
	Conical	Pyramidal	Broadly pyramidal	Total
Young (below 25 years)	14	21	10	45
Old (above 30 years)	7	20	18	45
Total	21	41	28	90

Contingency $\chi^2 = 6.23$, P>*

5.1.2.1.2. Floral density for two age groups

The floral density was noticed two types- densely and laxly, the latter was more common for both young and old age groups in commercial varieties (Table 5.28), the contingency χ^2 value was found significant (χ^2=6.15, P>*). Also, in cultivated varieties laxly type was more common for both young and old age groups (Table 5.29), contingency χ^2 value was found significant (χ^2= 4.12, P>*).

Laxly density of flowers was more common for the young age group whereas densely type was more common for the old age group for the ‘gutee’ type (Table 5.30), the contingency χ^2 value was observed significant (χ^2= 6.56, P>*).

5.1.2.1.3. Flower color for two age groups

The colors of flowers were light green with yellow slash, cream with yellow slash and light green with radish slash. In commercial varieties the most common flower color was cream with yellow slash for the young age group while light green with yellow slash was the most common flower color for the old age group (Table 5.31), the contingency χ^2 value was significant (χ^2= 8.0, P>*).

Light green with yellow slash color of flower was most common for the young age group and cream with yellow slash color of flowers was most common for the old age group in cultivated varieties (Table 5.32); the contingency χ^2 value was found significant (χ^2= 7.0, P>*).

The most common flower color for both young and old age groups was light green with yellow slash in ‘gutee’ trees whereas the least common flower color was light green with radish slash (Table 5.33); the contingency χ^2 was significant (χ^2=6.75, P>*).

Table 5.28 Floral density of two age groups in commercial varieties

Age group	Floral density		
	Densely	Laxly	Total
Young (below 25 years)	20	25	45
Old (above 30 years)	9	36	45
Total	29	61	90

Contingency $\chi^2 = 6.15$, P>*

Table 5.29 Floral density of two age groups in cultivated varieties

Age group	Floral density		
	Densely	Laxly	Total
Young (below 25 years)	10	35	45
Old (above 30 years)	19	26	45
Total	29	61	90

Contingency $\chi^2 = 4.12$, P>*

Table 5.30 Floral density of two age groups in *gutee* trees

Age group	Floral density		
	Densely	Laxly	Total
Young (below 25 years)	13	32	45
Old (above 30 years)	25	20	45
Total	38	52	90

Contingency $\chi^2 = 6.56$, P>*

Table 5.31 Flower color of two age groups in commercial varieties

Age group	Flower color			
	Light green with yellow slash	Cream with yellow slash	Light green with radish slash	Total
Young (below 25 years)	13	32	0	45
Old (above 30 years)	22	20	3	45
Total	35	52	3	90

Contingency $\chi^2 = 8.0$, P>*

Table 5.32 Flower color of two age groups in cultivated varieties

Age group	Flower color			
	Light green with yellow slash	Cream with yellow slash	Light green with radish slash	Total
Young (below 25 years)	26	18	1	45
Old (above 30 years)	18	20	7	45
Total	44	38	8	90

Contingency $\chi^2 = 7.0$, P>*

Table 5.33 Flower color of two age groups in *gutee* trees

Age group	Flower color			
	Light green with yellow slash	Cream with yellow slash	Light green with radish slash	Total
Young (below 25 years)	21	18	6	45
Old (above 30 years)	27	18	0	45
Total	48	36	6	90

Contingency $\chi^2 = 6.75$, P>*

5.1.2.2. Fruit characters

Variations of fruit characters were grouped into suitable scales following IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. The qualitative fruit characters studied were fruit size, skin color, pulp color, texture, taste and storage quality in days.

5.1.2.2.1. Fruit size for two age groups

Fruit size was divided into three categories on the basis of their weight- small (below150 g), medium (151-300 g) and large (more than 300 g). In commercial varieties the highest number of trees was found to have medium sized fruits for the young age group followed by large size while for the old age group maximum trees was observed to have large size fruits (Table 5.34); the contingency χ^2 value was significant (χ^2= 10.33, P>**).

Medium fruit size was noted in the maximum number of trees for the young and old age groups in cultivated varieties (Table 5.35); the contingency χ^2 was significant (χ^2= 7.15, P>*). Also, the most common fruit size for the young and old age groups in 'gutee' trees was medium whereas the least common was large (Table 5.36). The contingency χ^2 was significant (χ^2= 6.56, P>*).

Table 5.34 Fruit size of two age groups in commercial varieties

Age group	Fruit size			
	Small	Medium	Large	Total
Young (below 25 years)	1	26	18	45
Old (above 30 years)	2	11	32	45
Total	3	37	50	90

Contingency $\chi^2 = 10.33$, P>**

Table 5.35 Fruit size of two age groups in cultivated varieties

Age group	Fruit size			
	Small	Medium	Large	Total
Young (below 25 years)	10	20	15	45
Old (above 30 years)	7	32	6	45
Total	17	52	21	90

Contingency $\chi^2 = 7.15$, P>*

Table 5.36 Fruit size of two age groups in *gutee* trees

Age group	Fruit size			
	Small	Medium	Large	Total
Young (below 25 years)	19	24	2	45
Old (above 30 years)	10	27	8	45
Total	29	51	10	90

Contingency $\chi^2 = 6.56$, P>*

5.1.2.2.2. Skin color of ripe fruits for two age groups

The skin color of ripe fruits was found to vary from tree to tree at ripening stage- green, green with yellow slash, green with orange slash, yellow and yellow with radish slash. Immense variation in skin color of ripe fruits was observed which can be utilized for color selection to attract the consumers.

In commercial varieties green skin color of ripe fruits was recorded as the most common color for both young and old age group (Table 5.37); the contingency χ^2 value was highly significant ($\chi^2 = 17.73$, P>**).

For young age group green with yellow slash skin color was found as the most common color but for the old age group green skin color was the most common color in cultivated varieties (Table 5.38). The contingency χ^2 value was found significant ($\chi^2 = 10.07$, P>*).

In 'gutee' trees the most common skin color of ripe fruits for the young age group was green with yellow slash followed by green color and for the old age group the most common skin color of ripe fruits was green (Table 5.39); the contingency χ^2 value was significant ($\chi^2 = 12.50$, P>*).

Table 5.37 Skin color of ripe mango fruits of two age groups in commercial varieties

Age group	Skin color					
	Green	Green with yellow slash	Green with orange slash	Yellow	Yellow with radish slash	Total
Young (below 25 years)	25	7	11	0	2	45
Old (above 30 years)	33	10	0	2	0	45
Total	58	17	11	2	2	90

Contingency $\chi^2 = 17.73$, P>**

Table 5.38 Skin color of ripe mango fruits of two age groups in cultivated varieties

Age group	Skin color					
	Green	Green with yellow slash	Green with orange slash	Yellow	Yellow with radish slash	Total
Young (below 25 years)	16	22	0	4	3	45
Old (above 30 years)	22	13	3	7	0	45
Total	38	35	3	11	3	90

Contingency $\chi^2 = 10.07$, P>*

Table 5.39 Skin color of ripe mango fruits of two age groups in *gutee* trees

Age group	Skin color					
	Green	Green with yellow slash	Green with orange slash	Yellow	Yellow with radish slash	Total
Young (below 25 years)	20	22	0	2	1	45
Old (above 30 years)	32	8	2	3	0	45
Total	52	30	2	5	1	90

Contingency $\chi^2 = 12.50$, P>*

5.1.2.2.3. Pulp color of ripe fruits for two age groups

The color of fruit pulp at ripening stage was either light yellow, yellow, deep yellow, light orange or deep orange. In commercial varieties deep yellow and deep orange colors of pulp was observed in the highest number of trees for the young age group whereas deep yellow pulp color of fruits was found in the highest number of trees for the old age group (Table 5.40); the contingency χ^2 value was found highly significant ($\chi^2 = 17.04$, P>**).

Most common pulp color of fruits at ripening stage for the young age group was light yellow and deep yellow in cultivated varieties while for the old age group the most common pulp color of fruits was deep orange (Table 5.41). The least number of trees were observed to have deep orange pulp color for the young age group whereas for the old age group the least number of trees were observed to have yellow pulp color of fruits. Significant variations in respect of pulp color at ripening stage were observed for the age groups. The contingency χ^2 value for this character was highly significant ($\chi^2 = 18.88$, P>***).

In 'gutee' trees light orange pulp color of mature fruits was found most common for the young age group whereas for the old age group yellow, light orange and deep orange pulp were frequently observed (Table 5.42). The contingency χ^2 value was found significant ($\chi^2 = 10.35$, P>*).

Table 5.40 Pulp color of ripe mango fruits of two age groups in commercial varieties

Age group	Pulp color					
	Light yellow	Yellow	Deep yellow	Light orange	Deep orange	Total
Young (below 25 years)	4	12	13	3	13	45
Old (above 30 years)	9	13	21	2	0	45
Total	13	25	34	5	13	90

Contingency $\chi^2 = 17.04$, P>**

Table 5.41 Pulp color of ripe mango fruits of two age groups in cultivated varieties

Age group	Pulp color					
	Light yellow	Yellow	Deep yellow	Light orange	Deep orange	Total
Young (below 25 years)	17	0	17	9	2	45
Old (above 30 years)	11	2	12	4	16	45
Total	28	2	29	13	18	90

Contingency $\chi^2 = 18.88$, P>***

Table 5.42 Pulp color of ripe mango fruits of two age groups in *gutee* trees

Age group	Pulp color					
	Light yellow	Yellow	Deep yellow	Light orange	Deep orange	Total
Young (below 25 years)	8	1	10	14	12	45
Old (above 30 years)	5	11	7	11	11	45
Total	13	12	17	25	23	90

Contingency $\chi^2 = 10.35$, P>*

5.1.2.2.4. Texture of ripe fruits for two age groups

Three texture types of ripe fruits were recorded - soft, moderate and firm for the two age groups. In commercial varieties the texture of fruits of maximum young trees was soft but for the old age group the texture of maximum trees was found moderate (Table 5.43); the contingency χ^2 value was significant ($\chi^2_{=}$ 7.68, P>*).

In cultivated varieties the texture of fruits of maximum trees for the young age group was moderate while the texture of fruits of old age group was soft (Table 5.44); the contingency χ^2 value was significant ($\chi^2_{=}$ 7.39, P>*).

In 'gutee' trees the highest number of trees had fruits with soft texture for the young and the old age groups (Table 5.45). The contingency χ^2 value was noted significant ($\chi^2_{=}$ 6.52, P>*).

Table 5.43 Texture of ripe mango of two age groups in commercial varieties

Age group	Texture			
	Soft	Moderate	Firm	Total
Young (below 25 years)	26	19	0	45
Old (above 30 years)	14	29	2	45
Total	40	48	2	90

Contingency $\chi^2 = 7.68$, P>*

Table 5.44 Texture of ripe mango of two age groups in cultivated varieties

Age group	Texture			
	Soft	Moderate	Firm	Total
Young (below 25 years)	15	23	7	45
Old (above 30 years)	25	19	1	45
Total	40	42	8	90

Contingency $\chi^2 = 7.39$, P>*

Table 5.45 Texture of ripe mango of two age groups in *gutee* trees

Age group	Texture			
	Soft	Moderate	Firm	Total
Young (below 25 years)	29	15	1	45
Old (above 30 years)	27	10	8	45
Total	56	25	9	90

Contingency $\chi^2 = 6.52$, P>*

5.1.2.2.5. Taste of ripe fruits for two age groups

Taste of ripe fruits was excellent, good, fair, sour and sour and sweet. In commercial varieties the taste of fruits at ripening stage was excellent in maximum trees for both young and old age groups (Table 5.46). Variation between the two age groups for this character was significant and the contingency χ^2 value was significant (χ^2= 12.18, P>*).

In cultivated varieties excellent taste of fruits was noted in the maximum trees for both young and old age groups (Table 5.47). The contingency χ^2 value was observed significant (χ^2= 9.8, P>*).

In 'gutee' trees fair taste of fruits was recorded in the maximum trees for young age group whereas good taste of fruits was noted in the maximum trees of old age groups (Table 5.48). The variations between the two age groups regarding the taste of fruits at ripening stage were significant (χ^2= 13.24, P>*).

Table 5.46 Taste of ripe mango of two age groups in commercial varieties

Age group	Taste					
	Excellent	Good	Fair	Sour	Sour and sweet	Total
Young (below 25 years)	30	12	1	1	1	45
Old (above 30 years)	19	13	2	0	11	45
Total	49	25	3	1	12	90

Contingency $\chi^2 = 12.18$, P>*

Table 5.47 Taste of ripe mango of two age groups in cultivated varieties

Age group	Taste					
	Excellent	Good	Fair	Sour	Sour and sweet	Total
Young (below 25 years)	21	15	7	0	2	45
Old (above 30 years)	21	7	15	2	0	45
Total	41	22	23	3	2	90

Contingency $\chi^2 = 9.8$, P>*

Table 5.48 Taste of ripe mango of two age groups in *gutee* trees

Age group	Taste					
	Excellent	Good	Fair	Sour	Sour and sweet	Total
Young (below 25 years)	10	9	19	1	6	45
Old (above 30 years)	10	18	12	5	0	45
Total	20	27	31	6	6	90

Contingency $\chi^2 = 13.24$, P>*

5.1.2.2.6. Storage quality of fruits in days for two age groups

The storage quality of mature fruits which is very important for the fruit marketing was divided into three categories- 1-7 days, 8-14 days and 15-21 days.

In commercial varieties the storage quality of fruits in maximum trees was 8-14 days for both the young and old age groups (Table 5.49). The contingency χ^2 value was significant ($\chi^2 =$ 7.63, P>*).

In cultivated varieties the storage quality of fruits of maximum trees was 8-14 days and the least number of trees was 15-21 days for both young and old age groups (Table 5.50). The variations in storage quality of fruits was significant ($\chi^2 =$ 8.28, P>*).

The storage quality of fruits in maximum number of trees for the young age group was 15-21 days and for the old age group was 8-14 days in 'gutee' trees (Table 5.51). The contingency χ^2 value was significant for this character of fruits ($\chi^2 =$ 6.54, P>*).

Table 5.49 Storage quality of ripe mango of two age groups in commercial varieties

Age group	Storage quality			
	1-7 days	8-14 days	15-21 days	Total
Young (below 25 years)	1	39	5	45
Old (above 30 years)	5	40	0	45
Total	6	79	5	90

Contingency $\chi^2 = 7.63$, P>*

Table 5.50 Storage quality of ripe mango of two age groups in cultivated varieties

Age group	Storage quality			
	1-7 days	8-14 days	15-21 days	Total
Young (below 25 years)	3	41	1	45
Old (above 30 years)	9	30	6	45
Total	12	71	7	90

Contingency $\chi^2 = 8.28$, P>*

Table 5.51 Storage quality of ripe mango of two age groups in *gutee* trees

Age group	Storage quality			
	1-7 days	8-14 days	15-21 days	Total
Young (below 25 years)	0	20	25	45
Old (above 30 years)	3	27	15	45
Total	3	47	40	90

Contingency $\chi^2 = 6.54$, P>*

5.1.3. Quantitative Morphological Characters

The information on morphological characters of mango trees is important. Commercial, cultivated and 'gutee' trees were divided into two groups based on their age. The trees under twenty five years were specified as young and the trees above thirty years were specified as old. Tree to tree variation in morphological characters for the two age groups in commercial varieties, cultivated varieties and 'gutee' trees were observed and the results are given below.

5.1.3.1. Leaf characters

The leaves play an important role in photosynthesis as well as in fruit production. Four quantitative leaf characters were observed and were recorded following IBPGR Descriptor 1989 and IPGRI Descriptor 2006. The characters were petiole length, lamina length, lamina breadth and width of half leaf. The variation of these characters between the young and old age groups in commercial varieties, cultivated varieties and 'gutee' trees were recorded and data were evaluated for the statistical analysis.

5.1.3.1.1. Petiole length for two age groups

The data on petiole length of young and old age groups in commercial varieties, cultivated varieties and 'gutee' trees were evaluated and considerable variation was noted for this quantitative trait. T-test between the young and old age groups in commercial varieties, cultivated varieties and 'gutee' trees was carried out.

In commercial varieties the range of petiole length of the young and old age group varied from 2.34 cm to 5.04 cm and 1.64 cm to 5.08 cm respectively. The range of petiole length in old age group was higher than the young age group.

Table 5.52 Two tailed t-test of petiole length for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	3.3084	45	0.6698	2.1559	88	P>*
Old age group	3.004	45				

Table 5.53 Two tailed t-test of petiole length for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	2.9908	45	0.5609	2.2208	88	P>*
Old age group	3.2533	45				

Table 5.54 Two tailed t-test of petiole length for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	2.7022	45	0.5937	2.1166	88	P>*
Old age group	3.004	45				

The mean value of petiole length for the old age group was 3.004 cm where as the mean value for the young age group was 3.3084 cm which was higher than the old age group. Two tailed t-test was carried out and difference between the two age groups was significant (Table 5.52). The t-value was significant for this character (t=2.1559, P>*).

In cultivated varieties the range of petiole length for the young age group was found 2.16 cm to 4.36 cm whereas the range of petiole length for the old age group was noted 2.32 cm to 5.08 cm. The range of petiole length was higher in the old age group. The mean values of petiole length for the young and old age groups were recorded 2.9908 cm and 3.2533 cm respectively. The mean value for the old age group was higher than the young age group. Two tailed t-test was analyzed for the two age groups and difference in respect of petiole length was noticeable (Table 5.53). The t-value was significant (t=2.2208, P>*).

The range of petiole length varied from 1.6 cm to 4.02 cm and 1.72 cm to 4.86 cm for the young and old age groups respectively in 'gutee' trees. The range was found higher in the old age groups.

The mean value of petiole length for the young age group was obtained 2.7022 cm while for the old age group was 3.004 cm. Data of petiole length were evaluated for the two tailed t-test and significant variation was found in regard to petiole length between the two age groups (Table 5.54). The t-value was significant (t=2.1166, P>*).

5.1.3.1.2. Lamina length for two age groups

The data on lamina length for the young and old age groups in commercial varieties, cultivated varieties and 'gutee' trees were analyzed for the two tailed t-test. The variations in respect of lamina length between the two age groups in the three categories were recorded.

The lamina length ranged from 14.44 cm to 24.56 cm for the young age group and 14.66 cm to 22.56 cm for the old age group in commercial varieties. The range of lamina length was higher in young commercial varieties.

The mean value of lamina length for the young age group was found 19.9288 cm and for the old age group was found 19.0666 cm. The mean value for the young age group was higher than the old age group. Tree to tree variations in lamina length for the two age groups were observed (Table 5.55). The two tailed t-test was carried out and the t-value was significant (t=1.9976, P>*) which indicated that the lamina length for the young age group was significantly higher than the old age group.

The range of lamina length for the young age group in cultivated varieties was 13.34 cm to 24.08 cm whereas for the old age group was 13.48 cm to 25.16 cm which was higher than the young age group.

The mean value of lamina length in cultivated varieties for the young age group was recorded 18.8413 cm and for the old age group was 19.7166 cm which was higher than the young age group. The variation for this quantitative trait was noticeable between the two age groups (Table 5.56). The result of two tailed t-test showed significant difference between the age groups for lamina length (t=2.0072, P>*).

Table 5.55 Two tailed t-test of lamina length for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	19.9288	45	2.0475	1.9976	88	P>*
Old age group	19.0666	45				

Table 5.56 Two tailed t-test of lamina length for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	18.8413	45	2.0686	2.0072	88	P>*
Old age group	19.7166	45				

Table 5.57 Two tailed t-test of lamina length for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	16.9351	45	3.0248	2.0665	88	P>*
Old age group	18.2528	45				

In ‘gutee’ trees the range of lamina length varied from 10.24 cm to 23.46 cm and 9.6 cm to 26.58 cm for the young and old age groups respectively. The range of lamina length for the old age group was found to be higher than the young age group.

For the young age group the mean value of lamina length was 16.9351 cm while for the old age group the mean value of lamina length was 18.2528 cm which was higher than the young age group. The variations between the two age groups were recorded (Table 5.57) and the result of two tailed t-test showed significant difference between the young and old age groups for lamina length (t=2.0665, P>*).

5.1.3.1.3. Lamina breadth for two age groups

The data on lamina breadth for the young and old age groups were evaluated in commercial varieties, cultivated varieties and ‘gutee’ trees. The two tailed t-test of lamina breadth between the two age groups was carried out.

The range of variations of leaf breadth between the young and old age groups in commercial varieties was observed. For the young age group the range was 3.76 cm to 8.04 cm and for the old age group the range was 3.96 cm to 7.58 cm which was less than the young age group.

The mean value of leaf breadth for the young age group was 6.3172 cm while for the old age group the mean value was recorded 5.8946 cm. There was distinct difference in respect of lamina breadth between the two age groups (Table 5.58). The t-test was analyzed and the t-value was found significant for the two age groups for this character (t=2.0597, P>*).

In cultivated varieties the range of lamina breadth for the young age group was higher than the old age group. The range of lamina breadth for the young age group was found 3.82 cm to 7.34 cm and for the old age group was 4.14 cm to 7.26 cm.

The difference in mean values for the young and old age groups was observed during the calculation of t-test. The mean value for the old age group was 5.4064 cm which was higher than the young age group (5.1288 cm). The t-value was found significant (Table 5.59) which indicates that the difference for lamina breadth between the two age groups was significant (t=2.00, P>*).

For the young and old age groups the range of lamina breadth was 3.26 cm to 8.2 cm and 3.36 cm to 7.86 cm respectively in 'gutee' trees. The range of variation was higher in 'gutee' trees for the young age group.

The mean value for the old age group was 5.4035 cm which was higher than the mean value of young age group (4.9448 cm). The variation in lamina breadth between the age groups was observed (Table 5.60) and the analysis of t-test was carried out. The t-value was significant which indicated that the lamina breadth for the old age group was significantly higher than the young age group (t=2.0834, P>*).

Table 5.58 Two tailed t-test of lamina breadth for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	6.3172	45	0.9733	2.0597	88	P>*
Old age group	5.8946	45				

Table 5.59 Two tailed t-test of lamina breadth for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	5.1288	45	0.6579	2.0	88	P>*
Old age group	5.4064	45				

Table 5.60 Two tailed t-test of lamina breadth for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	4.9448	45	1.0444	2.0834	88	P>*
Old age group	5.4035	45				

5.1.3.1.4. Width of half leaf for two age groups

The range of variation of width of half leaf in commercial varieties, cultivated varieties and 'gutee' trees for the young and old age groups was recorded and t-test was carried out to find out the significance of difference for this character between the two age groups.

In commercial varieties the range of variation in respect of width of half leaf for the young and old age groups was 3.68 cm to 7.8 cm and 3.06 cm to 7.34 cm respectively. The range of width of half leaf was higher for the old age group.

The mean value was 6.128 cm and 5.5862 cm respectively for the young and old age groups. The difference in width of half leaf between the two age groups was found highly significant (Table 5.61). The result of t-test was highly significant for this character (t=2.624, P>**).

In cultivated varieties the range of width of half leaf was 3.72 cm to 7.24 cm and 4.04 cm to 7.14 cm for the young and old age group respectively. The young age group had the higher range for the width of half leaf.

For the young age group the mean value for width of half leaf was 4.9586 cm while for the old age group the value of mean was found 5.2291 cm which was higher than the young age group (Table 5.62). The data were analyzed for the t-test between the two age groups to evaluate the variation for this character and the t-value was found significant (t=1.9928, P>*).

Table 5.61 Two tailed t-test of width of half leaf for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	6.128	45	0.9795	2.624	88	P>**
Old age group	5.5862	45				

Table 5.62 Two tailed t-test of width of half leaf for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	4.9586	45	0.6439	1.9928	88	P>*
Old age group	5.2291	45				

Table 5.63 Two tailed t-test of width of half leaf for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	4.7762	45	1.0252	2.0739	88	P>*
Old age group	5.2244	45				

The range of width of half leaf in 'gutee' trees for the young age group was 3.16 cm to 8.1 cm and for the old age group was 3.24 cm to 7.56 cm. The young age group had the higher range of variations.

The mean value of young age group was 4.7762 cm and for the old age group was 5.2244 cm which was higher than the young age group. The difference between the two age groups was observed (Table 5.63) and the result of t-test was significant (t=2.0739, P>*) that is the width of half leaf for the old age group was significantly higher than the young age group.

5.1.4. Quantitative Reproductive Characters

The following reproductive characters of mango were observed and data were recorded according the IBPGR Descriptor 1989 and IPGRI Descriptor, 2006. The variations in reproductive plant parts- inflorescence, fruit and stone were observed and evaluated for the statistical analysis.

5.1.4.1. Panicle characters

Following IBPGR Descriptor 1989 and IPGRI Descriptor, 2006, two panicle characters were considered. The variations in panicle length and panicle breadth between the young and old age groups in commercial varieties, cultivated varieties and 'gutee' trees were observed and the results are given below.

5.1.4.1.1. Panicle length for two age groups

The variations in panicle length between the two age groups in commercial varieties, cultivated varieties and 'gutee' trees were recorded and data were evaluated for the statistical analysis.

In commercial varieties the ranges of variations of panicle length for the young and old age groups were 17.2 cm to 35.5 cm and 11.7 cm to 32.7 cm respectively. The variation for this character was higher in old age group.

The mean value for the young age group was 24.1155 cm while for the old age group was 22.2622 cm. The variation in panicle length between the two age groups were noted (Table 5.64) and the t-value was significant for this character which means the panicle length for the young age group was significantly higher than the old age group (t=2.0772, P>*).

The range of panicle length in cultivated varieties for the young age group was 17.1 cm to 47 cm whereas for the old age group was 11.7 cm to 39.9 cm which was lower than the young age group.

The mean value was 24.23 cm for the young age group whereas the mean value for the old age group was 24.11 cm which was lower than the young age group. The variations of panicle length for the two age groups were noted (Table 5.65) and t-test was carried out between the two age groups. The t-value was found non significant which indicates that there was no significant difference between the young and old age groups for panicle length (t=0.0956, P= N. S.).

Table 5.64 Two tailed t-test of panicle length for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	24.1155	45	4.2324	2. 0772	88	P>*
Old age group	22.2622	45				

Table 5.65 Two tailed t-test of panicle length for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	24.23	45	5.9493	0.0956	88	P=N. S.
Old age group	24.11	45				

Table 5.66 Two tailed t-test of panicle length for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	24.26	45	9.1565	0.2334	88	P=N. S.
Old age group	24.75	45				

For the young age group in 'gutee' trees the range of panicle length was 10 cm to 46 cm and for the old age group the range was 10.1 cm to 44 cm. The range of panicle length was higher in young age group.

In 'gutee' trees the value of mean for the young age group was 24.26 cm whereas for the old age group the mean value was 24.75 cm. The data were evaluated for the two tailed t-test (Table 5.66) and the t-value was recorded non significant that is there was no significant difference between the young and old age groups for panicle length in 'gutee' trees (t=0.2334, P= N. S.).

5.1.4.1.2. Panicle breadth for two age groups

The ranges of variations in panicle breadth in commercial varieties, cultivated varieties and 'gutee' trees for the young and old age groups were noted. The statistical analysis was carried out to find out the significance of difference for this character between the two age groups.

The range of panicle breadth in commercial varieties was observed 6.6 cm to 29.6 cm for the young age group while this range was 5.6 cm to 20.1 cm for the old age groups. The young age group showed higher range of variation.

The mean value of young age group for panicle breadth was 13.86 cm whereas the value of mean for the old age group was 13.0888 cm (Table 5.67). The two tailed t-test was analyzed and the t-value was non significant (t= 0.8902, P=N. S.). The difference in panicle breadth between the young and old age groups was non significant.

Table 5.67 Two tailed t-test of panicle breadth for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	13.86	45	4.1096	0.8902	88	P=N. S.
Old age group	13.0888	45				

Table 5.68 Two tailed t-test of panicle breadth for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	11.76	45	3.6983	2.001	88	P>*
Old age group	13.32	45				

Table 5.69 Two tailed t-test of panicle breadth for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	13.28	45	6.6966	0.3541	88	P=N. S.
Old age group	13.23	45				

In cultivated varieties the range of panicle breadth was 6.7 cm to 22 cm for the young age group whereas the range was 6.1 cm to 25.1 cm for the old age group which was higher than the young age group.

The mean value was 11.76 cm for the young age groups whereas the mean value was 13.32 cm for the old age group. The variations between the two age groups were recorded (Table 5.68) and the two tailed t-test was carried out to evaluate the data for this reproductive trait. The value of t was significant ($t= 2.001$, $P>*$). There was significant difference for panicle breadth between the two age groups.

In 'gutee' trees the panicle breadth ranged from 4.1 cm to 39 cm for the young age group and 6.1 cm to 28 cm for the old age group which was lower than the young age group.

The mean value of panicle breadth for the young age group was 13.28 cm and for the old age group was 13.23 cm (Table 5.69). The two tailed t-test was analyzed between the two age groups and t-value was found non significant ($t=0.3541$, P= N. S.). There was no significant difference between the young and old age groups for this reproductive character.

5.1.4.2. Fruit characters

Four quantitative fruit characters were observed and data were recorded following the IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. As the fruit weight, fruit length, fruit width and fruit diameter are directly related with the quantity of fruit production of a tree; so these are very important to the breeders and the mango producers. The variations of these characters were observed for the young and old age groups in commercial varieties, cultivated varieties and 'gutee' trees and data were recorded for statistical analysis.

5.1.4.2.1. Fruit weight for two age groups

Fruit weight is correlated with fruit size and large sized fruits are desirable to everyone; therefore fruit weight is the most important fruit character of mango. The data on fruit weight for young and old age groups in commercial varieties, cultivated varieties and 'gutee' trees were recorded and the variations obtained in this quantitative trait were evaluated for two tailed t-test between the young and old age groups.

The range of fruit weight for the young age groups was found 104 g to 556 g and for the old age group was found 84 g to 587 g in commercial varieties which was higher than the young age group.

For the young age group the mean value was 299.8666 g while for the old age group the mean value was recorded 365.2888 g. The variation in fruit weight between the two age groups was noticeable (Table 5.70). The two tailed t-test was carried out and the t value was found highly significant (t= 2.6618, P>**). The fruit weight of the old aged commercial varieties was significantly higher than the young age group.

Table 5.70 Two tailed t-test of fruit weight for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	299.8666	45	116.5906	2.6618	88	P>**
Old age group	365.2888	45				

Table 5.71 Two tailed t-test of fruit weight for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	273.2888	45	117.0199	1.9999	88	P>*
Old age group	223.9555	45				

Table 5.72 Two tailed t-test of fruit weight for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	182.0666	45	80.6731	0.5187	88	P=N. S.
Old age group	190.8889	45				

For the young age group the range of fruit weight was 114 g to 604 g whereas for the old age group the range was 63 g to 688 g in cultivated varieties. The range of fruit weight for the old age group was much higher than the young age group in cultivated varieties.

The mean value for the young age group was 273.2888 g and for the old age group was 223.9555 g respectively. The variations in fruit weight for the two age groups were observed (Table 5.71) and data were analyzed for the two tailed t-test. The value of t was found significant (t= 1.9999, P>*); that is the difference in fruit weight between the two age groups was significant.

In 'gutee' trees the range of variation of fruit weight for the young age group was 51 g to 453 g while for the old age group the range was recorded 82 g to 374 g which was lower than the young age group.

The mean values for the young and old age groups were 182.0666 g and 190.8889 g respectively (Table 5.72). The data were analyzed for two tailed t-test and the value of t was non significant (t=0.5187, P= N. S.). The difference in fruit weight between the young and old age groups in 'gutee' trees was non significant.

5.1.4.2.2. Fruit length for two age groups

Fruit length is an important character which varied from tree to tree. The variation of fruit length between the young and old age group was observed in commercial varieties, cultivated varieties and 'gutee' trees.

The fruit length varied from 7.22 cm to 13.92 cm for the young age group while the fruit length varied from 7.46 cm to 15.1 cm for the old age group in commercial varieties. The range of variation was higher in the old age group.

The mean values of fruit length for the young and old age groups were 10.4386 cm and 11.5628 cm respectively. The variation between the two age groups was observed (Table 5.73) and t-test was analyzed to evaluate the difference for this character. The t-value was found highly significant (t= 2.6199, P>**). The fruit length for the old age group was significantly higher than the young age group.

In cultivated varieties the fruit length varied from 7.54 cm to 16.48 cm and 5.34 cm to 16.52 cm for the young and old age group respectively. The range of fruit length was higher for the old age group.

The mean values of fruit length were 16.48 cm and 9.2675 cm respectively for the young and old age groups. The variations of fruit length for the two age groups were recorded (Table 5.74) and data were evaluated for the analysis of t-test. The value of two tailed t-test was found significant (t= 2.0149, P>*) that is the fruit length for the young age group was significantly higher than the old age group.

Table 5.73 Two tailed t-test of fruit length for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	10.4386	45	2.0418	2.6199	88	P>**
Old age group	11.5628	45				

Table 5.74 Two tailed t-test of fruit length for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	16.48	45	2.1818	2.0149	88	P>*
Old age group	9.2675	45				

Table 5.75 Two tailed t-test of fruit length for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	9.1311	45	1.6102	0.4805	88	P=N. S.
Old age group	9.2942	45				

In ‘gutee’ trees the range of variation of fruit length for the young age group was noted 6.38 cm to 12.5 cm while for the old age group the range was 7.18 cm to 13.04 cm which was lower than the young age group.

The mean fruit length for the young age group was 9.1311 cm and the old age group was 9.2942 cm (Table 5.75). The two tailed t-test was carried out to find out the difference of fruit length between the two age groups and the t-value was found non significant (t=0.4805, P= N. S.). There was no significant difference in ‘gutee’ trees between the two age groups for this character.

5.1.4.2.3. Fruit width for two age groups

Data on fruit width for the young and old age groups were recorded in commercial varieties, cultivated varieties and ‘gutee’ trees. The variations for this character between the two age groups were observed.

The range of fruit width in commercial varieties for the young age group varied from 5.38 cm to 9.22 cm and for the old age group 4.46 cm to 9.64 cm which was higher than the young age group.

The mean value of fruit width for the young age group was 7.4457 cm whereas the mean value for the old age group was 7.9417 cm in commercial varieties. The variation in fruit width was observed for the two age groups (Table 5.76). The analysis of two tailed t-test was carried out to find out the difference and t-value was found significant (t= 2.3919, P>*). The fruit width for the old age group was significantly higher than the fruit width for the young age group.

Table 5.76 Two tailed t-test of fruit width for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	7.4457	45	0.9837	2.3919	88	P>*
Old age group	7.9417	45				

Table 5.77 Two tailed t-test of fruit width for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	6.6382	45	1.0012	1.9961	88	P>*
Old age group	7.0595	45				

Table 5.78 Two tailed t-test of fruit width for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	6.2088	45	1.0296	0.6722	88	P=N. S.
Old age group	6.3547	45				

The range of fruit width for the young age group in cultivated varieties was found 4.64 cm to 9.1 cm while for the old age group 4.38 cm to 9.08 cm which was higher than the young age group.

The mean value of fruit width for the young age group was 6.6382 cm and for the old age group was 7.0595 cm. The variation in fruit width was observed between the two age groups (Table 5.77). The result of two-tailed t-test was significant (t= 1.9961, P>*) that is the fruit width for the old age group was significantly higher than the young age group.

The fruit width in 'gutee' tees for the young age group varied from 4.42 cm to 8.82 cm and for the old age group varied from 4.8 cm to 8.68 cm. The range of fruit width in young age group was higher than the old age group.

The mean value of fruit width for the young and old age group was 6.2088 cm and 6.3547 cm respectively (Table 5.78). The data were evaluated for two tailed t-test and t-value was found non significant (t=0.6722, P= N. S.). That is there was no significant difference between the young and old age groups for this quantitative trait.

5.1.4.2.4. Fruit diameter for two age groups

Data on fruit diameter for the two age groups were recorded and the two tailed t-test between the young and old age groups in commercial varieties, cultivated varieties and ‘gutee’ trees was carried out.

In commercial varieties the range of fruit diameter for the young and old age group varied from 16.64 cm to 27.4 cm and 16.72 cm to 28.36 cm respectively. The range of fruit diameter was higher for the old age group than the young age group.

The mean value of fruit diameter for the young age group was 22.9044 cm while the mean value for the old age group was 24.3177 cm. The variations in fruit diameter between the two age groups were observed (Table 5.79). The two tailed t-test was carried out and distinct difference was observed between the young and old age groups for this trait. The value of t was found highly significant (t= 2.7686, P>**).

Fruit diameter varied from 16.46 cm to 27.52 cm and 13.74 cm to 26.76 cm respectively for the young and old age groups in cultivated varieties. The range was found higher for the old age group.

The mean value of fruit diameter for the young age group was 21.5977 cm whereas the mean value for the old age group was 20.42 cm. The variation in fruit diameter was recorded (Table 5.80) and the analysis of two tailed t-test was carried out. The t-value was significant (t= 2.025, P>*) which indicate that the fruit diameter for the young age group was significantly higher than the old age group in cultivated varieties.

Table 5.79 Two tailed t-test of fruit diameter for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	22.9044	45	2.3384	2.7686	88	P>**
Old age group	24.3177	45				

Table 5.80 Two tailed t-test of fruit diameter for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	21.5977	45	2.7642	2.025	88	P>*
Old age group	20.42	45				

Table 5.81 Two tailed t-test of fruit diameter for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	19.532	45	2.6043	0.0154	88	P=N. S.
Old age group	19.5235	45				

The range of variation in respect of fruit diameter in ‘gutee’ trees for the young age group was 14.52 cm to 27.24 cm and for the old age group was 15.3 cm to 25.12 cm respectively. The range of variation for fruit diameter was higher in young age group.

For the young age group the mean value was 19.532 cm and for the old age group the mean value was 19.5235 cm (Table 5.81). The data were evaluated for the t-test and the t-value was non significant (t=0.0154, P= N. S.) which indicated that there was no significant difference between the young and old age groups for fruit diameter in ‘gutee’ trees.

5.1.4.3. Stone characters

Stone weight was recorded following the IBPGR Descriptor, 1989 and IPGRI Descriptor, 2006. The variations in stone weight for the young and old age groups in commercial varieties, cultivated varieties and ‘gutee’ trees were observed and data were evaluated for statistical analysis.

5.1.4.3.1. Stone weight for two age groups

Stone weight varied from 23 g to 62 g for the young age group and 22 g to 69 g for the old age group in commercial varieties. This range was higher in the old age group.

The mean value of stone weight for the young age group was 38.8444 g whereas the value of stone weight for the old age group was 43.5333 g (Table 5.82). The two tailed t-test was carried out and t-value was found significant (t= 2.129, P>*); that is there was significant difference in stone weight between the young and old age group in commercial varieties.

The stone weight ranged from 17 g to 70 g in cultivated varieties for the young age group and 15 g to 60 g for the old age group. The range of stone weight was higher for the young age group.

For the young age group the mean value of stone weight was 39.9555 g and for the old age group the mean value of stone weight was 35.0222 g. The variation in stone weight was observed for the two age groups (Table 5.83). The result of two tailed t-test was found significant (t= 2.004, P>*).

The range of stone weight was 13 g to 44 g for the young age group in ‘gutee’ trees while for the old age group the range of stone weight was 13 g to 54 g. The range of stone weight was higher for the old age group.

The mean value for the young age group was 24.3333 g while for the old age group was 28.0666 g. The variation in stone weight for the two age groups was observed (Table 5.84). The two tailed t-test was carried out and the value of t was significant (t= 2.0529, P>*) which indicated that there was significant difference for stone weight between the two age groups for this quantitative trait.

Table 5.82 Two tailed t-test of stone weight for two age groups in commercial varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	38.8444	45	11.05	2.129	88	P>*
Old age group	43.5333	45				

Table 5.83 Two tailed t-test of stone weight for two age groups in cultivated varieties

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	39.9555	45	11.6779	2.004	88	P>*
Old age group	35.0222	45				

Table 5.84 Two tailed t-test of stone weight for two age groups in *gutee* trees

Variables	Mean	No. of tree	Standard deviation	t	df	Level of significance
Young age group	24.3333	45	8.6265	2.0529	88	P>*
Old age group	28.0666	45				

5.2. The Character Differences Between Young and Old Age Groups of Mango

To describe the extent and pattern of changes in the morphological and reproductive characters between the young and old age groups of mango the results of both qualitative and quantitative characters were summarized and are presented in tables below (Table 5.85 & 5.86).

For the tree characters, the differences between the young and old age groups were much pronounced for three categories, for other characters also variation was noted. However, less pronounced variation was observed for the 'gutee' trees between the two age-groups, which indicates the nature of gene exchange (free recombination by cross pollination) and mode of reproduction (seed propagation) existing for these plants. The variation in fruit characters in the commercial category between the age groups indicates a change in the genetic background which is indicative of indirect selection in the past and from the mode of propagation (by grafting and cutting) of these economically important fruit species.

The pattern of changes in the quantitative characters was less prominent for the leaf characters in the three categories, but variation for the reproductive characters for the two age groups among the commercial and cultivated categories was more pronounced. However, little variation was found for the 'gutee' trees for these characters. Again, the lack of difference in age-groups in the 'gutee' mango may reflect the mode of reproduction and gradual decline in their numbers.

5.85 Summery table for variation in qualitative characters following the age difference on the basis of χ^2 tests

Characters	Extent of variation between the young and old age groups		
	Commercial varieties	Cultivated varieties	*Gutee* trees
A. Tree characters	++	++	+++
Tree shapes	+++	++	+++
Type of branching	+++	+++	+++
Quantity of timber	+++	+++	+++
Productivity of fruits	+++	+	++
Time of fruit maturity	+	++	+
B. Leaf characters			
Leaf orientation	++	+	+
Shape of leaf	++	++	+
Leaf margin	+	+	+
C. Inflorescence characters			
Inflorescence Shape	+	+	+
Floral density	+	+	+
Flower Color	+	+	+
D. Fruit characters			
Fruit size	++	+	+
Skin color	++	+	+
Pulp color	++	+++	+
Fruit texture	+	+	+
Taste	+	+	+
Storage quality in days	+	+	+

\+ = Low difference, ++ = Medium difference, +++= High difference

5.86 Summery table for variation in quantitative characters following the age difference on the basis of T-tests

Characters	Range of variations between the young and old age groups		
	Commercial varieties	Cultivated varieties	*Gutee* trees
A. Leaf characters			
Petiole length	+	+	+
Lamina length	+	+	+
Lamina width	+	+	+
Width of half leaf	++	+	+
B. Inflorescence characters			
Panicle length	+	-	-
Panicle width	-	+	-
C. Fruit characters			
Fruit weight	++	+	-
Fruit length	++	+	-
Fruit width	+	+	-
Fruit Diameter	++	+	-
D. Stone characters			
Stone weight	+	+	+

\+ = Low difference, ++ = Significant difference, - = No difference

CHAPTER – VI

6. RESULTS: TAXONOMY OF MANGO AS A CULTIVATED PLANT

The taxonomic studies of mango as a cultivated plant was carried out and the description of local cultivars were noted following the taxonomic keys. An attempt was taken to establish a suitable system of classification of commercial and cultivated varieties for their easy identification.

6.1 Mango Types and Their Classification

The present study was carried out in the six villages of Chapai Nawabganj district named Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga. The data on mango germplasm were collected from the fields, orchards and homesteads area and was matched with the 'A Monograph on Mango Varieties of Bangladesh' (Hossain and Ahmed 1994), 'Catalogue on Mango Germplasm' (Bhuyan *et. al.*, 2003) and "Descriptor for Mango Germplasm" (Ramachandra & Ramachandra, 2003). The local mango cultivars which did not matched with any of these and can be a valuable resource for plant breeders have been described in this chapter. However, as these local cultivars and 'gutee' trees are a potential source of desirable characters may be are existing and dispersing through cross pollination in nature and breeding through hybridization; so steps should be taken to document these valuable resources.

At Chapai Nawabganj a wide range of variability in mango cultivars were observed which needs a scientific approach for the collection and documentation. Because the large number of cultivated varieties and multiple names in different localities often create confusion. As a result the same variety is called by different names at different areas and in some cases different varieties are called by the same name. For an example, *Khudi khirshapat* and *Khirshapat* are not the same variety. But *Khudi khirshapat* is an unknown name to the consumers; it is known as small sized *Khirshapat* and sold with *Khirshapat*. Moreover, in the “Production technology of Mango” (Amzad, 1994), the description of the variety *Kuapahari* is given which is locally called *Kumapahari*. In the same way, the variety *Chock choke* and the cultivated variety *Nazim pasand* are also known as *Chickna* and *Nora,* respectively. Some mango traders added that they use to market the cultivar “*Himsagar*” as “*Rani pasand*” at a high price as the consumers don’t have enough idea about the locally cultivated varieties. Hence, the morphological characterization on fruit characters has a great importance. So, an attempt has been taken to collect and characterize the existing mango germplasms in the six villages of Chapai Nawabganj systematically to clear these confusions.

An effort has been taken to identify the commercial and cultivated varieties on the basis of phenotypic characters as there is a need for characterization of existing varieties. Twelfth International Horticultural Congress held in Berlin in 1938 recognized the importance of description and classification of varieties as a fundamental aspect of food research. It was affirmed at the Indian Horticultural Workers Conference held in New Delhi in 1947. Watt (1891) was the earliest to describe mango using scientific terminology. Subsequently Maries (1901-1902) describe 500 varieties of Indian mango. Woodhouse (1909) described 40 mango varieties of bihar, India. Burns and Prayag (1920) described 89 varieties of Bombay Presidency, India. Popnoe (1941) described 300 varieties of mango from all parts of the world. Sturrock and Wolfe (1944) described 38 mango varieties of Florida based on fruit characters only. All the workers did not include vegetative characters of varieties in their description. However, Mukherjee (1948) who described 72 varieties in Bengal, Bihar and Uttar Pradesh of India and Naik and Gangolly (1950) who described 335 varieties of South India using vegetative characters have also given key for identification of varieties. But the vegetative and reproductive characters of all the existing varieties have not been recorded systematically so far, except fruit characters. The fruit characters of some of the varieties had been described sporadically here and there. Considering this, an effort has been taken to propose a suitable key for varietal identification or classification following the system of David Prain from the book Bengal plants, Part-I (Prain, 1908) and using the keys for description from "The Mango" by Gangolly *et. al.* (1957), IBPGR Descriptor 1989 and Descriptor for Mango published by IPGRI in 2006. The identification system of fifty three commercial and locally cultivated varieties has been described in Keys for varietal identification (Table 6.1) with their photographs (Fig. 6.1.A, 6.1.B and 6.1.C).

Table 6.1 Key for varietal identification or classification:

Time of fruit maturity

A. Early Season

1. *Abidbhog*
2. *Boishakhi*
3. *Brindaboni*
4. *Chosha*
5. *Golapbas*
6. *Gopalbhog*
7. *Gourjeet*
8. *Gulle*
9. *Kalimeghi*
10. *Kumapahari*
11. *Sindura*

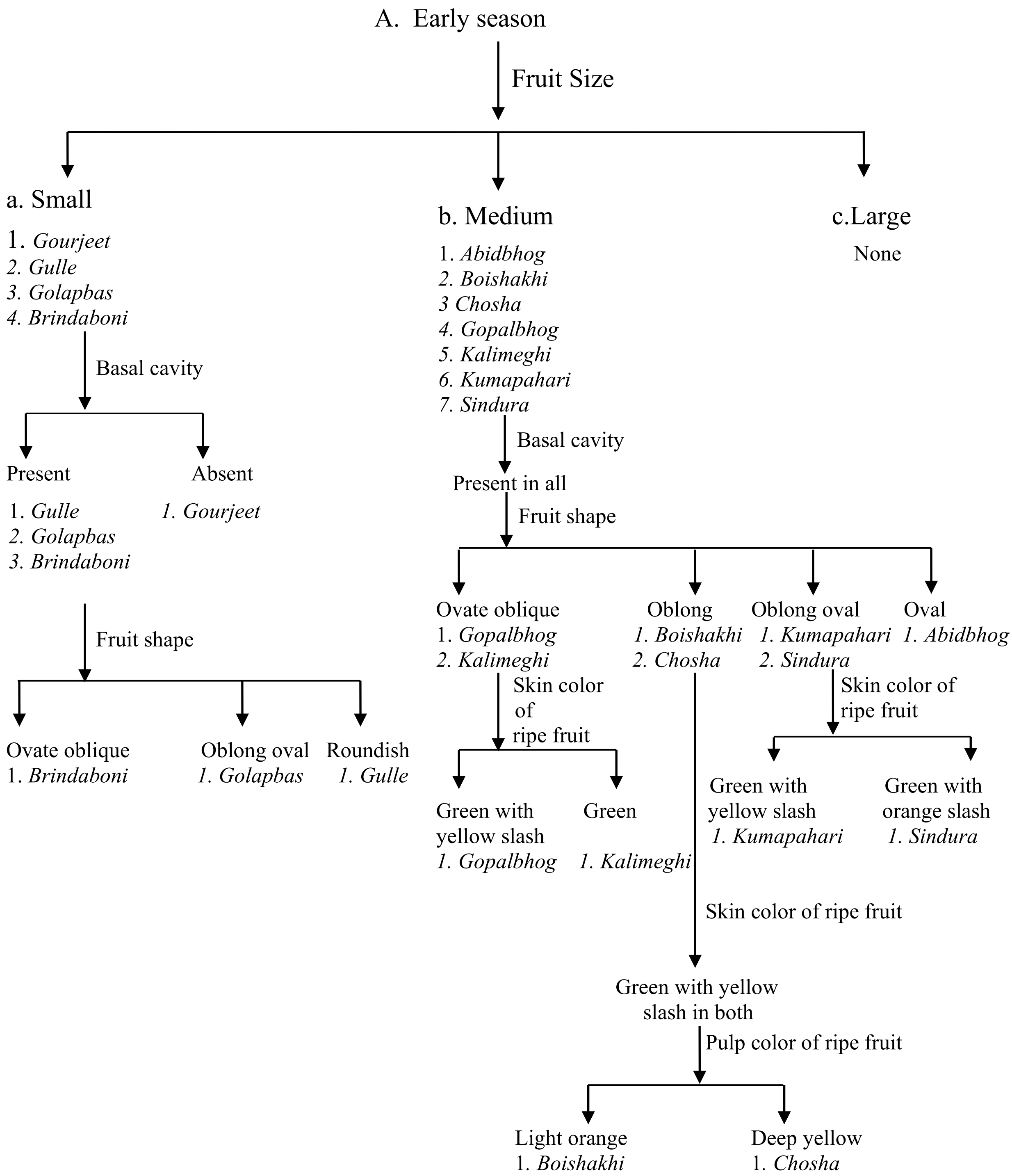
B. Mid Season

1. *Batasha*
2. *Bombai*
3. *Champa*
4. *Choto kalua*
5. *Dadbhog*
6. *Danadar*
7. *Dilshad*
8. *Hayati*
9. *Jhurki*
10. *Kalibhog*
11. *Kalua*
12. *Kancha mitha*
13. *Khejura*
14. *Khirshapat*
15. *Khudi khirshapat*
16. *Langra*
17. *Larua*
18. *Lugnee*
19. *Mirabhog*
20. *Pherdous pasand*
21. *Sathiarerkera*
22. *Sipia*

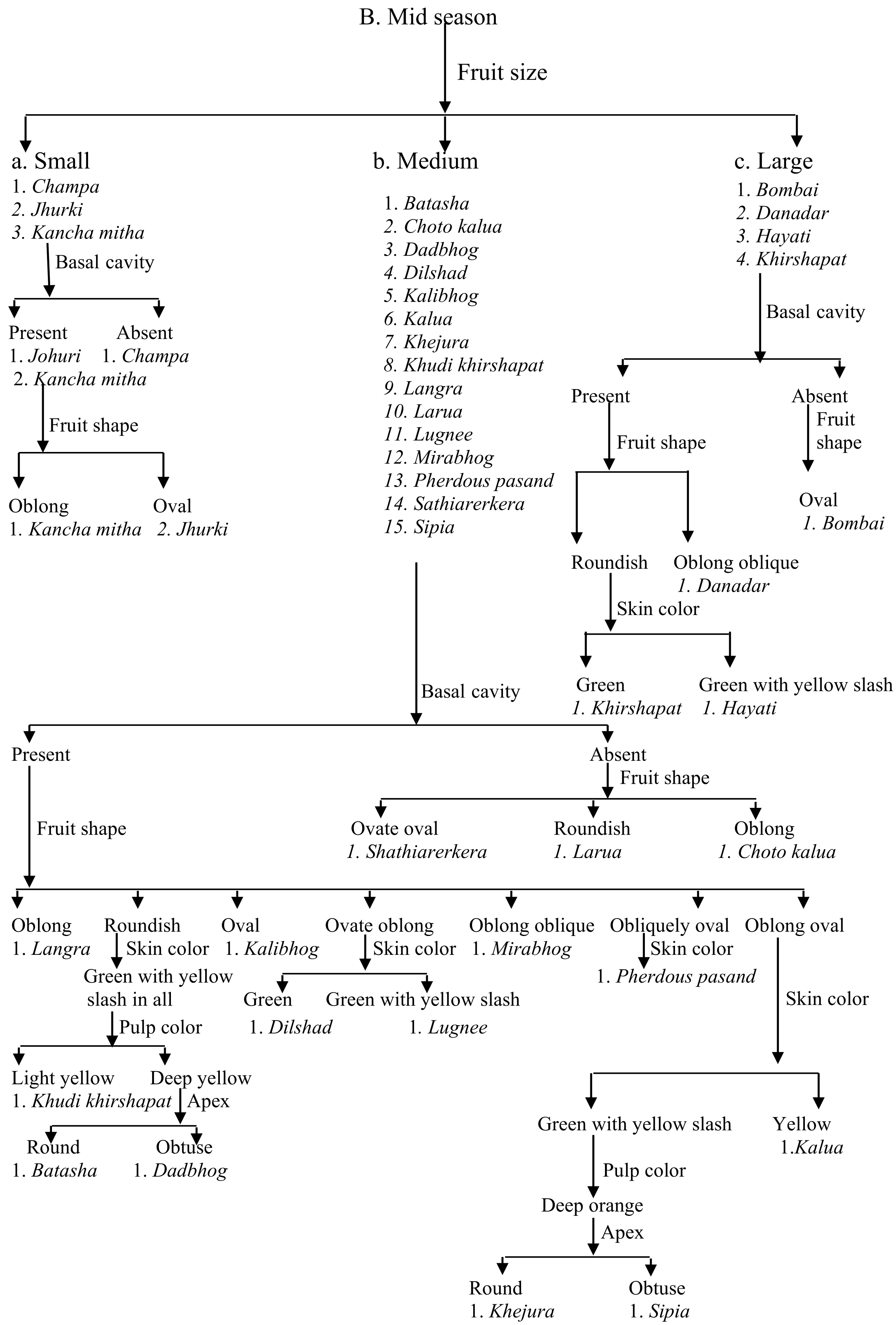
C. Late Season

1. *Alam shahi*
2. *Ashina*
3. *Bira*
4. *Bogla guti*
5. *Chal guti*
6. *Chock choke*
7. *Dofola*
8. *Fazli*
9. *Himsagar*
10. *Kohinoor*
11. *Lakhna*
12. *Lamba guti*
13. *Mohonbhog*
14. *Narkel phaki*
15. *Nazim pasand*
16. *Poichchha*
17. *Ri*
18. *Shantu*
19. *Surma fazli*
20. *Totapuri*

Cont.


A. Early season
Fruit Size
a. Small
1. Gourjeet
2. Gulle
3. Golapbas
4. Brindaboni
Basal cavity
Present
1. Gulle
2. Golapbas
3. Brindaboni
Absent
1. Gourjeet
Fruit shape
Ovate oblique
1. Brindaboni
Oblong oval
1. Golapbas
Roundish
1. Gulle
b. Medium
1. Abidbhog
2. Boishakhi
3 Chosha
4. Gopalbhog
5. Kalimeghi
6. Kumapahari
7. Sindura
Basal cavity
Present in all
Fruit shape
Ovate oblique
1. Gopalbhog
2. Kalimeghi
Skin color of ripe fruit
Green with yellow slash
1. Gopalbhog
Green
1. Kalimeghi
Oblong
1. Boishakhi
2. Chosha
Skin color of ripe fruit
Green with yellow slash in both
Pulp color of ripe fruit
Light orange
1. Boishakhi
Deep yellow
1. Chosha
Oblong oval
1. Kumapahari
2. Sindura
Skin color of ripe fruit
Green with yellow slash
1. Kumapahari
Green with orange slash
1. Sindura
Oval
1. Abidbhog
c.Large
None

Cont.


B. Mid season
Fruit size
a. Small
1. Champa
2. Jhurki
3. Kancha mitha
Basal cavity
Present
1. Johuri
2. Kancha mitha
Absent
1. Champa
Fruit shape
Oblong
1. Kancha mitha
Oval
2. Jhurki
b. Medium
1. Batasha
2. Choto kalua
3. Dadbhog
4. Dilshad
5. Kalibhog
6. Kalua
7. Khejura
8. Khudi khirshapat
9. Langra
10. Larua
11. Lugnee
12. Mirabhog
13. Pherdous pasand
14. Sathiarerkera
15. Sipia
c. Large
1. Bombai
2. Danadar
3. Hayati
4. Khirshapat
Basal cavity
Present
Fruit shape
Roundish
Skin color
Green
1. Khirshapat
Green with yellow slash
1. Hayati
Oblong oblique
1. Danadar
Absent
Fruit shape
Oval
1. Bombai
Basal cavity
Present
Fruit shape
Oblong
1. Langra
Roundish
Skin color
Green with yellow slash in all
Pulp color
Light yellow
1. Khudi khirshapat
Deep yellow
Apex
Round
1. Batasha
Obtuse
1. Dadbhog
Oval
1. Kalibhog
Ovate oblong
Skin color
Green
1. Dilshad
Green with yellow slash
1. Lugnee
Oblong oblique
1. Mirabhog
Obliquely oval
Skin color
1. Pherdous pasand
Oblong oval
Skin color
Green with yellow slash
Pulp color
Deep orange
Apex
Round
1. Khejura
Obtuse
1. Sipia
Yellow
1.Kalua
Absent
Fruit shape
Ovate oval
1. Shathiarerkera
Roundish
1. Larua
Oblong
1. Choto kalua

Cont.

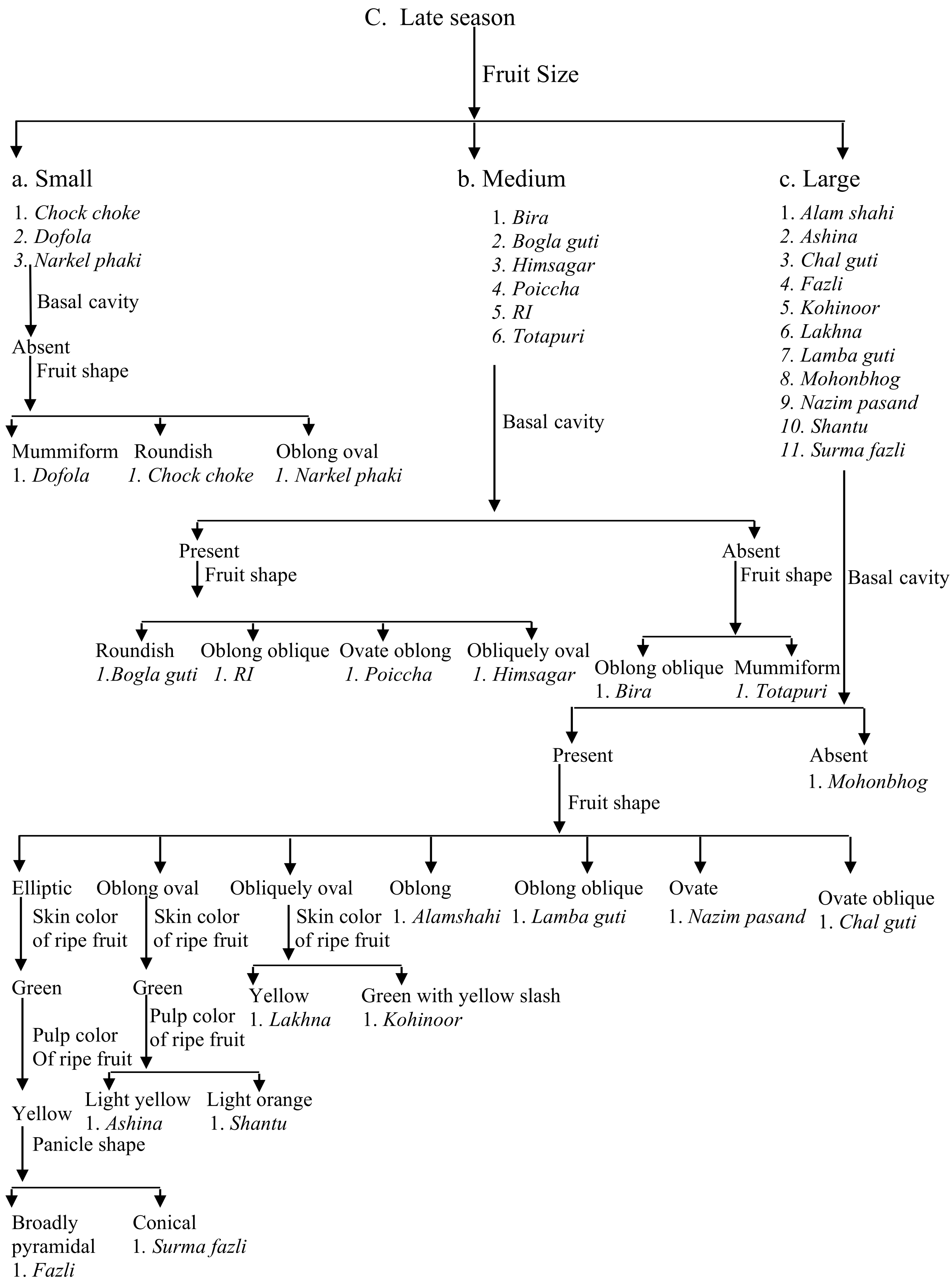
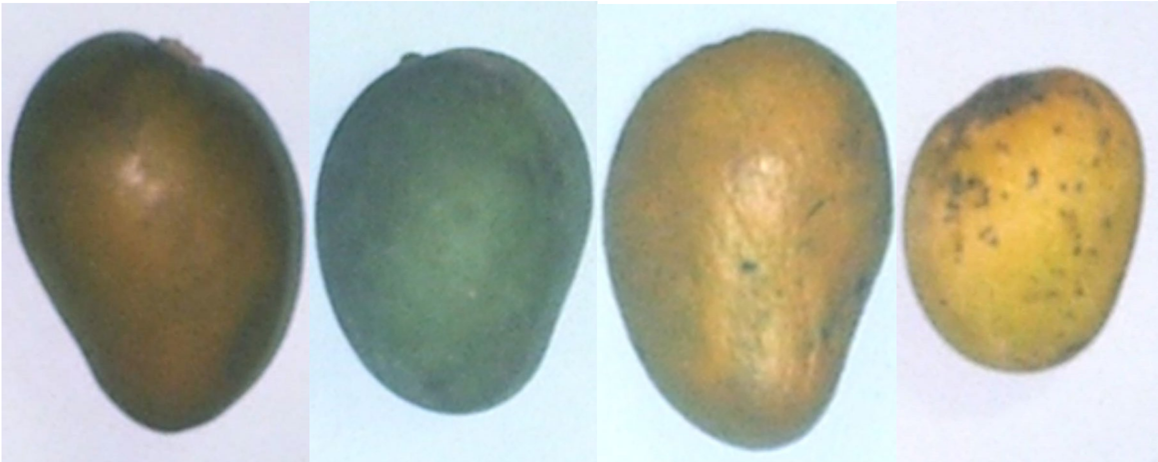
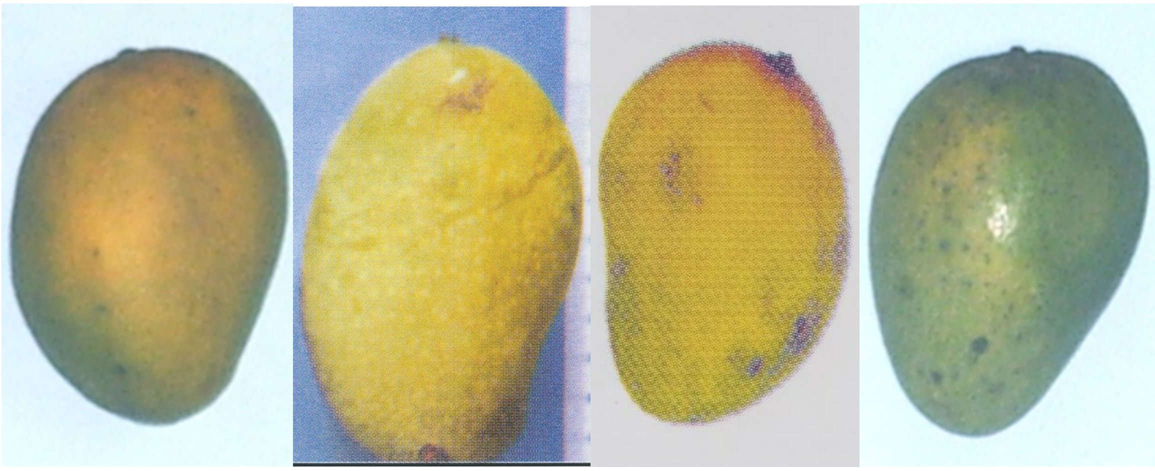

C. Late season
Fruit Size
a. Small
1. *Chock choke*
2. *Dofola*
3. *Narkel phaki*
Basal cavity
Absent
Fruit shape
Mummiform
1. *Dofola*
Roundish
1. *Chock choke*
Oblong oval
1. *Narkel phaki*
b. Medium
1. *Bira*
2. *Bogla guti*
3. *Himsagar*
4. *Poiccha*
5. *RI*
6. *Totapuri*
Basal cavity
Present
Fruit shape
Roundish
1.*Bogla guti*
Oblong oblique
1. *RI*
Ovate oblong
1. *Poiccha*
Obliquely oval
1. *Himsagar*
Absent
Fruit shape
Oblong oblique
1. *Bira*
Mummiform
1. *Totapuri*
c. Large
1. *Alam shahi*
2. *Ashina*
3. *Chal guti*
4. *Fazli*
5. *Kohinoor*
6. *Lakhna*
7. *Lamba guti*
8. *Mohonbhog*
9. *Nazim pasand*
10. *Shantu*
11. *Surma fazli*
Basal cavity
Present
Absent
1. *Mohonbhog*
Fruit shape
Elliptic
Skin color of ripe fruit
Green
Pulp color Of ripe fruit
Yellow
Panicle shape
Broadly pyramidal
1. *Fazli*
Conical
1. *Surma fazli*
Oblong oval
Skin color of ripe fruit
Green
Pulp color of ripe fruit
Light yellow
1. *Ashina*
Light orange
1. *Shantu*
Obliquely oval
Skin color of ripe fruit
Yellow
1. *Lakhna*
Green with yellow slash
1. *Kohinoor*
Oblong
1. *Alamshahi*
Oblong oblique
1. *Lamba guti*
Ovate
1. *Nazim pasand*
Ovate oblique
1. *Chal guti*

Fig. 6.1.A Early season mango varieties

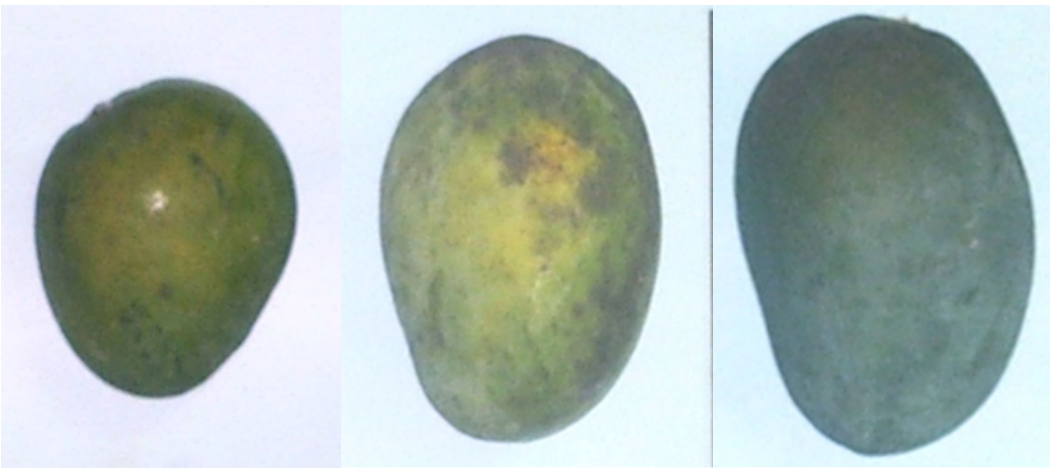


Brindaboni *Golapbas* *Gourjeet* *Gulli*

Small size fruits



Abidbhog *Boishakhi* *Chosha* *Gopalbhog*



Kalimeghi *Kumapahari* *Sindura*

Medium size fruits

Fig. 6.1.B Mid season mango varieties

Kancha mitha

Champa

Jhurki

Small size fruits

Batasha

Choto kalua

Dadbhog

Dilshad

Kalibhog

Kalua

Khejura

Medium size fruits

Fig. 6.1.B Mid season mango varieties

Khudi khirshapat *Langra* *Larua* *Lugnee*

Mirabhog *Pherdous pasand* *Shathiarerkera* *Sipia*

Medium size fruits

Bombai *Danadar* *Hayati* *Khirshapat*

Large size fruits

Fig. 6.1.C Late season mango varieties

Dofola *Chock choke* *Narkel phaki*

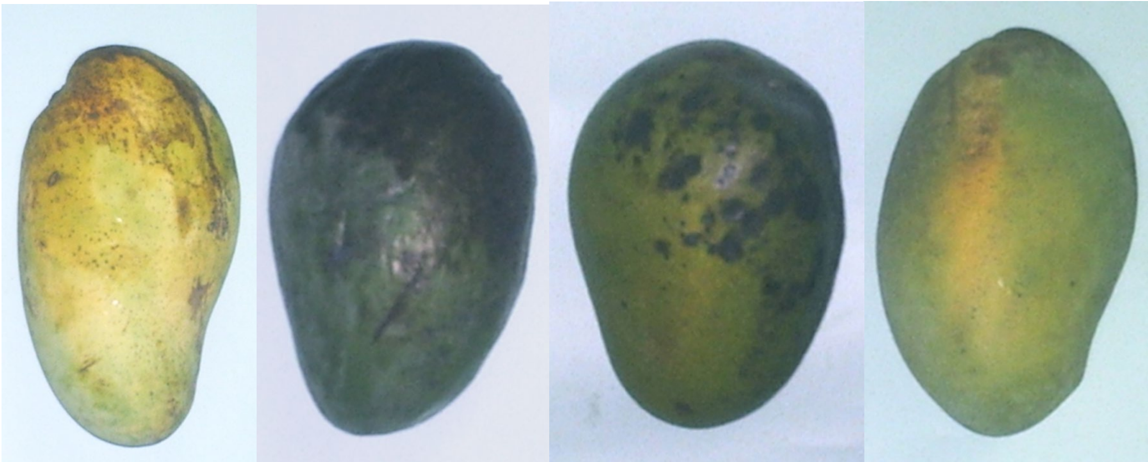
Small size fruits

Bira *Bogla guti* *Himsagar*

Poiccha *RI* *Totapuri*

Medium size fruits

Fig. 6.1.C Late season mango varieties



Alam shahi *Ashina* *Chal guti* *Fazli*

Kohinoor *Lakhna* *Lamba guti* *Mohonbhog*

Nazim pasand *Shantu* *Surma fazli*

Large size fruits

6.2. Description of Locally Cultivated Rare Mango Cultivars Observed at Chapai Nawabganj

The characteristics of undocumented or less known mango cultivars which were observed in the present study and did not matched with the published documents have been recorded according the IBPGR Descriptor 1989 and IPGRI Descriptor 2006. The names of the locally cultivated rare cultivars which are maintaining in different family orchards because of their special features but are at risk are as follows- *Alam shahi, Chal guti, Champa, Danadar, Gulli, Hayati, Jhurki, Lugnee, Mirabhog, Nazim pasand, Poiccha, Pherdous pasand, Shantu and Sipia.*

The cultivar Alam shahi was observed in different orchards of Bohalabari, Chondipur and Mirer chora villages. The oldest tree of *Alam shahi* was observed in an old orchard of Chondipur village, more than seventy years old. The orchard is rich in diversity and most of the trees are old which have been collected from the Jamindar (land lord) houses of Maldah and Murshidabad (West Bengal, India) by Atu Mia who was an influential land lord himself in Krisnogobindopur of Chapai Nawabganj. The number of *Alam shahi* trees surviving in this orchard is only two, older one is more than seventy five years old and younger one is around forty years old. The cultivar *Alam shahi* of this orchard owned first prize in 'Mango Festival' at Rajshahi in 1986 for the superior quality of its fruits. The cultivar was also found in the other orchards of Chondipur village which owner was Milu master, Joha Sen and Sukudi Amin who have collected the branches from Atu Mia's orchard. The number of *Alam shahi* tree recorded in Bohalabari and Mirer Chora village were only three and two, respectively.

The cultivar *Poiccha* was observed in the orchards of Bohalabari, Chondipur and Mirer chora village. The oldest tree (around seventy years) of *Poiccha* was observed in the same orchard from where the cultivar *Alamshahi* was observed and collected. The productivity of this cultivar is high and contain unusual flavor of fruits. However, there are many people who like this cultivar due to its unusual flavor.

Jhurki, Pherdous pasand and *Shantu* were observed in another orchard of Chondipur village, the age was around seventy five years. The number of trees of these three cultivars were only one each but these cultivars were also found in the orchards of Krisnogobindopur village.

Pherdous pasand is a medium sized fruit with excellent taste. The age of the tree is above sixty years and productivity is intermediate. One of the present owners, Badal Mia added that his grandfather had planted this cultivar at his own orchards at Ranihati.

The cultivar *Jhurki* from Chondipur village produces numerous small sized fruits which are sour in taste and have little market value. This cultivar had also found in the orchards of Rabu Biswas and Selim Mia at Bohalabari village and Kutu doctor at Komolakantapur village. The numbers of this cultivar in those orchards were only three (each had one) and all are mature.

Shantu was also observed in the same orchard at Chondipur village. The tree was about seventy years old and productivity was high, fruits medium sized with good taste, mature at late season. So, many people collected graft of this cultivar from this orchard. Two mature trees of this cultivar were also present in the orchard of Afsar Morol and two in the orchards of Major Sadik Ahmed and Sadequl Mia.

The fruits of *Lugnee* and *Chal guti* had been collected form an orchard of Bohalabari village. The number of *Lugnee* tree was only one in that orchard but this cultivar was also present in the other orchards of Bohalabari and Mirerchora villages. The fruits of *Lugnee* are medium in size and excellent in taste with firm texture. The appearance of the fruits is very attractive due to their glassy skin with green-yellow slash skin color. The fruits mature at mid season and the productivity of this cultivar is medium. If this cultivar gets enough publicity, it can become as a demandable commercial variety.

There are two *Chal guti* trees in the same orchard at Bohalabari village where *Lugnee* was present but the oldest (more than fifty years old) *Chal guti* tree was found in an orchard of Chondipur village. The total number of *Chal guti* tree at Chondipur was found four. This cultivar was also present in another orchard of Bohalabari village, the owner is Rabu Biswas. The fruit is large in size, taste is good, productivity is intermediate and matures at late season.

Mirabhog and *Danadar* these two cultivars were observed in Bohalabari village in the orchard of Golam Mohammad Mia. The number of *Mirabhog* tree was only one in that orchard, age was more than thirty years and its medium size fruits were excellent in taste. The *Mirabhog* was also found at Chondipur village at Badal Mia's orchard. Although the production of mature *Mirabhog* tree is low but due to its excellent taste, it has a great prospect to become as a popular commercial variety.

Danadar was another cultivar with excellent taste and large sized fruits. The number of this cultivar was also one in that orchard at Bohalabari village and the age of the tree was more than thirty years. *Danadar* was also present in Badal Mia's orchard and another was present in the orchard of Selim Biswas. The production of this mid season cultivar is intermediate.

Two tree of the cultivar of *Gulli* was observed in the two orchards of Bohalabari village. One is more than twenty years old and the other is near thirty years old (belongs to Lal Mia, Badal Mia and Sanaul Haque). This cultivar was also found at Chondipur village in Erphan's orchard which was also a mature tree. The fruit of this cultivar is small in size and the taste is fair.

Three mature tree of the cultivar *Champa* was observed at the house of Sah alam and Sultanul Alam at Bohalabari village. *Champa* was also present in the house of Gini Mia and in Shafiul Alam's orchard. The fruit of this cultivar is small in size, very sweet, excellent in taste and produce huge in number (good productivity).

The cultivar *Hayati, Nazim pasand* and *Sipia* was collected from an old orchard of Chondipur village (about eighty years). The number of *Hayati, Sipia* and *Chock choke* tree were only one each and all were mature. The fruits of *Hayati* are large and the taste is fair. This is a mid season cultivar with high productivity. Three trees of the *Sipia* was also present in the orchard of Azim Biswas at Chalkalampur village and also one tree was in the orchard of Sahabuddin Mia at Raninagar. The medium sized fruits of this cultivar are excellent in taste; productivity is intermediate with mid season maturity.

Nazim pasand, locally known as *Nora* in Badal Mia and Lal Mia's ownership, about seventy years old, is a very rare cultivar, also present in the orchard of Kamaluddin at Bohalabari village. *Nazim pasand* is a late season cultivar with intermediate productivity. The large sized fruits are soft in texture and fair in taste with low fiber. This cultivar can also be a choice to the consumers if it is introduced to them with proper exposure.

Chapai Nawabganj is one of the famous mango producing areas in Bangladesh. So, variations observed in the study areas was not an unexpected phenomenon but it is not expected that only a few varieties will get publicity and considered as commercial varieties whereas there are so many rare and superior cultivars which are present in different family orchards. The cultivars mentioned above only a small attempt to provide an idea about this matter. A detail description of the rare locally cultivated accessions along with their photographs are included in Appendix I and their dried samples are preserved in the Departmental Herbarium of Botany, University of Rajshahi, Bangladesh.

6.3. The *Gutee* Trees Collected from the Study Sites

In the past, most of the mango trees, in the study area, were seed propagated which is the main reason for the wide range of variation at infra species level. Now there are a large number of commercial and cultivated mango varieties here. As mango is a self-incompatible and cross pollinated fruit, so wide range of gene exchange is a normal phenomenon. Also, the success of fruit development depends on compatible pollen transfer, so a minimum degree of genetic variability of the trees flowering in the flowering season is essential for good fruit production. But most mango orchard owners and producers are not aware of these. During recent years, there is a widespread observation that premature fruit drop is increasing and mango productivity is declining. This may indicate the need for consideration of the above facts. There are a lot of 'gutee' trees and locally cultivated varieties at this region which are neglected but can be a great source of income and the base of varietal improvement. The short description of one hundred 'gutee' mango has been included in Appendix II to reveal the fact that the 'gutee' trees with their photographs can help to extend the market of the country and their dried samples are preserved in the Departmental Herbarium of Botany, University of Rajshahi, Bangladesh.

CHAPTER – VII

7. DISCUSSION

The present investigation attempts to document phenotypic variation and diversity among the mango (*Mangifera indica* L.) growing with the agro-climatic conditions at Chapai Nawabganj district of Bangladesh. Extensive field visits, sampling and survey were made in the six villages and found a wide range of variability for most of the characters. The result also showed the justification of categorizing the mango trees into three categories reflecting the differences in the characteristics associated with propagation, cultivation and preference, *e.g.* the commercial varieties, the cultivated varieties (local cultivars) and *'gutee'* (sexually propagated) trees. Emphasis was given on these 'gutee' trees because of their declining trend of variability.

The sample of sexually propagated 'gutee' trees collected from diverse habitats *e.g.* fallow lands, rode sides, home garden, mango orchards were found to exhibit wide variations in spite of their small numbers. In many cases in the cultivated varieties, some variabilities also recorded. The description of those varieties, in this study, is expected to help in order to assess the qualitative and quantitative characters and their inclusion in selection and breeding programs.

In the survey, a picture came out that the graft propagation technique was being used for last forty years for the wide expansion of the commercial varieties, which resulted in the decline of 'gutee' trees followed by overall reduction in the diversity of mango. It was also found that significant differences were observed for the qualitative and quantitative traits between the young (below 25 years) and old age (over 30 years) groups.

Previously a number of surveys were made in this region and mostly documented the more important 'commercial mango' varieties but in the present study special concern was given on the 'gutee' trees and less popular 'cultivated varieties' which would be needed for conservation due to their high genetic diversity and variability.

7.1. Variations on Phenotypic Characters Among Six Villages and the Three Categories of Mango Trees

In the present investigation, mango trees were selected for the study of morphological and reproductive characters of six villages under similar agro-climatic conditions. On the basis of the survey in mango orchards, fields, road sides, fallow lands, homesteads and following the opinion of the local people, the mango trees of the six villages were grouped into three categories according to Subedi *et. al.* (2005)- i) commercial varieties, ii) cultivated varieties or local cultivars and iii) sexually propagated seed-derived *'gutee'* trees to study the variations of phenotypic characters among the three categories and a distinct pattern of variation for the characters were observed. Broadly three groups of mango cultivars have also been recognized in Nepal which is all mono-embryonic in origin: i. Commercial cultivars; ii. Local cultivars and iii. 'Bijju' or chance seedlings (Kashkush *et al.* 2001; NARC 2003).

7.1.1. Qualitative Characters

Mango is a highly valued crop in Bangladesh but the information on the morphological and reproductive characters of different varieties under Chapai Nawabganj region are not complete. Here an attempt was taken to evaluate the presence of diversity of the six villages among the commercial varieties, cultivated varieties and 'gutee' trees. The tree, leaf, inflorescence, fruit and stone characters of mango showed wide range of variations. There was a significant difference for tree characters- age of the trees, tree shape, branching type, canopy structure, timber of the main trunk, productivity, time of fruit maturity and fruit bearing habit among the six villages and the three categories of mango trees. As the age of trees was divided into five point of scale, presence of mature (40^+ years) trees was observed as dominant group (Table 3.1). Among the three categories of mango trees old (30^+ years) and mature (40^+ years) trees were predominant over the other age group (Table 4.1). Variations were also observed for tree shape, branching type and canopy structure. Maximum number of trees of the six villages had symmetrical tree shape followed by irregular shape. The tall tree type which was the characteristics of relatively young trees was found in least number. Irregular canopy structure was found frequently among the six villages. The result of contingency χ^2 test confirmed the distinct variation for these characters not only among the three categories of mango trees but also among the six villages (Table 4.2, 4.3, 4.4 & 3.2, 3.3, 3.4). Moreover, significant variation was found for the quantity of the timber of the main trunk among the villages but no significant difference was found for this character among the three categories of mango trees (Table 3.5 & 4.5). It could be noted that the quantity of timber mostly depends upon the age of trees. The productivity of fruits of most of the trees of the six villages was medium followed by high production which may be due to the selection of high yielding trees by the local people especially since the last two decades. The productivity of fruits of maximum number of trees in the cultivated and 'gutee' categories was intermediate while in the commercial varieties was high. Highly significant difference was found for this tree character among the villages and among the three categories of mango trees (Table 3.6 & 4.6). This result supports the finding of Majumdar and Sharma (1990) who reported that the yield of mango is a highly variable factor which largely depends upon the cultivar. Singh (1978) reported that yield of mango also depend on the age of tree. Sarder *et. al.* (1995) studied the performance of introduced mango germplasm under Bangladesh conditions and recorded highest yield from the variety *Amrapali*. There were significant variation for the other two tree characters- time of fruit maturity and fruit bearing habit. The maximum number of trees of the six villages had alternative fruit bearing with mid season fruit maturation time (Table 3.7 & 3.8) In comparison to the cultivated varieties and 'gutee' trees, the number of late season varieties was highest in the commercial varieties (Table 4.7) which are known as "Namla" varieties by the local people. Haque *et. al.* (1993) evaluated twenty cultivars of mango at southern region of Bangladesh and recorded that the commercial variety *Gopalbhog* was the earliest to harvest and *Baromashi* was late to harvest. The time of fruit maturation is one of the most important characters for the selection of a variety for cultivation as the people get higher market price from the late season mango varieties. Alternative fruit bearing habit was observed in the highest number of 'gutee' trees in comparison with other two categories (Table 4.8).

Most of the trees of the six villages had erect leaf orientation with oval lanceolate leaf shape and acute leaf tip. Highly significant variation was observed for these characters among the six villages (Table 3.9,3.10 & 3.11) while wavy leaf margin was recorded as the most common type of leaf margin but no significant variation was found among the six villages for this character (Table 3.12). For leaf orientation and leaf margin no significant variation was observed among the commercial varieties, cultivated varieties and 'gutee' trees (Table 4.9 & 4.12) but for leaf shape and shape of leaf tip, the variations were significant (Table 4.10 & 4.11). Oval lanceolate leaf shape was most common among the three categories. Acute leaf tip was found in the highest number of trees in the commercial varieties but in the cultivated varieties and 'gutee' trees acuminate leaf tip was recorded as the most common type leaf tip. Rahim (2003) studied the characteristics of twenty two mango varieties in Mymensingh and reported acute leaf tip as the most common type of leaf tip. Tauhid and Nasir (1993) studied on the leaf characters of four mango varieties and found that the leaf shape varied from oval-lanceolate to oblong. They also found remarkable difference in the shape of leaf tip which supported the finding of the present study. It was noted that the mango trees which had erect leaf orientation with elliptic lanceolate leaf shape and flat leaf margin produced small sized fruits. According to local people, leaf margin and leaf shape can be considered as important characters for the identification of fruit size but further study is needed on this trait.

Highly significant variation was found for the shape of inflorescence among the six villages and the three categories of mango trees (Table 3.13 & 4.13). Conical shaped inflorescence was found most common among the commercial and cultivated varieties but in 'gutee' trees, the most common shape was pyramidal. Rahim (2003) reported the broadly pyramidal inflorescence shape as the most common type among the twenty two mango varieties in Mymensingh. Laxly arranged flowers on panicle were most common among the three categories of mango trees of the six villages but no significant variation was observed (Table 3.14 & 4.14). Rahim (2003) also recorded laxly arranged flowers on panicle as the most common type among the varieties. The range of flower color varied from light green with yellow slash, light green with radish slash, cream with yellow slash and cream with radish slash. Light green and cream colored flower with yellow slash were found in the maximum number of trees among the six villages (Table 3.15). The present report much agrees with that of Hossain and Talukdar (1974) who studied the panicle characteristics where its color varied from deep to light green. However, no significant variations were observed among the three categories of mango trees for this character (Table 4.15).

There was significant difference for fruit size among the six villages but most of the fruits were found medium in size (Table 3.16). Similar result was found for this fruit character under the climatic condition of Rajshahi district reported by Hossain and Talukdar (1974). Large sized fruits were found in the maximum number of trees in the commercial varieties in compare to other two categories. Fruit size is one of the main factors of human selection and these varieties obviously have undergone long period of selection as being cultivated in a large scale in the Indian Subcontinent (Singh, 1960). There was a highly significant difference among the categories for this fruit character (Table 4.16). Islam *et. al.* (1992) conducted an experiment on physico-chemical characteristics of ten mango cultivars and observed different size of fruits of different cultivars. Prasad (1977) also worked on fruit size and found highest fruit size in the variety *Bangalora*. The skin of most of the fruits among the three categories of the six villages was green, non glassy type and the variations for these characters were very highly significant (Table 3.17, 3.18 & 4.17, 4.18). Yellow skin color of fruit at ripening stage was found in a few numbers of trees in cultivated varieties and 'gutee' trees which was one of the reasons of conservation of these varieties by the local people. The yellow skin color of mature fruits attracts the consumers easily and the fruits get a higher selling price. The pulp color of ripe fruits among the commercial varieties, cultivated varieties and 'gutee' trees of the six villages varied from light yellow to deep orange and there was a highly significant variations for this trait among the three categories of the six villages (Table 3.19 & 4.19) This report was similar with the investigation carried out by Saha and Hossain (1988) who evaluated the fruit characteristics of eleven mango cultivars and reported that, the skin color at ripening stage varied from yellowish green to bright yellow and pulp color ranged from yellow to red. Sardar *et. al*. (1998) observed that fruit and skin color varied from green to yellow and yellow to orange respectively. However, the variability found in the present study confirms the findings of Mukherjee (1997), who reported that fruit color at maturity is dependent on genotype. The present investigation also agrees with Rahim (2003) who studied the mango cultivars and found the skin color of ripe fruits varied from green to yellow and pulp color varied from light yellow to orange.

Though there was no significant variation for flavor (Table 3.20 & 4.20) of mature fruit but for texture, taste and fibrousness of ripe fruits, the variations were highly significant among the three categories and among the studied villages (Table 4.21, 4.22, 4.23 & 3.21, 3.22, 3.23). Texture of ripe fruits was moderate with low fiber in most of the trees of the six villages (Table 3.21, 3.23) and taste of most of the mango was excellent followed by good (Table 3.22). This result was much similar with the findings of Anila and Radha (2003) who worked with mango varieties in Kerala. In maximum number of trees in commercial and cultivated varieties, the texture of ripe fruits was moderate while in 'gutee' trees the maximum number of ripe fruits had soft texture (Table 4.21). Firm texture of ripe fruit is considered as desirable character for suitable transportation and as table fruit, but found only in a few trees among the three categories. Taste of ripe fruits is one of the most important characters which determine the acceptability of a variety to a great extent. The maximum number of trees in the commercial and cultivated varieties had excellent taste of ripe fruits while in 'gutee' trees the maximum number of trees had fair taste for ripe fruits (Table 4.22). Several researchers have worked on fruit characters of mango. Kamaluddin (1967) in his book "Amer Chash" (Production Technology of Mango) made an attempt to describe the fruit characters of important mango varieties of Bangladesh. He described the weight, taste, flavor, skin color and time of fruit maturity of those varieties. Subedi *et. al.*(2009) have also worked on the fruit morphology of commercial varieties, local cultivars and chance seedlings in Nepal and found significant variations in fruit size, skin color, pulp color, flavor, quantity of fiber and taste. The fibrousness of ripe fruits of maximum number of trees was low in commercial varieties but moderate in the cultivated varieties and 'gutee' trees (Table 4.23). In this investigation, it was found that most of the people like low fiber containing mango varieties.

A highly significant difference was found for presence or absence of beak, sinus and basal cavity on fruits. In maximum number of trees of the six villages beak and sinus on fruit was absent and basal cavity was present (Table 3.24, 3.25 & 3.27). The beak and sinus on fruits were absent in most of the cultivated varieties and 'gutee' trees but present in the commercial varieties (Table 4.24 & 4.25). On the other hand, basal cavity was present in most of the mango trees in the commercial and cultivated varieties but absent in 'gutee' trees (Table 4.27). The most common type of apex was obtuse among the three categories of mango trees of the six villages and remarkable variations were observed for this fruit character (Table 3.26 & 4.26). Anila and Radha (2003) found beak and sinus absent and apex obtuse in most of the mango cultivars which much supports the findings of the present study. Storage quality is one of the most important characters in fruit marketing. The mango traders like those varieties which have a long period of keeping quality. The storage quality of maximum number of trees among the three categories of the six villages was 8-14 days (Table 3.28 & 4.28) but there were a number of 'gutee' trees which storage quality was 15-21 days that can be used in cross breeding programmes. Ahmed *et. al.* (1960) studied the harvesting and marketing of mango fruits. According to their research, mango cannot be stored successfully for a long period as they are very perishable fruits. They recorded the maximum storage time of ripe fruits only one month.

Stone size, presence of fiber on stone and veins on stone showed highly significant differences for both among the villages and among the three categories of mango trees. Stone size was large, presence of fiber on stone was high and vein on stone was elevated in maximum number of trees of the six villages (Table 3.29, 3.30 & 3.31). In commercial varieties stone size was large and veins on stone was elevated in most of the trees while in cultivated varieties and 'gutee' trees the stone size was medium and veins on stone was labeled in the maximum number of trees (Table 4.29 & 4.31). However, in the maximum number of trees among the three categories presence of fiber on stone was high (Table 4.30). Bakshi and Bajwa (1959) studied the stone size of sixty varieties of mango in Punjab. Guha *et. al.* (1994) reported the stone size is positively correlated with fruit size.

The distinct variation of qualitative characters among the three categories of mango trees confirms the fact that a wide range of diversity was present among the mango varieties of the study area.

7.1.2. Quantitative Characters

Many workers have studied quantitative morphological and reproductive characters to study genetic variation (Bailey and Arthral, 1946; Stephen 1949 and Rodes *et. al*,. 1970). Subedi *et. al.* (2005) studied the fruits from 216 mango cultivars in Nepal and evaluated for qualitative and quantitative characteristics to assess the genetic variation and relationships. In this study, the highly significant difference of leaf characters-petiole length, lamina length, lamina breadth and width of half leaves were recorded not only among the villages but also within the villages (Table 3.33, 3.35, 3.37 & 3.39). The most common range for petiole length was found 1-3 cm for the six villages except Mirer chora (Fig 3.1) and the mean and mode value of this village had been calculated 3.37 cm and 3.70 cm, respectively which were higher than the other villages (Table 3.32). The range of petiole length for maximum number of trees was 3.0-5.0 cm in the commercial varieties which was relatively higher than the cultivated varieties and 'gutee' trees. The most common range for this character was 1.0-3.0 cm for these two categories (Fig 4.1). The maximum number of trees of the six villages had 14-19 cm range for lamina length (Fig 3.2) and 5-7 cm range for both leaf width and width of half leaf (Fig 3.3 & 3.4). The present result is much similar with the findings of Tauhid and Nasir (1993) who found the range of lamina length from 15.88 cm to 19.72 cm and leaf width 3.5-6 cm. The range of lamina length for most of the trees in 'gutee' was 9.0-14.0 cm which was lower in comparison with other two categories (Fig 4.2) as the most common range for lamina length in the commercial and cultivated varieties were 19.0-24.0 cm followed by 14.0-19.0 cm. The most common range for lamina breadth and width of half leaf in the commercial and cultivated varieties were 5.0-7.0 cm (Fig 4.3 & 4.4). Although the 'gutee' trees had the same range for lamina breadth but for width of half leaf the most common range was 3.0-5.0 cm. The mean and mode value for the leaf characters were highest in the commercial varieties in comparison with other two categories except lamina length where the highest mean and mode value was recorded in the cultivated varieties (Table 4.32, 4.34, 4.36 & 4.38). Highly significant difference of the above mentioned leaf characters were observed not only among the three categories but also within the categories (Table 4.33, 4.35, 4.37 & 4.39). Rahim (2003) studied the leaf characters on twenty two mango cultivars in Mymensingh and found the most common range for petiole length 3.0-5.0 cm. He also recorded the range of lamina length and lamina breadth varied from 14.50-24.33 cm and 4.27-6.93 cm respectively. However, he recorded the most common range for lamina length 19.0-24.0 cm and for lamina breadth 5.0-7.0 cm which agrees with the record of present investigation to a great extent. So, one point emerge from the leaf characters is that the commercial varieties have larger leaf size, also the cultivated varieties have large leaves in compare to 'gutee' trees. This is expected as the first two were being supposed to elite types with higher productivity and larger leaves were selected during the selection for the yield and quality characters over the years.

The range of panicle length was recorded 10-50 cm although the maximum number of trees of the six villages had 20-30 cm range for panicle length (Fig 3.5). However, Islam *et. al.* (1995) of Mango Research Station, Chapai Nawabganj reported on floral characteristics of eight mango cultivars that the panicle length varied from 27.79 cm to 33.77 cm. Haque *et. al.* (1993) evaluated twenty elite mango cultivars at Southern Bangladesh stated that the panicle length varied from 26.6 cm to 46.0 cm which is similar to the present report. The range of panicle breadth for most of the mango trees of the six villages was 10-16 cm (Fig 3.6). The variations for floral characteristics among the villages and within the villages were high and significant (Table 3.41 & 3.43). However, For panicle length and panicle breadth, the most common range in the commercial and cultivated varieties was 20.0-30.0 cm and 10.0-16.0 cm respectively (Fig 4.5 & 4.6) which was relatively higher than the 'gutee' trees in which the most common range for these two quantitative traits were recorded 10.0-20.0 cm and 4.0-10.0 cm respectively. There was no significant difference for these two floral characters among the three categories of mango trees (Table 4.41 & 4.43). Rahim (2003) noted that, the most common range for panicle length and panicle breadth grown in Mymensing was 20.0-30.0 cm and 10.0-16.0 cm respectively which is very similar to the present study.

The fruit characters are the most important characters for their influence in monetary value. In the present study fruit weight, fruit length, fruit width and fruit diameter indicated high level of variation in the six villages (Table 3.45, 3.47, 3.49 & 3.51). The range of fruit weight for the maximum number of trees among the six villages was 151-300 g which indicated the medium sized fruits were the most common in these villages (Fig 3.7). The lowest range for fruit weight of the studied villages was recorded 1-150 g. while the highest range was 601-750 g. However, Mollah and Siddique (1973) found 620.4 g as the highest fruit weight. The range of fruit length, fruit breadth and fruit diameter for the six villages varied from 5-17 cm, 4-10 cm and 13-29 cm, respectively and the most common range for these characters were 8-11 cm, 6-8 cm and 21-25 cm respectively (Fig. 3.8, 3.9 & 3.10). Among the three categories of mango trees, the range of fruit weight for maximum number of trees in the cultivated varieties and 'gutee' trees was 151.0-300.0 g which was relatively lower than the commercial varieties as the range of fruit weight for the maximum number of trees of the commercial category was 301.0-450.0 g followed by 451.0-600.0 g (Fig 4.7). The higher range of fruit weight was one of the most desirable characters for selecting a variety for cultivation. The highest mean and mode had been calculated in the commercial varieties and significant variation for this trait among and within the three categories (Table 4.44 & 4.45) indicated the scope of selection. Rahim (2003) also recorded highly significant variation among the mango collection he studied found the range of fruit weight from 180.0-535.0 g. Hossain and Talukdar (1974) mentioned that the commercial variety *Fazli* had the heaviest fruit (683.27 g) and the less known variety *Bira* had the lightest fruits (113.86 g). In another study, Bhuyan and Islam (1986) recorded the highest fruit weight in the commercial variety *Fazli* (404.45 g) and lowest in cultivated variety *Khudi khirshapat* (202.88 g). However, Ghose and Hossain (1988) reported that the variety *Kalibhog* had maximum fruit weight (655 g) and *Brindaboni* had minimum one (106 g).

The range of fruit length, fruit breadth and fruit diameter for the three categories of mango trees among the six villages varied from 5-17 cm, 4-10 cm and 13-29 cm respectively (Fig 3.8, 3.9 & 3.10). According to Saha and Hossain (1988) fruit length and breadth varied from 7.6-14.1 cm and 5.9-7.3 cm while Ghose and Hossain (1988) recorded the range of fruit length and breadth 7.1- 13.1 cm and 5.4- 8.6 cm respectively. Anila and Radha (2003) found the range of fruit diameter 19-27 cm which has a little difference with the findings of the present study. There were highly significant differences for these fruit characters among the villages and within the villages (Table 3.47, 3.49 & 3.51). The most common ranges for fruit length, fruit width and fruit diameter in the cultivated varieties and 'gutee' trees was 8.0-11.0 cm, 6.0-8.0 cm and 17.0-21.0 cm respectively (Fig 4.8, 4.9 & 4.10) but in the commercial varieties the most common range for fruit length was the same as other two categories, whereas the most common range for fruit width and fruit diameter was recorded higher, 8.0-10.0 cm and 25.0-29.0 cm respectively. As expected, the highest mean and mode for these three fruit characters was found for the commercial varieties (Table 4.46, 4.48 & 4.50). The highly significant variation for the fruit characters among and within the commercial varieties, cultivated varieties and 'gutee' trees (Table 4.47, 4.49 & 4.51) indicated the wide range of variation among the existing mango trees of this region. Rahim (2003) noted the range of fruit length and fruit width from 7.56-22.36 cm and 6.56-10.89 cm respectively. Haque *et. al.* (1993) evaluated the varietal characteristics from Southern Bangladesh and recorded fruit length and fruit breadth varied from 10.0-17.0 cm and 8.5-14.7 cm respectively. Bhuyan and Islam (1986) recorded the range of fruit length 8.0-18.0 cm. They recorded the lowest fruit length in the local cultivar *Shathiarkera* (8.26 cm) and highest fruit length in the commercial variety *Fazli* (17.7 cm). They found the lowest fruit breadth in the local variety *Fonia* (6.54 cm) and highest fruit breadth in *Fazli* (10.74 cm). Chaudhari *et. al.* (1997) evaluated the South Indian mango varieties and found fruit diameter varied from 5.5-10.2 cm.

The stone weight also varied significantly among the six villages, range being 10-70 g but for most trees, the stone weight was 25-40 g (Fig 3.11). The highest mean was found in the Bohalabari village which was 44.48 g (Table 3.52) and a highly significant variation was found for this character (Table 3.53). The present report agrees with that of Haque *et. al.* (1993) who noted that the stone weight among the cultivars varied from 14-70 g. The stone weight for the three categories of mango trees varied from 10.0-70.0 g. There was highly significant variation for this character among (also within the categories) the categories (Table 4.53). The most common range of stone weight for the commercial and cultivated varieties was 41.0-55.0 g and 26.0-40.0 g respectively but in ‘gutee’ trees was 11.0-25.0 g and 26.0-40.0 g. Hossain and Talukdar (1974) recorded the highest stone weight in the variety *Dilshad* (144.58 g) and lowest in the commercial variety *Gopalbhog*. Haque *et. al.* (1993) recorded the range of stone weight varied from 14.0-70.0 g among the cultivars which agrees with the present study. Rahim (2003) noted the range of stone weight varied from 22.0-58.0 g which is similar in the present study for the commercial varieties.

For the villages, the results showed significant differences in both qualitative and quantitative characters among the six villages. This indicated a general trend in variation of morphological and reproductive characters due to the habitat differences. However, the morphological and reproductive characters showed a pattern of changes among the three categories of mango. The difference in qualitative characters for commercial varieties in comparison with other two categories were much prominent indicating long and more intense selection for characters contributing to better crop quality while the cultivated varieties showed an intermediate position in this regard and the ‘gutee’ in the lesser end. Similar pattern of changes in quantitative characters was also observed for the three categories; the commercial varieties showed better combination for performance and the cultivated varieties showed intermediate performance and both were better than the ‘gutee’ trees. The wide range of variability and distinct differences among the three categories, indicated not only the opportunity to use the desirable characters of cultivated varieties and ‘gutee’ trees in selection and cross breeding programmes for improvement but also the need of public attention to create market demand of those varieties. This finding supports the earlier studies of fruit tree species where morphological and reproductive traits have been found useful in identification and assessment of varieties for large scale fruit production (Leakey *et al.* 2000).

7.2. Variations Between the Age Groups

The qualitative and quantitative traits of the two age groups (below twenty five years and above thirty years) among the commercial varieties, cultivated varieties and 'gutee' were observed; the results showed a high range of variation for not only among the categories but also between the age groups.

7.2.1. Qualitative Characters

To find out the variations of the productive mango trees which were planted within twenty five years (below 25 years) and planted more than thirty years ago (more than 30 years); trees surveyed were termed as 'young' and 'old', respectively. During selection, a margin was kept between these two groups, the border line between the two were about 10 years. Among the different plant parts, all the tree characters for the commercial varieties, cultivated varieties and 'gutee' trees showed a highly significant variation between the two age groups. The most common tree shape for the young age group in the commercial varieties was symmetrical whereas in the cultivated varieties and 'gutee' trees the shape was irregular. For the old age group the most common tree shape for the commercial and cultivated varieties were round while for the 'gutee' trees the most common tree shape was symmetrical. The variation for this character between the two age groups was highly significant (Table 5.1, 5.2 & 5.3). It was recorded that many mango orchards which are established within last twenty five years, the owners mainly have planted the commercial varieties and have pruned the trees to keep a certain shape to allow sunlight penetration, spraying chemicals and using fertilizers. Thus in the commercial varieties the maximum number of mango trees of the young age group has got symmetrical tree shape but this technique was not implemented on the cultivated varieties and 'gutee' trees for the same age group. Medium main trunk with several branches at top was found in the maximum number of trees in the cultivated varieties for the both age groups while this type of branching was most common only for the old age group in 'gutee' trees. Slender main trunk with few branches at top was found in maximum number of trees of the commercial varieties and 'gutee' trees in case of young age group. The variations in branching pattern for the young and old age groups among the three categories were highly significant (Table 5.4, 5.5 & 5.6). The timber of the main trunk in maximum number of trees among commercial varieties, cultivated varieties and 'gutee' trees for the young age group was medium while for the old age group was good. As the quantity of timber of the main trunk largely depends on the age of the trees there was highly significant difference for this character between the two age groups among the three categories (Table 5.7, 5.8 & 5.9).

The productivity of fruits in maximum number of the trees for the young and old age groups in the commercial varieties was intermediate and high correspondingly but in the cultivated varieties was high and intermediate respectively. However, the productivity in most of 'gutee' trees for both age groups was intermediate. As commonly expected, fruit production capacity of a tree also increase with the age; but the productivity in the maximum number of trees for the young age group was high may be due to the result of selection for high productivity. The variations between the two age groups for this character were significant (Table 5.10, 5.11 & 5.12).

The fruit maturation time of maximum number of trees for the young age group in the commercial varieties and 'gutee' trees was mid season while in the cultivated varieties was late season. The time of fruit maturity of maximum number of trees in the commercial varieties for the old age group was late season whereas in the cultivated varieties and 'gutee' trees were mid season. The late season varieties have a high market demand because mango supply in the market becomes reduced, so this character is considered desirable. In the cultivated varieties, the late season fruit maturation was recorded as most common for the young age group, may be due to the selection of late season varieties which seemed to be absent in 'gutee' trees. There was significant difference for fruit maturation time between the two age groups in the commercial varieties and 'gutee' trees as well as in the cultivated varieties (Table 5.13, 5.14 & 5.15).

Distinct variation was observed for leaf characters between the young and old age groups among the commercial varieties, cultivated varieties and 'gutee' trees. Although the spreading leaf orientation was the most common type for young age group among the three categories; the variation in leaf orientation between the two age groups among the three categories was significant (Table 5.16, 5.17 & 5.18). Tauhid and Nasir (1993) also found spreading leaf orientation was most common among mango cultivars under the climatic condition of Faisalabad, Pakistan. Oval lanceolate leaf shape was recorded more common than the other two types of leaf shapes; this shape was the most common for both the age groups in the commercial varieties and 'gutee' trees and for the old age group in the cultivated varieties. The variation of leaf shape between the age groups among the three categories was highly significant (Table 5.19, 5.20 & 5.21). Wavy leaf margin was most common type and crinkled leaf margin was least common type, for both age groups among the three categories and the variations were significant (Table 5.22, 5.23 & 5.24).

The most common inflorescence shape for the both age groups in the cultivated varieties and 'gutee' trees were conical and pyramidal respectively while in the commercial varieties the most common inflorescence shape for the young age group was broadly pyramidal and the old age group was pyramidal. The variation in inflorescence shape is relatively low in 'gutee' trees. However, the variation was significant among the three categories between the two age groups for this character (Table 5.25, 5.26 & 5.27). Significant variation was also observed for floral density (Table 5.28, 5.29 & 5.30) and flower color (Table 5.31, 5.32 & 5.33) between the age groups among the three categories of mango trees.

Fruit characters showed significant difference between the young and old age groups. In commercial varieties the fruit size of maximum number of trees was medium (150-300 g) for the young age group and large (more than 300 g) for the old age group but in cultivated varieties and 'gutee' trees the fruit size of maximum number of trees was medium for both age groups. Significant variations were observed for this fruit character between the age groups among all categories (Table 5.34, 5.35 & 5.36). Also, noticeable variation was observed for skin color of mature fruits for the young and old age groups among the three categories. The most common skin color of mature fruits in the cultivated varieties and 'gutee' trees were green with yellow slash for the young age groups but green for the old age groups. In commercial varieties the most common skin color of mature fruits was green for the both age groups. Significant variation was found between the two age groups among the three categories for this character (Table 5.37, 5.38 & 5.39). Pulp color of mature fruits varied from light yellow to deep orange among the three categories of mango trees for both young and old age groups. For the young age group deep yellow and deep orange pulp color of fruits were most common in the commercial varieties, light yellow and deep yellow pulp color of fruits were most common in the cultivated varieties and light orange pulp color of fruits was most common in 'gutee' trees. For the old age groups deep yellow pulp color of mature fruits was most common in the commercial varieties and deep orange pulp color was most common in cultivated varieties. In 'gutee' trees yellow, light orange and deep orange pulp color of mature fruits were frequently found. The variations in pulp color of ripe fruits between the young and old age groups were significant among the three categories (Table 5.40, 5.41 & 5.42). The texture of mature fruit was observed soft in most of 'gutee' trees for both young and old age group while in commercial varieties the texture of mature fruit in the maximum number of trees was soft for the young age group but moderate for the old age group. The texture of mature fruit in maximum number of trees of cultivated varieties for the young age group was moderate but for the old age group was soft. There were significant variations between the two age groups among the commercial varieties, cultivated varieties and 'gutee' trees for this trait (Table 5.43, 5.44 & 5.45). Subedi *et. al*. (2009) have also found distinct variations in pulp color and texture of mango cultivars in Nepal but the skin color of mature fruits showed no significant difference.

Taste is one of the most important characters to popularize a variety among the people. The taste of fruits in maximum number of 'gutee' trees was fair for the young age group but for the old age group was good. Excellent taste of fruits was found in most of the trees for both young and old age groups in commercial varieties but the number was higher in the young age group which may be the cause of human selection process. In cultivated varieties excellent taste was found in most of the trees for both young and old age groups. Significant difference was recorded for the young and old age groups among the three categories (Table 5.46, 5.47 & 5.48). Storage quality of mature fruits for the maximum number of trees of young and old age group at room temperature were 8-14 days in commercial and cultivated varieties. Significant variations between the two age groups among the three categories for this trait were also observed (Table 5.49, 5.50 & 5. 51).

7.2.2. Quantitative Characters

Two tailed t-tests were carried out between the young and old age group for the quantitative morphological and reproductive characters. Phenotypic characters showed significant difference between the two age groups for the commercial varieties, cultivated varieties and 'gutee'. The t-values were significant for petiole length (Table 5.52, 5.53 & 5.54), lamina length (Table 5.55, 5.56 & 5.57) and lamina width (Table 5.58, 5.593 & 5.60). The mean value of the young age group was higher than the old age group in the commercial varieties for these three morphological characters while in the cultivated varieties and 'gutee' trees, the mean value of old age groups were always higher than the young age groups. The width of half leaf was significantly different for the two age groups in the commercial varieties; also the difference for this character between the age groups for the cultivated varieties and 'gutee' trees was significant (Table 5.61, 5.62 & 5.63). Only in the commercial varieties, the mean values of all the leaf characters for the young age groups were found higher than the old age groups. This difference may either be age-specific or may be some contribution of human selection for better quality or vigorous plants within the same varieties.

Significant difference was found for panicle length between the two age groups in the commercial varieties where the panicle length for young age group was higher than the old age group but in the cultivated varieties and 'gutee' trees the difference was non-significant (Table 5.64, 5.65 & 5.66). Significant difference was found for panicle breadth between the age groups in cultivated varieties but no significant difference was found between the age groups of commercial varieties and 'gutee' trees (Table 5.67, 5.68 & 5.69).

Fruit characters showed significant difference between the young and old age groups for the commercial and cultivated varieties while no significant variation was found between the age groups for the 'gutee' trees. In commercial varieties the fruit weight, fruit length, fruit width and fruit diameter of old age group was significantly higher than the young age group which may indicate that the older trees were more vigorous than the young age groups and difference between the age groups was confirmed by the t-test (Table 5.70, 5.73, 5.76 & 5.79). On the other hand; fruit weight, fruit length and fruit diameter of young age group was significantly higher than the old age group in the cultivated varieties but fruit width of old age group was significantly higher than the young age group (Table 5.71, 5.74, 5.77 & 5.80). The higher value of fruit characters for the young age group may be due to the involvement of human selection for better quality within the same varieties. However, although the fruit weight, fruit length and fruit width was higher for the old age groups in 'gutee' trees but no significant difference was found between the age groups for these fruit characters (Table 5.72, 5.75 & 5.78). There was no significant difference for fruit diameter between the two age groups of 'gutee' trees (Table 5.81). The stone weight was significantly higher for the old age group in the commercial varieties and 'gutee' trees but lower in the cultivated varieties. There was significant difference for stone weight between the age groups (Table 5.82, 5.83 & 5. 84) for the three categories of mango trees.

The differences between the young and old age groups were much pronounced for both in qualitative and quantitative characters in the commercial varieties whereas less pronounced in 'gutee' trees. The pattern of changes in the qualitative and quantitative characters between the two age groups was much prominent in commercial varieties and cultivated varieties and less prominent in 'gutee' trees. This indicates impacts of human selection process which has been largely implemented on the commercial varieties and may result in declining the variation. The selection pressure on cultivated varieties is relatively less than the commercial varieties. The 'gutee' trees may be still remaining under natural condition as these remain under limited selection pressures. Although the 'gutee' trees are rich in natural genetic resources because of the limited public interest but for the same reason these trees are declining as people are replacing these by the commercial varieties using grafting method. In a study comparing the age group differences in jackfruit, similar difference was found between 'young' and 'old' age groups indicating the effects of human selection for fruit quality and maturity (Sarker and Zuberi, 2011). The genetic diversity in mango has another important relevance in mango production. Most of the mango varieties so far examined is known to be self-incompatible, so the extent of cross pollination is very important (Sharma and Singh 1970; Dag and Gazid 1976 ; Ram 1976, Krishnaand and Singh 2007). This reveals that the steps should be taken to conserve the genetic diversity of this unique fruit.

7.3 Taxonomic Studies of Mango Cultivars

In Chapai Nawabganj commercially good quality mango varieties are mainly cultivated in those orchards which are established within twenty to thirty years. However, there are many other less known cultivated varieties and 'gutee' trees in the old orchards, and also in fallow lands, road sides, fields and homestead areas which produces fruits with great variability. The large genetic diversity, a valuable wealth that exists for mango at infra species level can be used for the varietal improvement of this fruit. In the present research, it was observed there were a number of cultivated varieties which were not only better than commercial varieties but also a source of cash to the owners. Because of the lack of publicity and documentation, in many cases, they were considered as 'gutee trees' the name commonly attached with 'inferior quality'. These cultivated varieties could be commercially utilized if they would get proper publicity by the appropriate authority. The information on varietal characterization should be available which would be a great support to the scientists engaged in the improvement of mango.

The description of fourteen rare mango cultivars (Chap-VI) named-*Alam shahi, Chalguti, Champa, Chock choke, Danadar, Gulli, Hayati, Jhurki, Lugnee, Mirabhog, Nora or Nazim pasand, Pherdous pasand, Poiccha, Shantu* and *Sipia* have been given with the photographs of different plant parts (Appendix-I) which are being cultivated not only in the studied villages but also in some other villages in that region. However, no published documents were found on these cultivated varieties and did not match with any published or unpublished records.

The survey made in the six villages to collect data on the mango at infra species levels indicated that the most of the owners had little information about the source of collection of trees of their own orchards; many were collected and planted by their ancestors. The morphological characterization has a great importance as it helps for planning a systematical breeding program. In Chapter-VI, a detailed account of mango taxonomy was presented with a proposal to introduce a suitable key for varietal identification or classification following the system of David Prain from the book Bengal Plants, Part-I (Prain, 1908) and using the keys for description from "The Mango" by Gangolly *et. al.* (1957), IBPGR Descriptor 1989 and 'Descriptor for Mango' published by IPGRI in 2006 to characterize the mango trees of commercial varieties and local cultivars (cultivated varieties) of the six villages at Chapai Nawabganj with a view that the information provided in the present study may form a basis for further research on mango documentation. For easy identification, fruit characters were used, as fruits are only available in most instances. Character like 'time of maturity' 'fruit size', 'basal cavity', 'fruit shape', 'skin color' were used to group and identify the individual entries. The keys following the IBPGER Descriptor 1989 and IPGRI Descriptor 2006 were used in several trials to test its effectiveness and it was observed that it can be successfully used by literate people if they are trained in fruit morphology and the traits used. As mentioned earlier, the description of fourteen rare cultivars which did not match with any published documents along with their photographs has been added (Chapter-VI and appendix-I) to provide help in identification. Among the fourteen cultivars *Alamshahi, Champa, Danadar, Hayati, Nazim pasand, Pherdous pasand* and *Shantu* have good possibility to become popular if necessary steps are taken and can be used for selection as parents in the breeding programs. As the large number of varieties with their multiple local names create confusion and several cultivated varieties and 'gutee' trees are undocumented and un-named; there is a need to describe and categorize the existing mango varieties systematically to make it clear.

7.4 Variations Observed in *Gutee* trees

After visiting the six villages- Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga, the data were used to study the range of diversity among the mango trees growing at Chapai Nawabganj region. The description of one hundred 'gutee' trees along with photographs (Appendix-II) have been added to reveal the fact that the 'gutee' trees can help to extend the market of the country and can be the base of varietal improvement. By the survey, a picture came out that the graft propagated trees are mostly planted within thirty years whereas the old and mature trees are propagated by seed. As, the local people of Chapai Nawabganj directly or indirectly are engaged with mango business for their livelihood so they are playing an important role to keep the variability of mango varieties of this region intentionally and unintentionally. Though there are many local cultivars besides the commercial varieties and 'gutee' trees but at present people are showing interest only on those varieties which have good productivity and market demand, the number of which are very few. At the present time, people are changing the local cultivars and 'gutee' trees into commercial varieties by using the 'Top layering' method. In this method the owners do not cut off the mango trees which they do not want, they only join 500-1000 small shoots of the desirable varieties at the top of the branches of a local cultivar or 'gutee' tree during the rainy season. If the stems join properly the leaves come out within few days and after one of two years the tree produces the fruits of the desirable variety. This method is largely implemented on the old 'gutee' trees which is a threat for their existence and cause of loss of variability. From the survey it is also revealed that the recent trend of graft propagation only for some selected commercial varieties creates a threat for the diversity and genetic resources of mango of this leading mango growing region of Bangladesh. On the other hand, the selective commercial varieties like *Fazli, Ashina, Khirshapat, Langra, Gopalbhog, Bombai and Lakhna (Lakhan bhog)* were not enough to meet the ever increasing demand of the large population of Bangladesh. Not only the less known cultivars; the 'gutee' trees can also be a substitute of the commercial varieties.

Not only that, the new areas, where the mango cultivation is expanding, the people are planting only some high yielding commercial varieties which cannot be considered as a good practice by the scientists. Many orchards are often planted with one of the good varieties, many plants grafted from the same donor (scion) which may cause pollination problem due to self-incompatibility (Dag, 1976; Ram 1976; Krishnaand and Singh 2007). The village of Mirer chora is a good example of this problem as the old *gutee* and non-commercial varieties are at risk of elimination and only few 'commercial' types are being planted, but the local people are not much conscious about this problem. Though some people have a good knowledge about the mango germplasm and are maintaining less known superior quality mango trees in their family orchards but actually they are not aware about the need for long term maintenance and conservation. Conservation of mango genetic resources is intimately interlinked with the perspective of the farmers who grow, use and market them. Due to the recalcitrant nature of mango seeds *ex-situ* conservation of mango is difficult. So, it cannot be stored in conventional gene banks (Bompard 1995). The most viable tool for the conservation of recalcitrant-seeded species is the *in-situ* conservation method as it extends the conservation of a species beyond the level of the individual to the habitat or ecosystem. It is a cheap and convenient way of conserving biological diversity where the species is allowed to grow in its natural environment in which it has been growing since a long time. This reduces the cost of conservation efforts enormously. It is possible only if the mango improvement and development is taken up as a separate programme.

CHAPTER – VIII

8. CONCLUSION AND FUTURE PROPOSED STUDY

8.1. Conclusion

The current study was carried out to document and describe the existing vegetative propagated and sexually propagated mango germplasms of the six villages at Chapai Nawabganj, the famous mango producing district of Bangladesh. To identify the present state of diversity, surveys were made to collect the data on mango germplasms of Bohalabari, Komolakantapur, Mirer chora, Chondipur, Shaheb gram and Noya lavanga villages. The morphological characterizations of three hundred fifty seven trees were divided into qualitative (31 characters) and quantitative (11 characters). The morphological characterization indicated a high level of diversity not only among the villages (Summery Table 3.54 & 3.55) but also among the commercial varieties, cultivated varieties and 'gutee' trees and between the two age groups (below 25 years & above 30 years) in the study area. The trees of the study area were divided into three categories- commercial varieties, cultivated varieties and 'gutee' trees, to identify the phenotypic range of variation among them and two hundred seventy trees (90 from each group) were selected. The result strongly indicated a pattern of morphological change among the categories. The difference for qualitative characters of the commercial varieties was more prominent than the cultivated varieties and 'gutee' trees (Summery Table 4.54). For quantitative characters, the commercial varieties showed better adaptation in respect to leaf, fruit and stone characters than the other two categories (Summery Table 4.55). As the graft propagation method is largely implemented since the last two decades and only commercial varieties are getting preference for this practice, it was expected that there might exist significant variations of qualitative and quantitative characters between the two age groups which was confirmed by the results. The difference between the two age groups for qualitative and quantitative characters were much pronounced in the commercial varieties whereas in 'gutee' trees were least pronounced (Summery Table 5.85 & 5.86). A suitable key was developed following the system of David Prain (Prain, 1908) and using the keys for description from "The Mango" by Gangolly *et. al.* (1957), IBPGR Descriptor 1989 and IPGRI Descriptor for Mango 2006, for the identification of the commercial varieties and available locally cultivated varieties of the study area. The complete description of fourteen local cultivars have been added which showed potentially good characters for marketing including excellent taste, low fiber content, good fruit weight, attractive skin color and maturation period for different seasons *etc*. However, all desired characters were not found in one unique variety. This indicated the fact that there are many locally cultivated varieties of mango which are not getting proper attention and if immediate steps are not taken many of them may become endangered or extinct before documentation. Also the descriptions of hundred 'gutee' trees (Appendix-II) have been added as an indication of the richness of variations of diversity exists in the mango populations which demand to conserve them immediately. The result of current study provides breeders with information regarding the extent of mango genetic diversity in Chapai Nawabganj as well as a means to do selections for better parents to use in crossing schemes. So, conservational steps for mango germplasm management on a sustainable basis should be taken to keep the mango genetic diversity undisturbed and stable.

8.2 Future Proposed Study.

Morpho-agronomic and morphological variability, variation between and within populations had been utilized in this attempt. Other more advanced approaches utilizing polymorphism (allelic series for a variety of traits, mean and total number of alleles per locus) and polymorphic loci, simple genetic variation (alleles, heterozygote frequency) could also be utilized. Also as measures of diversity, e.g. allele and genotype frequencies, gene diversity measure (Nei's gene diversity index), heterozygosity measurement (average heterozygosity/locus) and disequilibrium coefficients can be considered (Schnell and Knight. 1993, Schnell *et al,* 1995).

It is also true that cultivar identification based on phenotypic traits is difficult and some times inaccurate due to the influence of the environment and the limiting number of discriminating characters. So, recently, molecular identification has been employed with various molecular methods in many species of fruit trees (Wunsch and Hormaza 2002, Ukoskit, 2007). Micro satellites, or simple-sequence repeats (SSRs), have proven to be particularly valuable here, because these are multi-allelic, co-dominantly inherited, widely dispersed across the genome, easily scored, and their analysis can be automated (Morgante and Olivieri, 1993, Queller *et. al.*, 1993, Kashi, 1997). Now micro satellite markers have been developed which offer potential use for varietal identification and genome mapping (Ukoskit, 2007). Recently the genetic diversity and relationship in mango genotypes *(Mangifera indica* L.) of Malda district was investigated using random amplified polymorphic DNA (RAPD) markers (Roy and Abhishek, 2011). The materials examined in this study have been preserved for micro satellite / RAPD analysis in near future.

CHAPTER – IX

9. REFERENCES

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CHAPTER – X

10. APPENDICES

APPENDIX-I: Detail Description of Locally Cultivated Rare Accessions

I.1. Name of the Cultivar: *Alam shahi*

Place of Collection: Chapai Nawabganj (Chondipur village)

Tree Characteristics:

Age of tree:	Mature (40^{+} Yr)
Tree shape:	Symmetrical
Branching type:	Main trunk short, branches from the base
Canopy structure:	Globose
Timber of the main trunk:	Very good
Productivity:	Low
Time of fruit maturity:	Late season

Leaf Characteristics:

Leaf orientation:	Spreading
Shape of leaf:	Ovate lanceolate
Shape of leaf tip:	Acute
Leaf margin:	Crinkled
Petiole length (cm):	2.88
Lamina length (cm):	19.22
Lamina breadth (cm):	6.10
Width of half leaf (cm):	5.86

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Broadly pyramidal
Floral density:	Laxly
Flower color:	Cream with yellow slash
Panicle length (cm):	26.1
Panicle breadth (cm):	19.9

Fruit Characteristics:

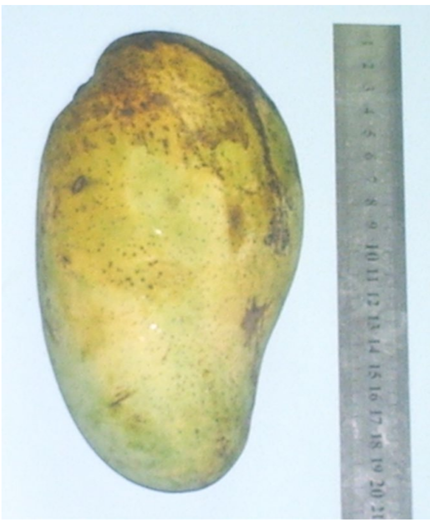
Fruit size:	Large
Fruit shape:	Oblong
Skin type:	Glassy
Skin color:	Green with yellow slash
Pulp color:	Deep yellow
Flavor:	Pleasant
Texture:	Firm
Taste:	Excellent
Fiber:	Low
Beak type:	Pointed
Sinus:	Absent
Apex:	Obtuse
Basal cavity:	Present
Storage quality (days):	7
Fruit bearing habit:	Alternate
Fresh weight (g):	688
Fruit length (cm):	16.52
Fruit width (cm):	9.08
Fruit diameter (cm):	27.32

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Labeled
Stone size:	Large
Stone weight (g):	60

A. Leaf **B. Inflorescence** **C. Mature fruits**

D. Single fruit **E. Fruit showing pulp**

Fig. App I.1 Different plant parts of *Alam shahi*

I.2. Name of the Cultivar: *Chal guti*
Place of Collection: Chapai Nawabganj (Bohalabari village)

Tree Characteristics:

Age of tree:	Medium (20^{+} Yr)
Tree shape:	Irregular
Branching type:	Main trunk medium, several branches at top
Canopy structure:	Irregular
Timber of the main trunk:	Medium
Productivity:	Intermediate
Time of fruit maturity:	Late season

Leaf Characteristics:

Leaf orientation:	Spreading
Shape of leaf:	Ovate lanceolate
Shape of leaf tip:	Sub-acuminate
Leaf margin:	Flat
Petiole length (cm):	2.66
Lamina length (cm):	17.92
Lamina breadth (cm):	5.02
Width of half leaf (cm):	4.74

Inflorescence Characteristics:

Inflorescence position:	Terminal
Inflorescence shape:	Conical
Floral density:	Laxly
Flower color:	Light green with yellow slash
Panicle length (cm):	26.0
Panicle breadth (cm):	8.1

Fruit Characteristics:

Fruit size:	Large
Fruit shape:	Ovate oblique
Skin type:	Non glassy
Skin color:	Green
Pulp color:	Light yellow
Flavor:	Pleasant
Texture:	Moderate
Taste:	Good
Fiber:	Low
Beak type:	Absent
Sinus:	Absent
Apex:	Round
Basal cavity:	Present
Storage quality (days):	8
Fruit bearing habit:	Alternate
Fresh weight (g):	546
Fruit length (cm):	13.2
Fruit width (cm):	7.9
Fruit diameter (cm):	27.52

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Depressed
Stone size:	Large
Stone weight (g):	63

A. Leaf

B. Inflorescence

C. Mature fruits

D. Single fruit

E. Fruit showing pulp

Fig. App I.2 Different plant parts of *Chal guti*

I.3. Name of the Cultivar: *Champa*

Place of Collection: Chapai Nawabganj (Bohalabari village)

Tree Characteristics:

Age of tree:	Young (10^+ Yr)
Tree shape:	Irregular
Branching type:	Main trunk medium, several branches at top
Canopy structure:	Irregular
Timber of the main trunk:	Medium
Productivity:	High
Time of fruit maturity:	Mid season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Ovate lanceolate
Shape of leaf tip:	Acuminate
Leaf margin:	Wavy
Petiole length (cm):	2.8
Lamina length (cm):	21.88
Lamina breadth (cm):	4.98
Width of half leaf (cm):	4.72

Inflorescence Characteristics:

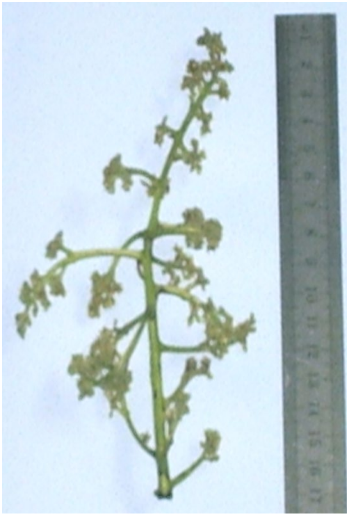
Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Conical
Floral density:	Densely
Flower color:	Light green with yellow slash
Panicle length (cm):	19.2
Panicle breadth (cm):	10.8

Fruit Characteristics:

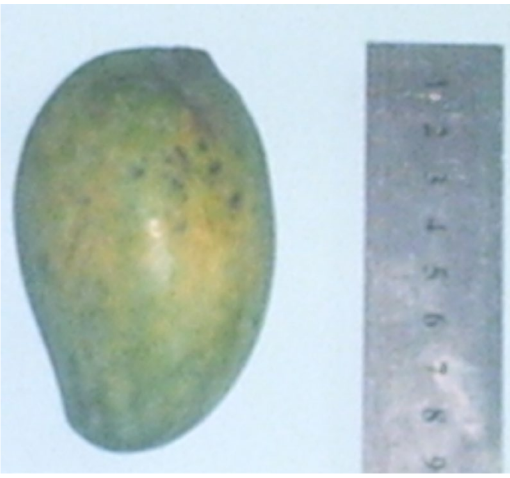
Fruit size:	Small
Fruit shape:	Oblong elliptic
Skin type:	Non glassy
Skin color:	Green with yellow slash
Pulp color:	Light yellow
Flavor:	Pleasant
Texture:	Soft
Taste:	Excellent
Fiber:	Low
Beak type:	Absent
Sinus:	Absent
Apex:	Obtuse
Basal cavity:	Absent
Storage quality (days):	10
Fruit bearing habit:	Regular
Fresh weight (g):	115
Fruit length (cm):	7.66
Fruit width (cm):	5.32
Fruit diameter (cm):	16.46

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Elevated
Stone size:	Small
Stone weight (g):	21



A. Leaf **B. Inflorescence** **C. Mature fruits**



D. Single fruit **E. Fruit showing pulp**

Fig. App I.3 Different plant parts of *Champa*

I.4. Name of the Cultivar: *Danadar*

Place of Collection: Chapai Nawabganj (Bohalabari village)

Tree Characteristics:

Age of tree:	Old (30^+ Yr)
Tree shape:	Irregular
Branching type:	Main trunk medium, several branches at top
Canopy structure:	Irregular
Timber of the main trunk:	Medium
Productivity:	Intermediate
Time of fruit maturity:	Mid season

Leaf Characteristics:

Leaf orientation:	Spreading
Shape of leaf:	Elliptic lanceolate
Shape of leaf tip:	Acute
Leaf margin:	Wavy
Petiole length (cm):	3.14
Lamina length (cm):	25.16
Lamina breadth (cm):	5.42
Width of half leaf (cm):	5.36

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Broadly pyramidal
Floral density:	Densely
Flower color:	Light green with yellow slash
Panicle length (cm):	16.6
Panicle breadth (cm):	11.4

Fruit Characteristics:

Fruit size:	Large
Fruit shape:	Oblong oblique
Skin type:	Non glassy
Skin color:	Green
Pulp color:	Deep yellow
Flavor:	Pleasant
Texture:	Soft
Taste:	Excellent
Fiber:	Medium
Beak type:	Absent
Sinus:	Absent
Apex:	Obtuse
Basal cavity:	Present
Storage quality (days):	9
Fruit bearing habit:	Alternate
Fresh weight (g):	341
Fruit length (cm):	11.46
Fruit width (cm):	8.06
Fruit diameter (cm):	24.04

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Elevated
Stone size:	Large
Stone weight (g):	55

A. Leaf

B. Inflorescence

C. Mature fruits

D. Single fruit

E. Fruit showing pulp

Fig. App I.4 Different plant parts of *Danadar*

I.5. Name of the Cultivar: *Gulli*

Place of Collection: Chapai Nawabganj (Bohalabari village)

Tree Characteristics:

Age of tree:	Medium (20^{+} Yr)
Tree shape:	Tall
Branching type:	Main trunk slender, few branches at top
Canopy structure:	Spreading
Timber of the main trunk:	Medium
Productivity:	Low
Time of fruit maturity:	Early season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Elliptic lanceolate
Shape of leaf tip:	Acuminate
Leaf margin:	Flat
Petiole length (cm):	5.3
Lamina length (cm):	25.78
Lamina breadth (cm):	6.14
Width of half leaf (cm):	6.04

Inflorescence Characteristics:

Inflorescence position:	Auxiliary
Inflorescence shape:	Broadly pyramidal
Floral density:	Densely
Flower color:	Light green with radish slash
Panicle length (cm):	23.5
Panicle breadth (cm):	12.7

Fruit Characteristics:

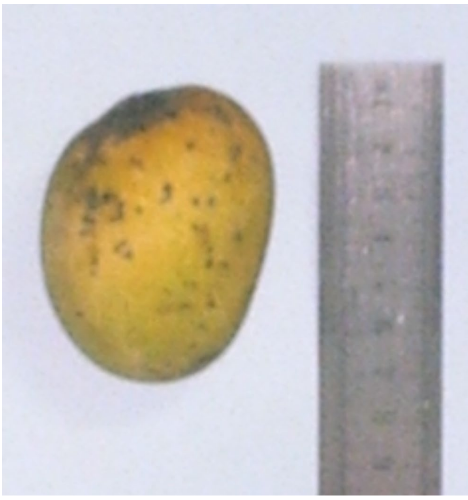
Fruit size:	Small
Fruit shape:	Roundish
Skin type:	Non glassy
Skin color:	Green with yellow slash
Pulp color:	Light yellow
Flavor:	Pleasant
Texture:	Soft
Taste:	Fair
Fiber:	Low
Beak type:	Absent
Sinus:	Absent
Apex:	Round
Basal cavity:	Present
Storage quality (days):	6
Fruit bearing habit:	Alternate
Fresh weight (g):	150
Fruit length (cm):	7.54
Fruit width (cm):	5.94
Fruit diameter (cm):	20.88

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Depressed
Stone size:	Small
Stone weight (g):	31



A. Leaf **B. Inflorescence** **C. Mature fruits**




D. Single fruit **E. Fruit showing pulp**

Fig. App I.5 Different plant parts of *Gulli*

I.6. Name of the Cultivar: *Hayati*
Place of Collection: Chapai Nawabganj (Chondipur village)

Tree Characteristics:

Age of tree:	Mature (40^{+} Yr)
Tree shape:	Irregular
Branching type:	Main trunk medium, several branches at top
Canopy structure:	Irregular
Timber of the main trunk:	Good
Productivity:	High
Time of fruit maturity:	Mid season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Elliptic lanceolate
Shape of leaf tip:	Acute
Leaf margin:	Wavy
Petiole length (cm):	2.34
Lamina length (cm):	19.76
Lamina breadth (cm):	5.78
Width of half leaf (cm):	5.70

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Broadly pyramidal
Floral density:	Densely
Flower color:	Cream with yellow slash
Panicle length (cm):	21.6
Panicle breadth (cm):	16.3

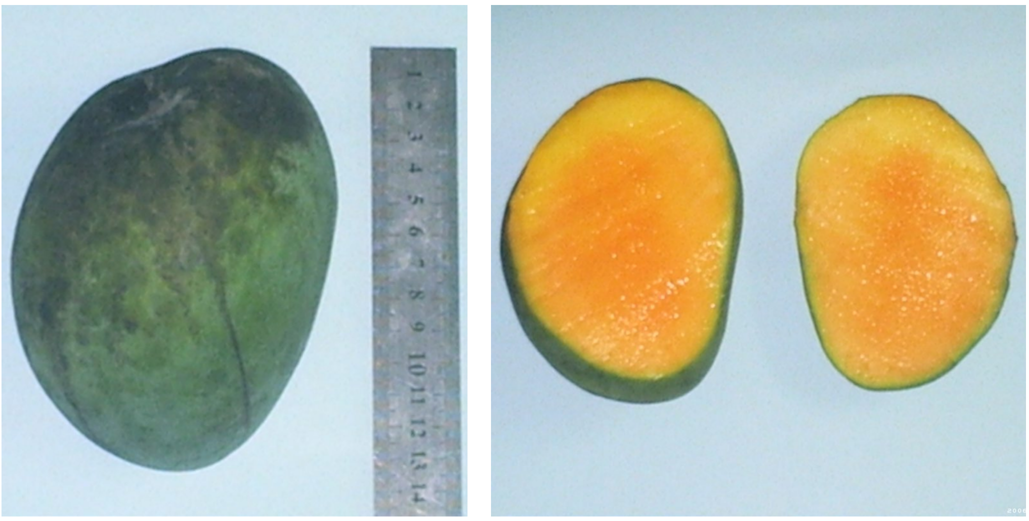
Fruit Characteristics:

Fruit size:	Large
Fruit shape:	Roundish
Skin type:	Non glassy
Skin color:	Green with yellow slash
Pulp color:	Deep yellow
Flavor:	Pleasant
Texture:	Soft
Taste:	Fair
Fiber:	Medium
Beak type:	Absent
Sinus:	Absent
Apex:	Round
Basal cavity:	Present
Storage quality (days):	12
Fruit bearing habit:	Alternate
Fresh weight (g):	482
Fruit length (cm):	10.42
Fruit width (cm):	8.94
Fruit diameter (cm):	28.76

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Labeled
Stone size:	Large
Stone weight (g):	48

A. Leaf **B. Inflorescence** **C. Mature fruits**



D. Single fruit **E. Fruit showing pulp**

Fig. App I.6 Different plant parts of *Hayati*

I.7. Name of the Cultivar: *Jhurki*

Place of Collection: Chapai Nawabganj (Chondipur village)

Tree Characteristics:

Age of tree:	Mature (40^{+} Yr)
Tree shape:	Round
Branching type:	Main trunk slender, few branches at top
Canopy structure:	Spreading
Timber of the main trunk:	Medium
Productivity:	High
Time of fruit maturity:	Mid season

Leaf Characteristics:

Leaf orientation:	Spreading
Shape of leaf:	Elliptic lanceolate
Shape of leaf tip:	Acute
Leaf margin:	Flat
Petiole length (cm):	2.52
Lamina length (cm):	15.38
Lamina breadth (cm):	4.68
Width of half leaf (cm):	4.04

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Conical
Floral density:	Laxly
Flower color:	Cream with yellow slash
Panicle length (cm):	34.5
Panicle breadth (cm):	14.9

Fruit Characteristics:

Fruit size:	Small
Fruit shape:	Oblong oval
Skin type:	Non glassy
Skin color:	Green
Pulp color:	Light orange
Flavor:	Pleasant
Texture:	Soft
Taste:	Sour
Fiber:	Low
Beak type:	Absent
Sinus:	Absent
Apex:	Obtuse
Basal cavity:	Present
Storage quality (days):	7
Fruit bearing habit:	Regular
Fresh weight (g):	63
Fruit length (cm):	6.22
Fruit width (cm):	4.38
Fruit diameter (cm):	13.74

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Elevated
Stone size:	Small
Stone weight (g):	15



A. Leaf **B. Inflorescence** **C. Mature fruits**


D. Single fruit **E. Fruit showing pulp**

Fig. App I.7 Different plant parts of *Jhurki*

I.8. Name of the Cultivar: *Lugnee*

Place of Collection: Chapai Nawabganj (Bohalabari village)

Tree Characteristics:

Age of tree:	Mature (40^+ Yr)
Tree shape:	Irregular
Branching type:	Main trunk short, branches from the base
Canopy structure:	Irregular
Timber of the main trunk:	Good
Productivity:	Intermediate
Time of fruit maturity:	Mid season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Oval lanceolate
Shape of leaf tip:	Sub-acuminate
Leaf margin:	Flat
Petiole length (cm):	2.88
Lamina length (cm):	18.38
Lamina breadth (cm):	5.28
Width of half leaf (cm):	5.18

Inflorescence Characteristics:

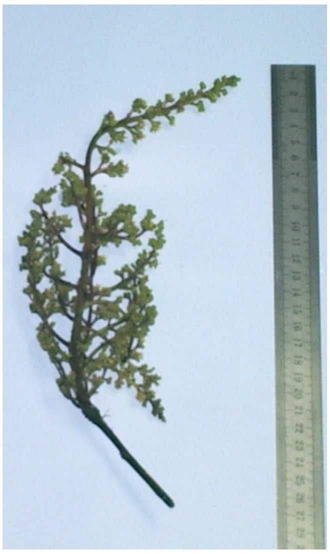
Inflorescence position:	Terminal
Inflorescence shape:	Pyramidal
Floral density:	Laxly
Flower color:	Light green with yellow slash
Panicle length (cm):	22.6
Panicle breadth (cm):	13.8

Fruit Characteristics:

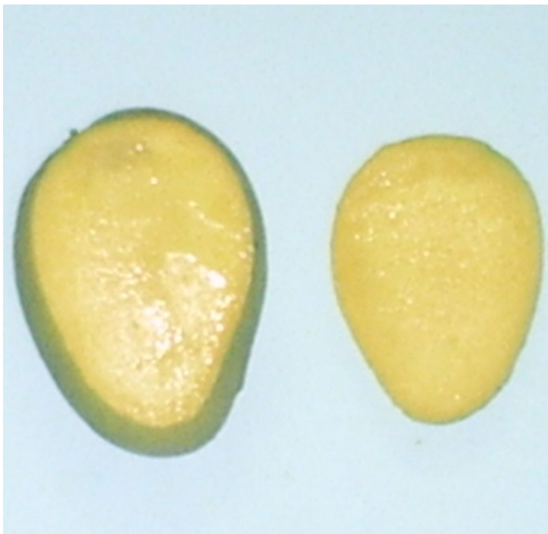
Fruit size:	Medium
Fruit shape:	Ovate oblong
Skin type:	Glassy
Skin color:	Green with yellow slash
Pulp color:	Light yellow
Flavor:	Pleasant
Texture:	Firm
Taste:	Excellent
Fiber:	Medium
Beak type:	Prominent
Sinus:	Absent
Apex:	Round
Basal cavity:	Present
Storage quality (days):	15
Fruit bearing habit:	Alternate
Fresh weight (g):	169
Fruit length (cm):	8.52
Fruit width (cm):	6.32
Fruit diameter (cm):	19.34

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Labeled
Stone size:	Medium
Stone weight (g):	31



A. Leaf **B. Inflorescence** **C. Mature fuits**



D. Single fruit **E. Fruit showing pulp**

Fig. App I.8 Different plant parts of *Lugnee*

I.9. Name of the Cultivar: *Mirabhog*
Place of Collection: Chapai Nawabganj (Bohalabari village)

Tree Characteristics:

Age of tree:	Old (30^+ Yr)
Tree shape:	Symmetrical
Branching type:	Main trunk slender, few branches at top
Canopy structure:	Globose
Timber of the main trunk:	Very poor
Productivity:	Low
Time of fruit maturity:	Mid season

Leaf Characteristics:

Leaf orientation:	Spreading
Shape of leaf:	Elliptic lanceolate
Shape of leaf tip:	Sub-acuminate
Leaf margin:	Wavy
Petiole length (cm):	3.54
Lamina length (cm):	22.22
Lamina breadth (cm):	5.5
Width of half leaf (cm):	5.42

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Conical
Floral density:	Densely
Flower color:	Light green with yellow slash
Panicle length (cm):	25.6
Panicle breadth (cm):	10.3

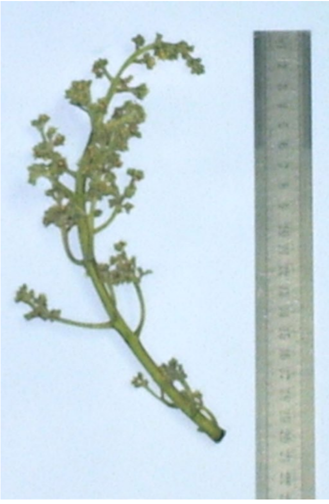
Fruit Characteristics:

Fruit size:	Medium
Fruit shape:	Oblong oblique
Skin type:	Non glassy
Skin color:	Green with yellow slash
Pulp color:	Yellow
Flavor:	Pleasant
Texture:	Moderate
Taste:	Excellent
Fiber:	Low
Beak type:	Absent
Sinus:	Absent
Apex:	Obtuse
Basal cavity:	Present
Storage quality (days):	12
Fruit bearing habit:	Alternate
Fresh weight (g):	291
Fruit length (cm):	10.78
Fruit width (cm):	7.52
Fruit diameter (cm):	23.2

Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Depressed
Stone size:	Medium
Stone weight (g):	52

A. Leaf



B. Inflorescence

C. Mature fruits

D. Single fruit

E. Fruit showing pulp

Fig. App I.9 Different plant parts of *Mirabhog*

I.10. Name of the Cultivar: *Nazim pasand*

Place of Collection: Chapai Nawabganj (Chondipur village)

Tree Characteristics:

Age of tree:	Mature (40^{+} Yr)
Tree shape:	Symmetrical
Branching type:	Main trunk medium, several branches at top
Canopy structure:	Globose
Timber of the main trunk:	Good
Productivity:	Intermediate
Time of fruit maturity:	Late season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Oval lanceolate
Shape of leaf tip:	Acuminate
Leaf margin:	Flat
Petiole length (cm):	3.3
Lamina length (cm):	17.42
Lamina breadth (cm):	5.5
Width of half leaf (cm):	5.34

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Conical
Floral density:	Densely
Flower color:	Cream with yellow slash
Panicle length (cm):	25.7
Panicle breadth (cm):	8.4

Fruit Characteristics:

Fruit size:	Large
Fruit shape:	Ovate
Skin type:	Non glassy
Skin color:	Green with yellow slash
Pulp color:	Light yellow
Flavor:	Pleasant
Texture:	Soft
Taste:	Fair
Fiber:	Low
Beak type:	Pointed
Sinus:	Absent
Apex:	Obtuse
Basal cavity:	Present
Storage quality (days):	7
Fruit bearing habit:	Alternate
Fresh weight (g):	329
Fruit length (cm):	10.44
Fruit width (cm):	8.3
Fruit diameter (cm):	24.76

Stone Characteristics:

Presence of fiber:	Present
Veins on stone:	Depressed
Stone size:	Large
Stone weight (g):	41

A. Leaf

B. Inflorescence

C. Mature fruits

D. Single fruit

E. Fruit showing pulp

Fig. App I.10 Different plant parts of *Nazim pasand*

I.11. Name of the Cultivar: *Poiccha*

Place of Collection: Chapai Nawabganj (Chondipur village)

Tree Characteristics:

Age of tree:	Mature (40^+ Yr)
Tree shape:	Irregular
Branching type:	Main trunk medium, several branches at top
Canopy structure:	Irregular
Timber of the main trunk:	Medium
Productivity:	High
Time of fruit maturity:	Late season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Elliptic lanceolate
Shape of leaf tip:	Acute
Leaf margin:	Wavy
Petiole length (cm):	2.76
Lamina length (cm):	16.12
Lamina breadth (cm):	4.22
Width of half leaf (cm):	4.12

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Broadly pyramidal
Floral density:	Laxly
Flower color:	Cream with yellow slash
Panicle length (cm):	23.3
Panicle breadth (cm):	14.2

Fruit Characteristics:

Fruit size:	Medium
Fruit shape:	Ovate oblong
Skin type:	Non glassy
Skin color:	Green
Pulp color:	Light yellow
Flavor:	Unpleasant
Texture:	Moderate
Taste:	Fair
Fiber:	Low
Beak type:	Absent
Sinus:	Present
Apex:	Obtuse
Basal cavity:	Present
Storage quality (days):	10
Fruit bearing habit:	Regular
Fresh weight (g):	170
Fruit length (cm):	8.82
Fruit width (cm):	6.56
Fruit diameter (cm):	19.16

Stone Characteristics:

Presence of fiber:	Present
Veins on stone:	Depressed
Stone size:	Medium
Stone weight (g):	34

A. Leaf

B. Inflorescence

C. Mature fruits

D. Single fruit

E. Fruit showing pulp

Fig. App I.11 Different plant parts of *Poiccha*

I.12. Name of the Cultivar: *Pherdous pasand*

Place of Collection: Chapai Nawabganj (Chondipur village)

Tree Characteristics:

Age of tree:	Mature (40^+ Yr)
Tree shape:	Round
Branching type:	Main trunk short, branches from the base
Canopy structure:	Globose
Timber of the main trunk:	Very good
Productivity:	Intermediate
Time of fruit maturity:	Mid season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Ovate lanceolate
Shape of leaf tip:	Acute
Leaf margin:	Crinkled
Petiole length (cm):	2.76
Lamina length (cm):	15.94
Lamina breadth (cm):	4.96
Width of half leaf (cm):	4.82

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Broadly pyramidal
Floral density:	Densely
Flower color:	Light green with radish slash
Panicle length (cm):	32.2
Panicle breadth (cm):	18.3

Fruit Characteristics:

Fruit size:	Medium
Fruit shape:	Obliquely oval
Skin type:	Non glassy
Skin color:	Green with yellow slash
Pulp color:	Light orange
Flavor:	Pleasant
Texture:	Soft
Taste:	Good
Fiber:	Medium
Beak type:	Absent
Sinus:	Absent
Apex:	Obtuse
Basal cavity:	Present
Storage quality (days):	8
Fruit bearing habit:	Alternate
Fresh weight (g):	246
Fruit length (cm):	10.08
Fruit width (cm):	7.28
Fruit diameter (cm):	22.14

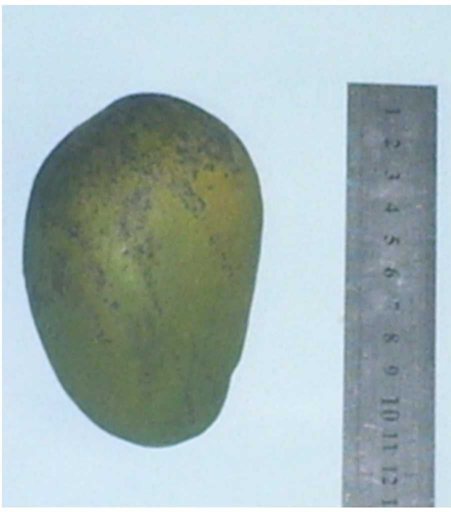
Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Elevated
Stone size:	Medium
Stone weight (g):	43

A. Leaf

B. Inflorescence

C. Mature fruits



D. Single fruit

E. Fruit showing pulp

Fig. App I.12 Different plant parts of *Pherdous pasand*

I.13. Name of the Cultivar: *Sipia*

Place of Collection: Chapai Nawabganj (Chondipur village)

Tree Characteristics:

Age of tree:	Mature (40^{+} Yr)
Tree shape:	Round
Branching type:	Main trunk medium, several branches at top
Canopy structure:	Globose
Timber of the main trunk:	Good
Productivity:	Intermediate
Time of fruit maturity:	Mid season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Elliptic lanceolate
Shape of leaf tip:	Acute
Leaf margin:	Flat
Petiole length (cm):	1.66
Lamina length (cm):	20.14
Lamina breadth (cm):	5.24
Width of half leaf (cm):	5.16

Inflorescence Characteristics:

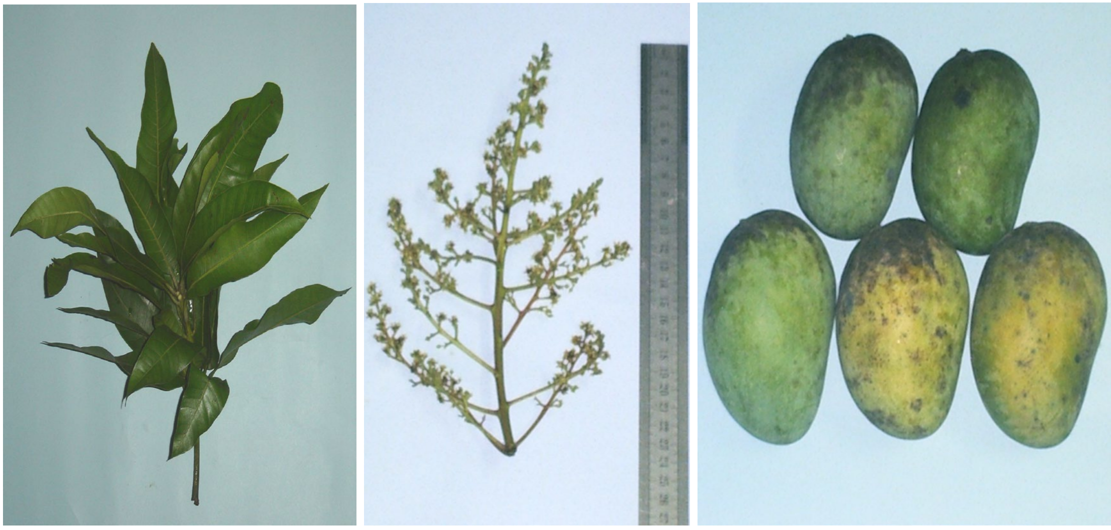
Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Broadly pyramidal
Floral density:	Laxly
Flower color:	Cream with yellow slash
Panicle length (cm):	21.9
Panicle breadth (cm):	18.3

Fruit Characteristics:

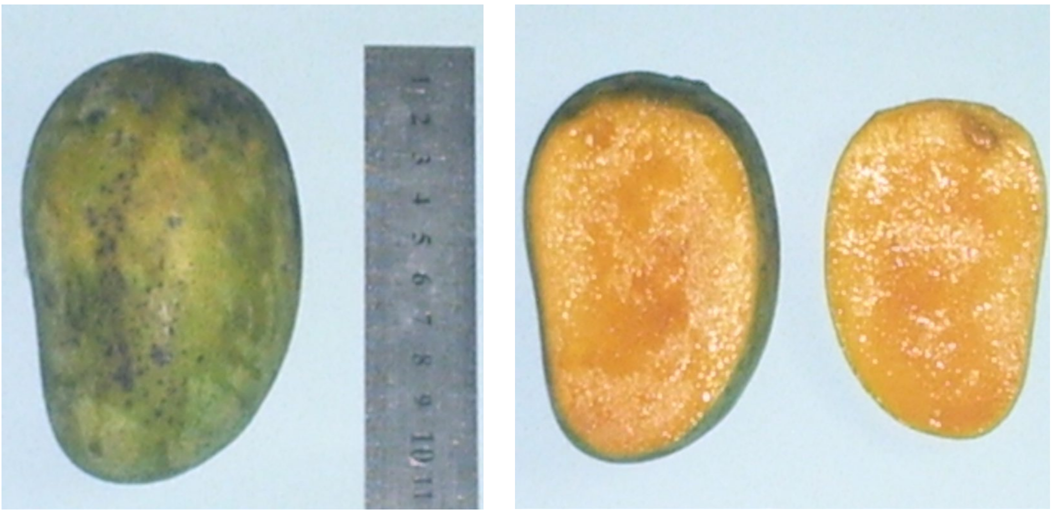
Fruit size:	Medium
Fruit shape:	Oblong oval
Skin type:	Non glassy
Skin color:	Green with yellow slash
Pulp color:	Deep orange
Flavor:	Pleasant
Texture:	Soft
Taste:	Excellent
Fiber:	Low
Beak type:	Absent
Sinus:	Absent
Apex:	Obtuse
Basal cavity:	Present
Storage quality (days):	9
Fruit bearing habit:	Alternate
Fresh weight (g):	229
Fruit length (cm):	9.68
Fruit width (cm):	6.44
Fruit diameter (cm):	20.06

Stone Characteristics:

Presence of fiber:	Present
Veins on stone:	Labeled
Stone size:	Medium
Stone weight (g):	30



A. Leaf　　B. Inflorescence　　Mature fruits



D. Single fruit　　E. Fruit showing pulp

Fig. App I.13 Different plant parts of *Sipia*

I.14. Name of the Cultivar: *Shantu*

Place of Collection: Chapai Nawabganj (Chondipur village)

Tree Characteristics:

Age of tree:	Mature (40^{+} Yr)
Tree shape:	Round
Branching type:	Main trunk short, branches from the base
Canopy structure:	Globose
Timber of the main trunk:	Very good
Productivity:	High
Time of fruit maturity:	Late season

Leaf Characteristics:

Leaf orientation:	Erect
Shape of leaf:	Oval lanceolate
Shape of leaf tip:	Acute
Leaf margin:	Wavy
Petiole length (cm):	3.16
Lamina length (cm):	19.64
Lamina breadth (cm):	5.84
Width of half leaf (cm):	5.68

Inflorescence Characteristics:

Inflorescence position:	Terminal and auxiliary
Inflorescence shape:	Conical
Floral density:	Laxly
Flower color:	Cream with yellow slash
Panicle length (cm):	27.2
Panicle breadth (cm):	12.1

Fruit Characteristics:

Fruit size:	Medium
Fruit shape:	Oblong oval
Skin type:	Non glassy
Skin color:	Green
Pulp color:	Light orange
Flavor:	Pleasant
Texture:	Moderate
Taste:	Good
Fiber:	Medium
Beak type:	Absent
Sinus:	Absent
Apex:	Round
Basal cavity:	Present
Storage quality (days):	10
Fruit bearing habit:	Alternate
Fresh weight (g):	348
Fruit length (cm):	12.1
Fruit width (cm):	8.48
Fruit diameter (cm):	22.78

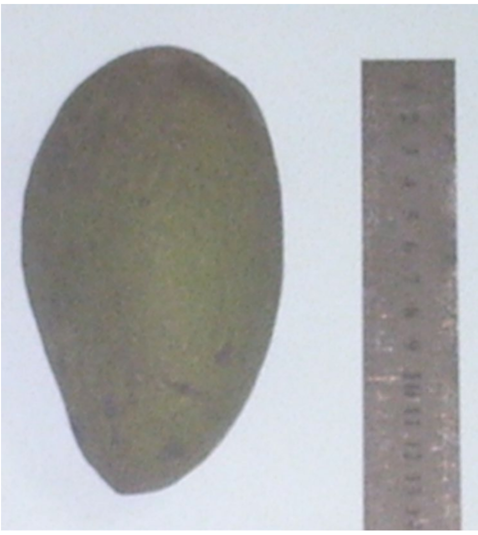
Stone Characteristics:

Presence of fiber:	Absent
Veins on stone:	Labeled
Stone size:	Large
Stone weight (g):	60

A. Leaf

B. Inflorescence

C. Mature fruits



D. Single fruit

E. Fruit showing pulp

Fig. App I.14 Different plant parts of *Shantu*

APPENDIX-II: Detail Description of *Gutee* Trees Collected from the Villages

II.1. *Gutee*- 1 (local name *Nokkani*)

The 'gutee' is known as *Nokkani* and was collected from the Bohalabari village. The name is given by the owner due to its beak. The fruit is medium in size, ovate, skin glassy, skin color yellow with green slash, pulp color deep yellow, flavor pleasant, texture soft, taste fair, fiber medium, beak pointed, sinus absent, apex obtuse and basal cavity absent. The average weight of this fruit is 155 g, the average length is 7.96 cm, the average width is 5.36 cm and the average diameter is 17.2 cm. The stone size is small, average weight is 27 g. After ripening the fruit can be stored for twelve days. It is a mid season 'gutee' with alternative fruit bearing and intermediate productivity.

II.2. *Gutee*- 2 (local name *Khatashe*)

The 'gutee' is locally known as *Khatashe* and was collected from the Chondipur village. The name is given by the local people due to its taste. The meaning of Khatas is sour. The fruit is medium in size, obliquely oval, skin glassy, skin color of ripe fruit yellow, pulp color light yellow, flavor unpleasant, texture moderate, taste sour and sweet, fiber high, beak pointed, sinus present, apex round and basal cavity present. The average weight of this fruit is 270 g, the average length is 9.98 cm, the average width is 6.28 cm and the average diameter is 20.88 cm. The stone size is small and average weight is 37 g. After ripening the fruit can be stored for thirteen days. It is a mid season 'gutee' which fruit bearing is regular and productivity is high.

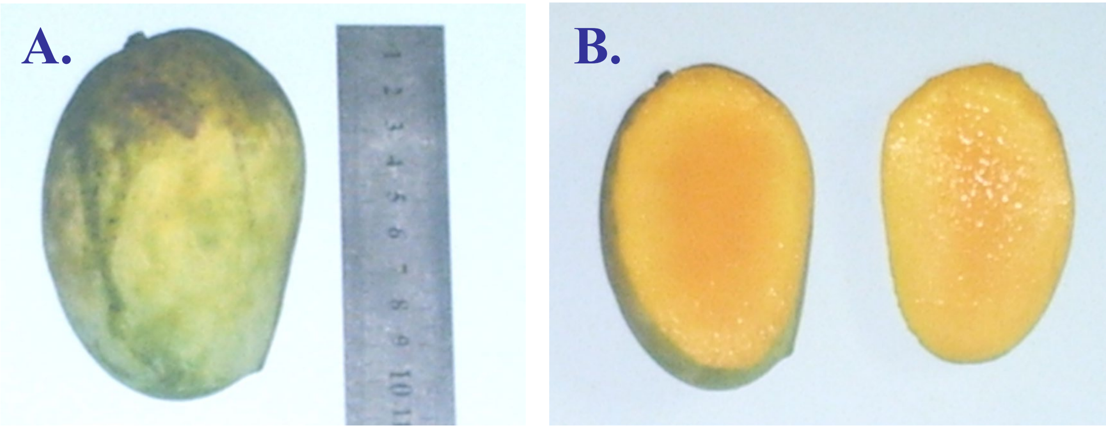


Fig. App II.1 Single fruit (A) and fruit showing pulp (B) of *Nokkani*

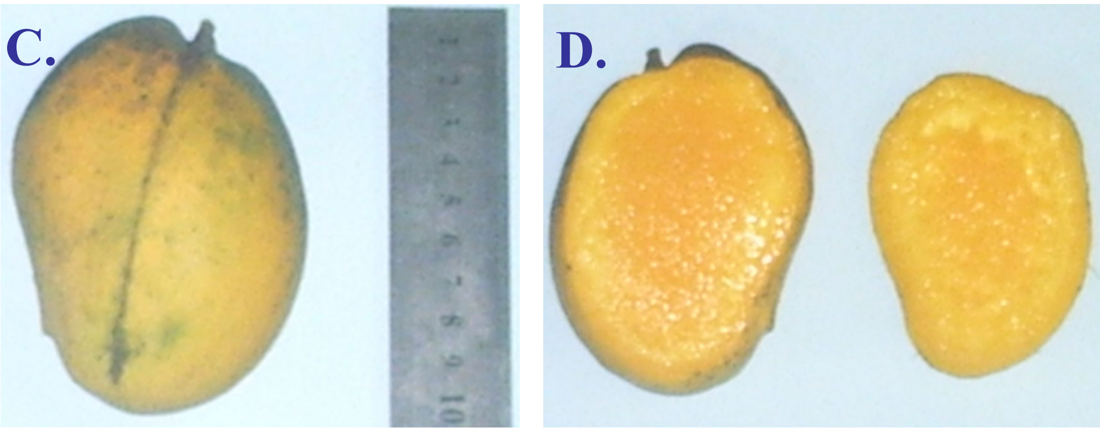


Fig. App II.2 Single fruit (C) and fruit showing pulp (D) of *Khatashe*

II.3. *Gutee*- 3

The 'gutee' was collected from the Komolakantapur village. The fruit is medium in size, oblong oblique, skin non glassy, skin color of ripe fruit is green with orange slash, pulp color deep orange, flavor pleasant, texture soft, taste fair, fiber low, beak absent, sinus absent, apex round and basal cavity present. The average fruit weight, length, width and diameter are 226 g, 12.24 cm, 7.16 cm and 20.24 cm respectively. The stone size is large and average stone weight is 29 g. After ripening the fruit can be stored for 13 days. It is a mid season 'gutee' which fruit bearing is regular and productivity is intermediate.

II.4. *Gutee* - 4

The 'gutee' was collected from the Komolakantapur village. The fruit is medium in size, obliquely oval, skin non glassy, skin color of ripe fruit is green with yellow slash, pulp color deep orange, flavor pleasant, texture soft, taste excellent, fiber low, beak absent, sinus absent, apex obtuse and basal cavity present. The average weight of this fruit is 181 g, the average length is 8.36 cm, the average width is 6.3 cm and average diameter is 19.62 cm. The stone size is medium and average stone weight is 22 g. Storage quality of ripe fruit is 12 days, matures at mid season, fruit bearing regular and productivity intermediate.

II.5. *Gutee*- 5

The fruit of this 'gutee' was medium and collected from the Komolakantapur village. The fruit is oblong, skin non glassy, skin color of ripe fruit is green with yellow slash, pulp color deep yellow, flavor pleasant, texture soft, taste excellent, fiber low, beak absent, sinus absent, apex acute and basal cavity present. The average fruit weight, length, width and diameter are 262 g, 10.4 cm, 6.84 cm and 22.42 cm respectively. The stone size is large and average stone weight is 32 g. The storage quality of ripe fruit is fifteen days and matures at mid season. The fruit bearing is alternative and productivity is intermediate.

II.6. *Gutee*- 6

Gutee of similar character was also collected from the Komolakantapur village. The fruit is medium, oblong, skin non glassy, skin color of ripe fruit is green, pulp color light yellow, flavor pleasant, texture soft, taste fair, fiber low, beak pointed, sinus absent, apex acute and basal cavity absent. The average weight of this fruit is 185 g, the average length is 10.76 cm, the average width is 6.76 cm and average diameter is 18.98 cm. The stone size is large and average stone weight is 28 g. After ripening the fruit can be stored for twelve days. It is a mid season 'gutee', fruit bearing is regular and productivity is high.

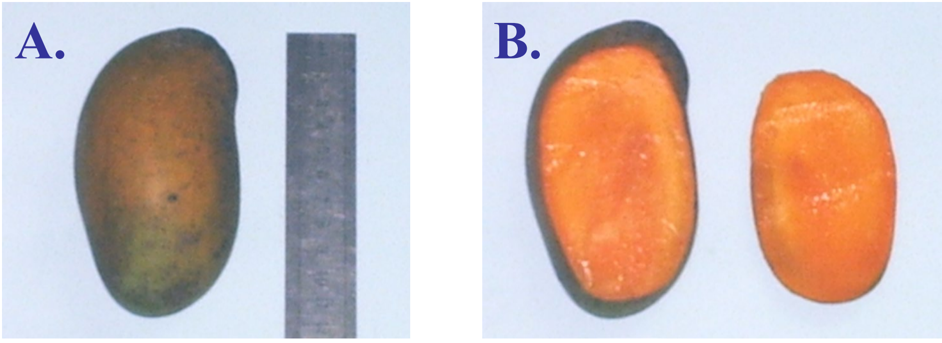


Fig. App II.3 Single fruit (A) and fruit showing pulp (B) of *Gutee*-3

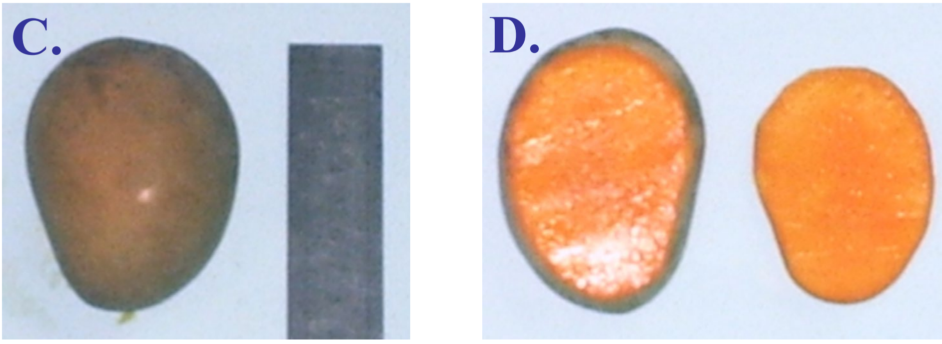


Fig. App II.4 Single fruit (C) and fruit showing pulp (D) of *Gutee*-4

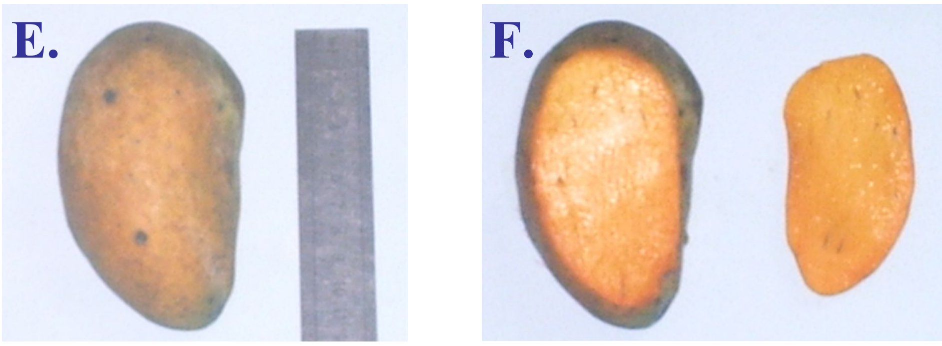


Fig. App II.5 Single fruit (E) and fruit showing pulp (F) of *Gutee*-5

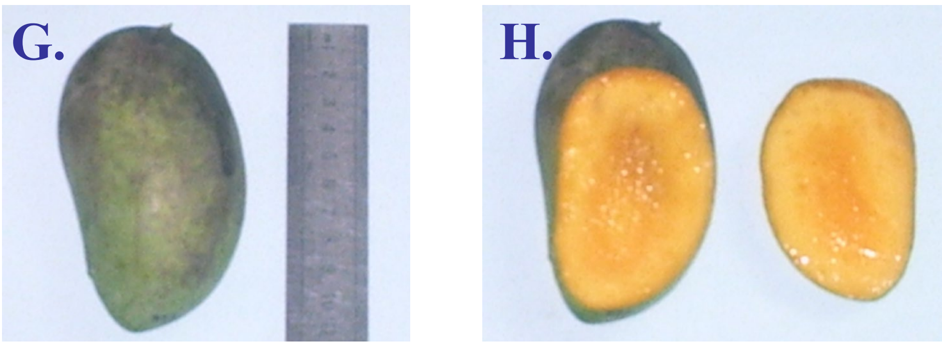


Fig. App II.6 Single fruit (G) and fruit showing pulp (H) of *Gutee*-6

II.7. *Gutee*- 7

The fruit of this 'gutee' was collected from Komolakantapur village and size is medium. The fruit shape is oblong oval, skin non glassy, skin color of ripe fruit is green with yellow slash, pulp color light orange, flavor pleasant, texture soft, taste good, fiber low, beak and sinus absent, apex obtuse and basal cavity absent. The average weight, length, width and diameter of fruit are 170 g, 8.24 cm, 6.08 cm and 19.26 cm respectively. The stone size is medium and average stone weight is 20 g. After ripening the fruit can be stored for about nine days. It is a mid season 'gutee' with alternative fruit bearing and high productivity.

II.8. *Gutee*- 8

The 'gutee' collected from the Komolakantapur village is high productive and fruit bearing habit is regular which matures in mid season and storage quality is about 15 days. The fruit is medium, ovate oblong, skin non glassy, skin color of ripe fruit green with yellow slash, pulp color deep orange, flavor pleasant, texture firm, taste good, fiber medium, beak pointed, apex obtuse, sinus and basal cavity present. The average weight, length, width and diameter are 155 g, 7.76 cm, 6.08 cm and 18.8 cm respectively. The stone is medium in size and average stone weight is 31 g.

II.9. *Gutee*- 9

The fruit collected from Komolakantapur village was medium in size, oblong oval, skin non glassy, skin color of ripe fruit yellow, pulp color deep orange, flavor pleasant, texture firm, taste good, fiber medium, beak absent, sinus absent, apex round and basal cavity absent. The average weight of this fruit is 176 g, the average length is 9.04 cm, the average width is 6.46 cm and average diameter is 19.4 cm. The stone size is medium, average weight is 28 g. After ripening the fruit can be stored for about 12 days. It is a mid season 'gutee', fruit bearing is regular and productivity is high.

II.10. *Gutee*- 10

The productivity of the 'gutee' is high, fruits mature at mid season, fruit bearing is alternative and was collected from Komolakantapur. The medium sized fruit is oblong oblique with non glassy green with yellow slashed skin, light orange pulp and fair taste. The flavor is pleasant, texture moderate, fiber medium, beak pointed, sinus absent, apex obtuse and basal cavity present. The average weight of this fruit is 204 g, the average length is 9.44 cm, the average width is 6.06 cm and average diameter is 19.16 cm. The stone size is large, average weight is 24 g. After ripening the fruit can be stored for 13 days.

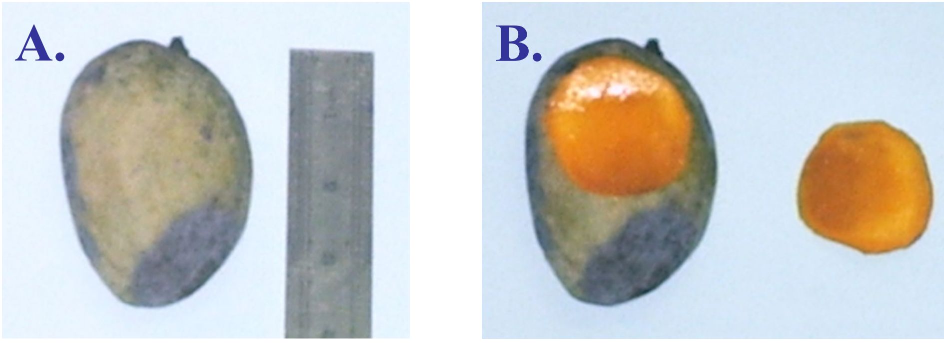


Fig. App II.7 Single fruit (A) and fruit showing pulp (B) of *Gutee*-7

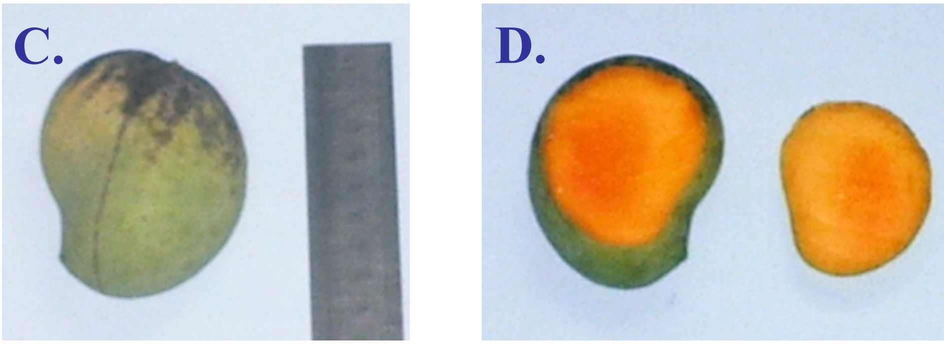


Fig. App II.8 Single fruit (C) and fruit showing pulp (D) of *Gutee*-8

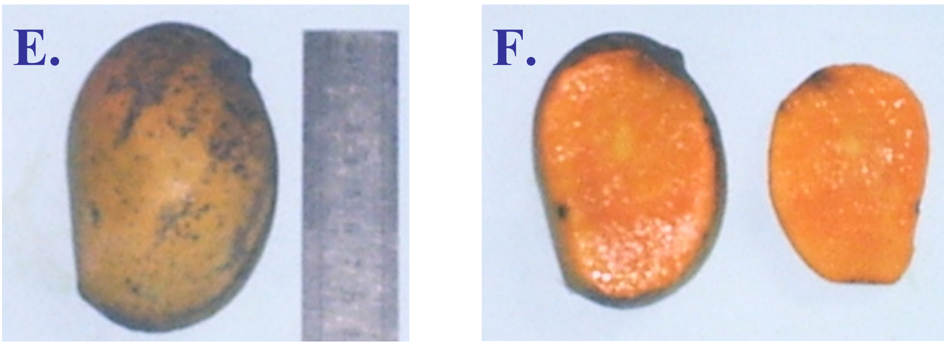


Fig. App II.9 Single fruit (E) and fruit showing pulp (F) of *Gutee*-9

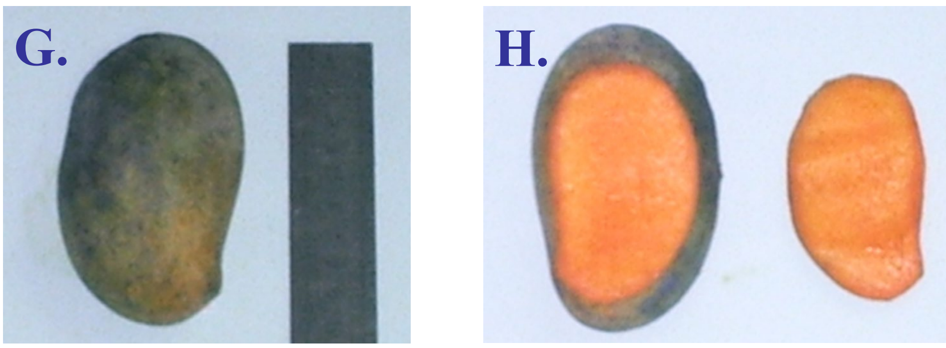


Fig. App II.10 Single fruit (G) and fruit showing pulp (H) of *Gutee*-10

II.11. *Gutee*- 11

The productivity of this mid season 'gutee' is high; fruit bearing is alternative with at least fifteen days storage quality. The fruit is large in size, ovate oblong, skin of ripe fruit is non glassy and green with light orange pulp and fair taste. The flavor is pleasant, texture soft but quantity of fiber is high. The Beak, sinus and basal cavity is absent while apex is obtuse. The average weight, length, width and diameter of this fruit are 328 g, 12.2 cm, 8.08 cm and 23.96 cm respectively. The average weight of large sized stone is 28 g. This 'gutee' with similar character was also collected from Komolakantapur village.

II.12. *Gutee*- 12

The shape of the small sized 'gutee' is oval and productivity is intermediate which matures at mid season. The skin of the ripe fruit is green and non glassy, the pulp is light yellow, flavor pleasant, texture soft, taste is fair, fiber low, beak and sinus is absent, apex obtuse and basal cavity is present. The fruit bearing habit is alternative and storage quality is ten days. The average weight of the fruit is 129 g, average length is 7.64 cm, average width 5.72 cm and the average diameter is 18.6 cm. The stone is medium and average weight is 19 g. This 'gutee' was collected from Komolakantapur.

II.13. *Gutee*- 13

The productivity of the 'gutee' is high which matures at late season and fruit bearing is alternative with at least fourteen days storage quality. The medium sized fruit is oblong with non glassy green colored skin, deep orange pulp and excellent taste with pleasant flavor. The fruit texture is soft, fiber low; apex obtuse but beak, sinus and basal cavity is absent. The average weight of this fruit is 176 g, the average length is 6.54 cm, the average width is 5.88 cm and the average diameter is 18.18 cm. The stone is medium with average weight 22 g. This 'gutee' was collected from Komolakantapur.

II.14. *Gutee*- 14

The fruit is medium, oblong, skin non glassy and green with orange slash, pulp color deep orange, flavor pleasant, texture soft, taste excellent and fiber low. The beak, sinus and basal cavity is absent and apex obtuse. The fruit bearing is alternative and can be stored for 14 days. The average weight, length, width and diameter of fruit are 278 g, 9.54 cm, 7.3 cm and 22.4 cm respectively. The stone size is medium, average weight is 28 g. This high productive mid season 'gutee' was collected from Komolakantapur.

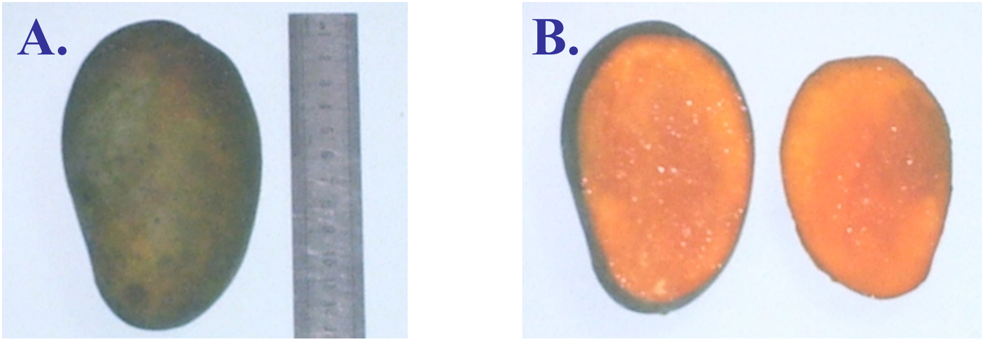


Fig. App II.11 Single fruit (A) and fruit showing pulp (B) of *Gutee*-11

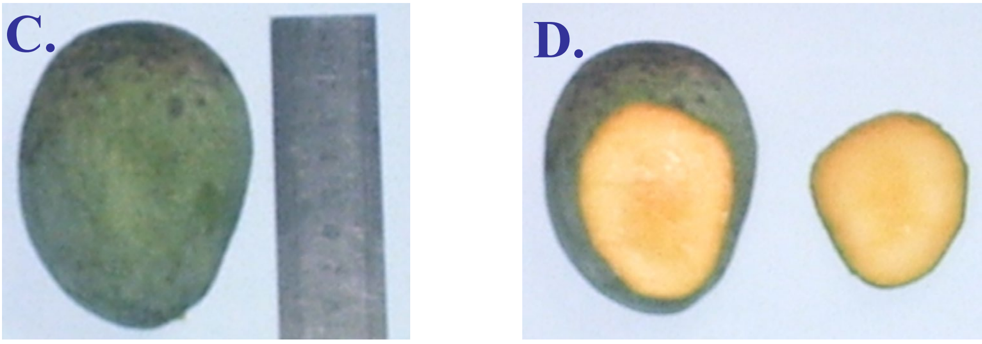


Fig. App II.12 Single fruit (C) and fruit showing pulp (D) of *Gutee*-12

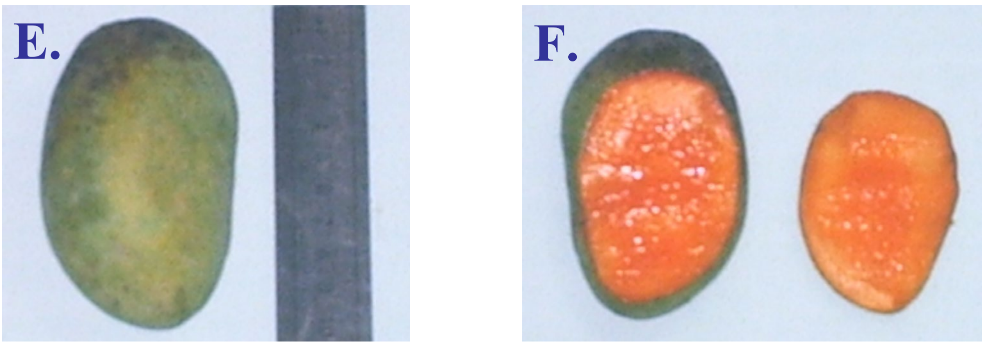


Fig. App II.13 Single fruit (E) and fruit showing pulp (F) of *Gutee*-13

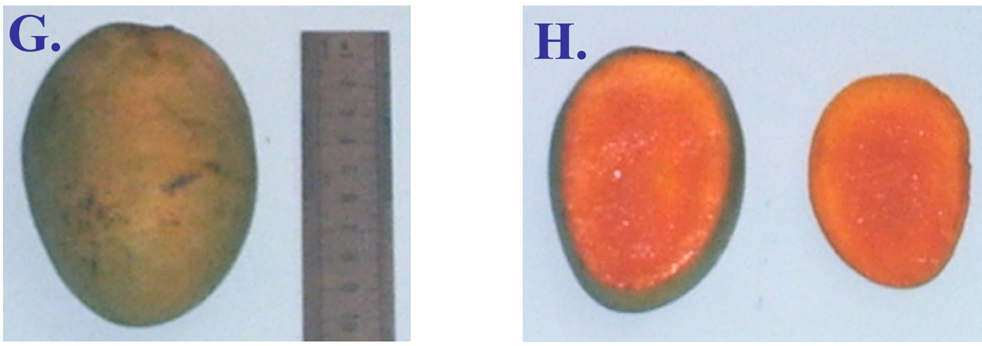


Fig. App II.14 Single fruit (G) and fruit showing pulp (H) of *Gutee*-14

II.15. *Gutee*- 15

The late season 'gutee' is high productive and fruit bearing is alternative with 15 days storage quality. The medium sized fruit is oblong with non glassy green skin, light orange pulp and excellent taste. The flavor is pleasant, texture soft, fiber low, beak, sinus and basal cavity absent, apex obtuse. The average weight of fruit is 158 g, the average length is 9.46 cm, the average width is 5.92 cm and the average diameter is 18.2 cm. The stone size is large, average weight is 47 g. This 'gutee' was also collected from Komolakantapur.

II.16. *Gutee*- 16

The production of fruit of this mid season 'gutee' is high and fruit bearing habit is alternative. The fruit is medium in size, oblong oval, skin is non glassy and green, pulp color deep yellow, flavor pleasant, texture soft, fiber low and taste is excellent. The beak of the fruit is pointed, apex obtuse, sinus and basal cavity is absent. The average weight, length, width and diameter of fruit are 250 g, 10.36 cm, 7.26 cm and 20.72 cm respectively. The stone size is large and average weight is 41 g. After ripening the fruit can be stored for sixteen days. This 'gutee' was collected from Shaheb gram.

II.17. *Gutee*- 17

The productivity of the 'gutee' is high, maturation period mid season and fruit bearing is alternative with at least sixteen days storage quality. The medium sized fruit is oblong oval with non glassy green with yellow slash skin, light orange pulp and good taste. The flavor is pleasant, texture soft, fiber low, beak, sinus and basal cavity is absent, apex obtuse. The average weight of this fruit is 273 g, the average length is 10.58 cm, the average width is 7.2 cm and the average diameter is 21.28 cm. The stone size is large, average weight is 47 g. This 'gutee' was collected from Komolakantapur.

II.18. *Gutee*- 18

The 'gutee' collected from Komolakantapur is medium in size, oblong oval, skin non glassy and green with yellow slash and pulp is light orange. The flavor of fruit is pleasant, texture soft, fiber low and taste is fair. The beak is pointed, apex obtuse, sinus and basal cavity is absent. The average weight, length, breadth and diameter of the fruit are 191 g., 10.04 cm, 7.0 cm and 19.12 cm respectively. The stone size is medium and average stone weight is 25 g. The productivity of the 'gutee' is high, matures at mid season; fruit bearing is alternative and can be stored at least 11 days.

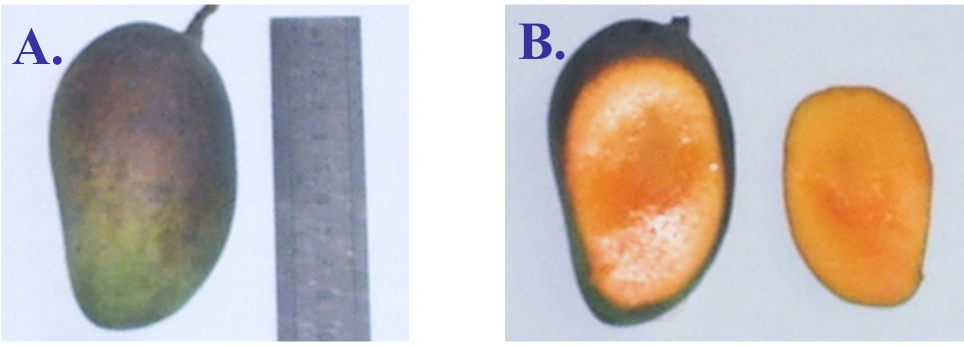


Fig. App II.15 Single fruit (A) and fruit showing pulp (B) of *Gutee*-15

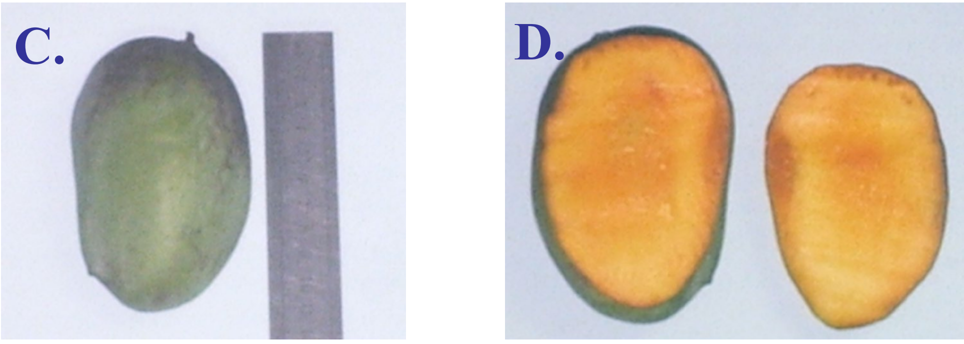


Fig. App II.16 Single fruit (C) and fruit showing pulp (D) of *Gutee*-16

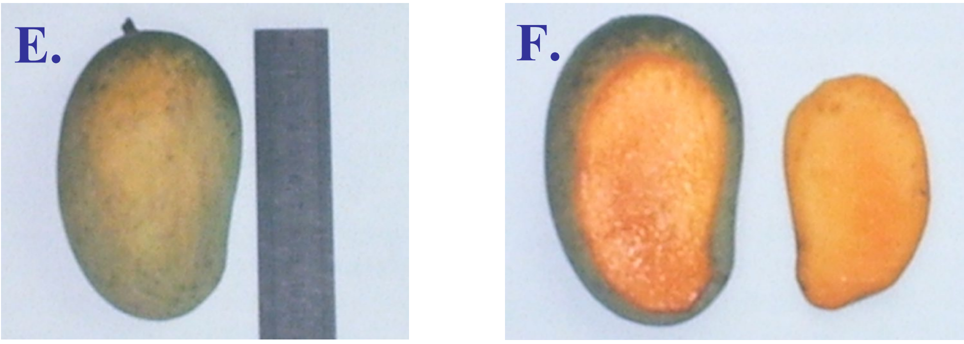


Fig. App II.17 Single fruit (E) and fruit showing pulp (F) of *Gutee*-17

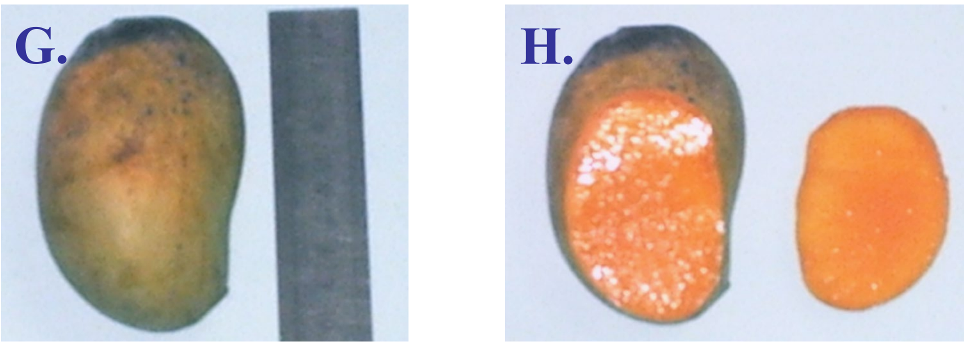


Fig. App II.18 Single fruit (G) and fruit showing pulp (H) of *Gutee*-18

II.19. *Gutee*- 19

The fruit is small, obliquely oval, skin non glassy and green, pulp color deep orange, flavor pleasant, texture soft, fiber low and taste excellent. The beak and sinus absent, apex obtuse and basal cavity present. The fruit bearing is alternative and can be stored for 10 days. The average weight of this fruit is 100 g, the average length is 7.18 cm, the average width is 5.14 cm and the average diameter is 18.3 cm. The stone size is medium, average weight is 18 g. The production of fruit is intermediate which matures at early season. The 'gutee' was collected from Komolakantapur.

II.20. *Gutee*- 20

The productivity of the 'gutee' is intermediate, matures at early season and fruit bearing is regular with fifteen days storage quality. The fruit is small, oblong oval with non glassy green skin, deep orange pulp and fair taste. The flavor is pleasant, texture soft, fiber low, beak pointed, sinus absent, apex round and basal cavity absent. The average weight of this fruit is 52 g, the average length is 6.8 cm, the average width is 4.44 cm and the average diameter is 14.56 cm. The stone size is small, average weight is 13 g. This 'gutee' was collected from Komolakantapur.

II.21. *Gutee*- 21

The 'gutee' is medium in size, ovate oblique, skin non glassy and green; pulp is light orange. The flavor of fruit is pleasant, texture soft, fiber low and taste is good. The beak is absent, apex obtuse, sinus absent and basal cavity is present. The average weight, length, breadth and diameter of the fruit are 163 g, 8.44 cm, 5.7 cm and 18.8 cm respectively. The stone size is medium and average stone weight is 26 g. The productivity of the 'gutee' is high, matures at late season; fruit bearing is alternative and can be stored at least fourteen days. This 'gutee' was collected from Shaheb gram.

II.22. *Gutee*- 22

The 'gutee' is high productive, fruit matures at mid season and fruit bearing is alternative. The fruit is medium in size, oblong oval with non glassy green with yellow slashed skin, light orange pulp and excellent taste. The flavor is pleasant, texture soft, fiber low, beak and sinus absent but basal cavity present, apex round. The average weight of this fruit is 236 g, the average length is 10.1 cm, the average width is 7.1 cm and the average diameter is 21.22 cm. The stone size is large, average weight is 47 g. After ripening the fruit can be stored for about sixteen days. This 'gutee' was also collected from Shaheb gram.

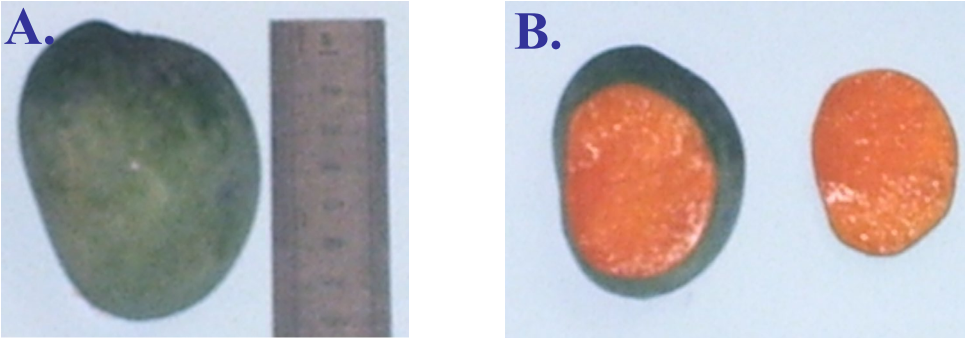


Fig. App II.19 Single fruit (A) and fruit showing pulp (B) of Gutee-19

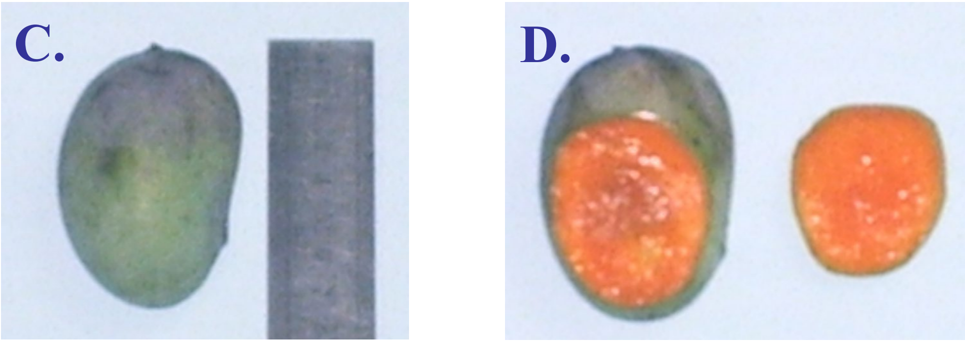


Fig. App II.20 Single fruit (C) and fruit showing pulp (D) of Gutee-20

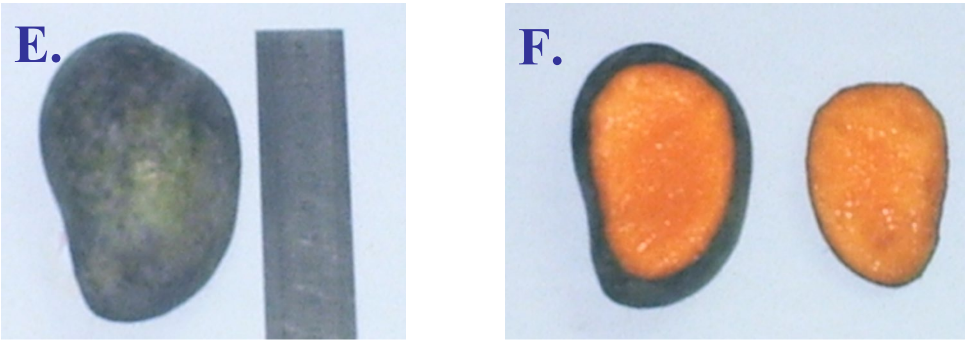


Fig. App II.21 Single fruit (E) and fruit showing pulp (F) of Gutee-21

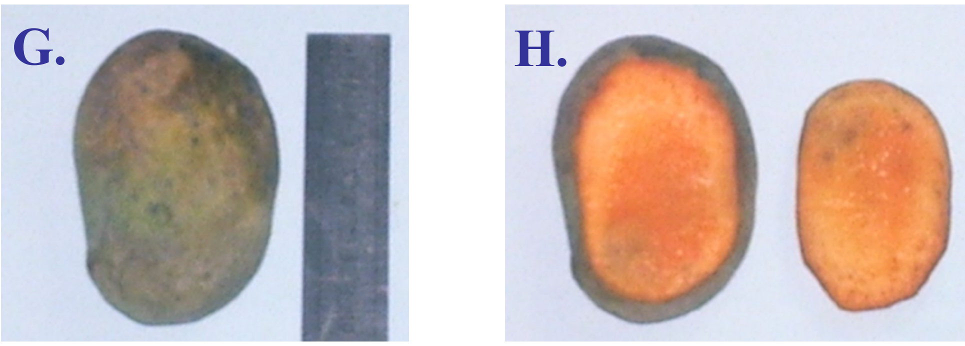


Fig. App II.22 Single fruit (G) and fruit showing pulp (H) of Gutee-22

II.23. ***Gutee*- 23**

The productivity of the 'gutee' is high, maturation period mid season and fruit bearing is alternative. The large sized fruit is oblong oval with non glassy green skin, deep orange pulp and good taste. The flavor is pleasant, texture soft, fiber medium, beak and sinus absent, apex obtuse and basal cavity absent. The average weight of this fruit is 308 g, the average length is 12.0 cm, the average width is 7.76 cm and the avarage diameter is 21.7 cm. The stone size is large, average weight is 51 g. After ripening the fruit can be stored for about sixteen days. This 'gutee' was collected from Shaheb gram.

II.24. ***Gutee*- 24**

The 'gutee' is small in size, oblong oblique, skin non glassy and green; pulp is yellow. The flavor of fruit is pleasant, texture soft, fiber high and taste is good. The beak is absent, apex obtuse, sinus and basal cavity is absent. The average weight, length, breadth and diameter of the fruit are 118 g, 7.78 cm, 5.72 cm and 17.78 cm respectively. The stone size is medium and average stone weight is 21 g. The productivity of the 'gutee' is high, matures at mid season; fruit bearing is regular and can be stored at least fifteen days. This 'gutee' was also collected from Shaheb gram.

II.25 ***Gutee*- 25**

The mid season 'gutee' is low productive and fruit bearing is regular with 13 days storage quality. The small sized fruit is oblong oval with glassy yellow skin, light yellow pulp and sour taste. The flavor is pleasant, texture firm, fiber high, beak pointed, sinus present, apex round and basal cavity absent. The average weight of fruit is 110 g, the average length is 8.88 cm, the average width is 6.06 cm and the average diameter is 17.8 cm. The stone size is medium, average weight is 31 g. This 'gutee' was collected from Shaheb gram.

II.26. ***Gutee*- 26**

The productivity of the 'gutee' is intermediate, maturity early season and fruit bearing is alternative. The medium sized fruit is oblong oval with non glassy green skin, deep orange pulp and good taste. The flavor is pleasant, texture soft, fiber medium, beak prominent, sinus and basal cavity absent and apex round. The average weight of fruit is 163 g, the average length is 8.0 cm, the average width is 5.94 cm and the average diameter is 19.98 cm. The stone size is medium, average weight is 21 g. After ripening the fruit can be stored for about ten days. This 'gutee' was also collected from Shaheb gram.

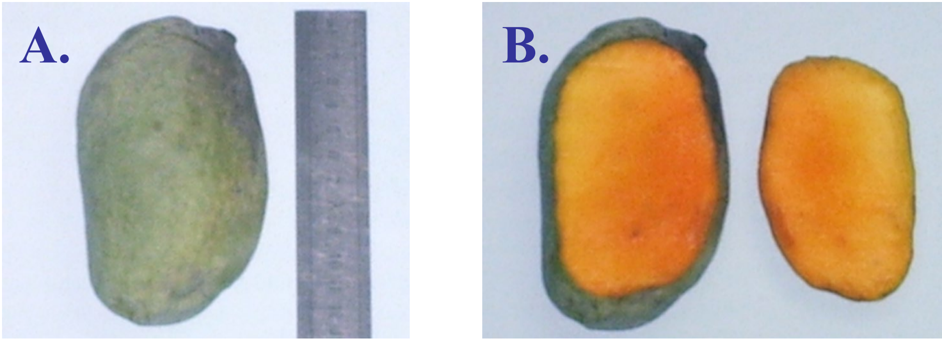


Fig. App II.23 Single fruit (A) and fruit showing pulp (B) of *Gutee*-23

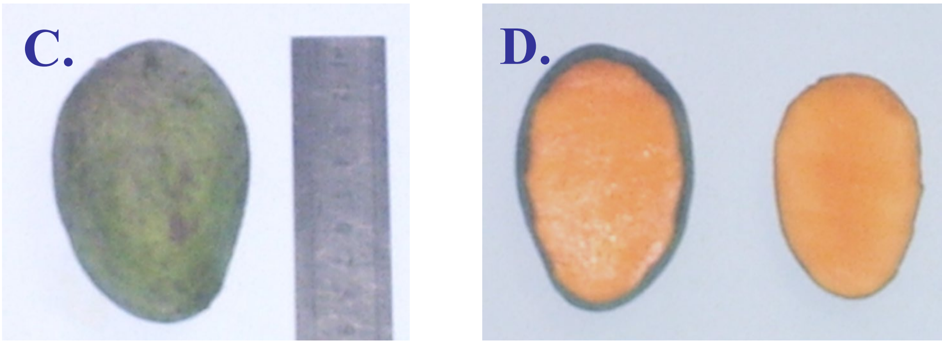


Fig. App II.24 Single fruit (C) and fruit showing pulp (D) of *Gutee*-24

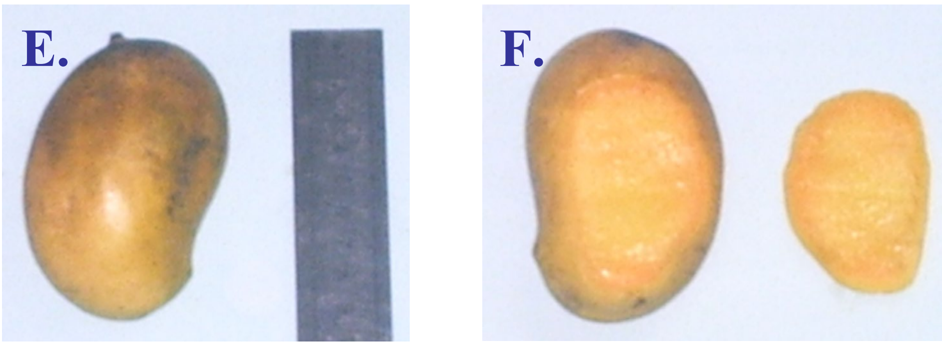


Fig. App II.25 Single fruit (E) and fruit showing pulp (F) of *Gutee*-25

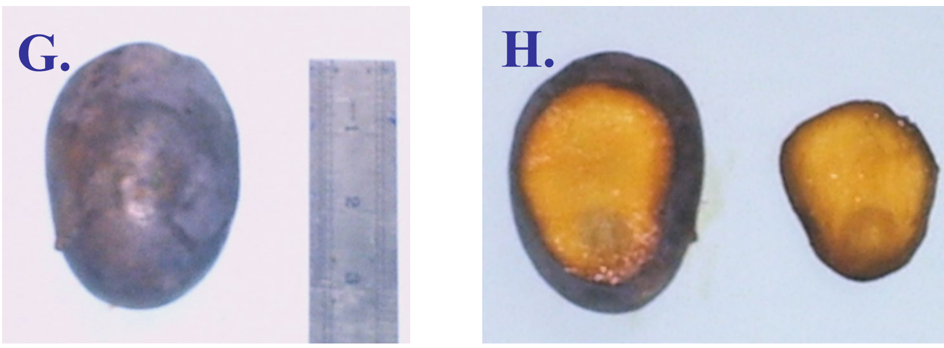


Fig. App II.26 Single fruit (G) and fruit showing pulp (H) of *Gutee*-26

II.27. *Gutee*- 27

The 'gutee' is small in size, oblong oval, skin non glassy and green and pulp is yellow. The flavor of fruit is pleasant, texture firm, fiber high and taste is good. The beak and sinus is absent, apex obtuse and basal cavity is present. The average weight, length, breadth and diameter of the fruit are 110 g, 8.34 cm, 5.44 cm and 17.4 cm respectively. The stone size is medium and average stone weight is 21 g. The productivity of the 'gutee' is intermediate, matures at early season; fruit bearing is alternative and can be stored at least 12 days. This 'gutee' was also collected from Shaheb gram.

II.28. *Gutee*- 28

The productivity of the 'gutee' is intermediate, matures at mid season, fruit bearing alternative and storage quality 13 days. The fruit is medium in size, oblong oblique, skin non glassy and green with yellow slash, pulp deep orange, taste excellent, flavor pleasant, texture soft, fiber low, beak and sinus absent, apex obtuse and basal cavity present. The average weight, length, width and diameter of fruit are 202 g, 10.06 cm, 6.56 cm and 19.08 cm respectively. The average weight of large size stone is 23 g. This 'gutee' was collected from Shaheb gram.

II.29. *Gutee*- 29

The fruit is small, oblong, skin non glassy and green, pulp color deep orange, flavor pleasant, texture soft, fiber low and taste is sour and sweet. The beak, sinus and basal cavity is absent and apex obtuse. The fruit bearing is regular and can be stored for fourteen days. The average weight of this fruit is 123 g, the average length is 8.24 cm, the average width is 4.7 cm and the average diameter is 15.22 cm. The stone size is small, average weight is 21 g. The production of fruit is intermediate and fruit matures at mid season. The 'gutee' was collected from Shaheb gram.

II.30. *Gutee*- 30

The production of the 'gutee' is intermediate, fruit matures at mid season and fruit bearing is alternative. The fruit is medium in size, roundish with non glassy green with yellow slash skin, deep orange pulp and excellent taste. The flavor is pleasant, texture moderate, fiber low, beak prominent, apex round and sinus absent but basal cavity present. The average weight, length, width and diameter of this fruit are 209 g, 7.34 cm, 6.1 cm and 20.3 cm respectively. The stone size is small, average weight is 18 g. After ripening the fruit can be stored for thirteen days. This 'gutee' was also collected from Shaheb gram.

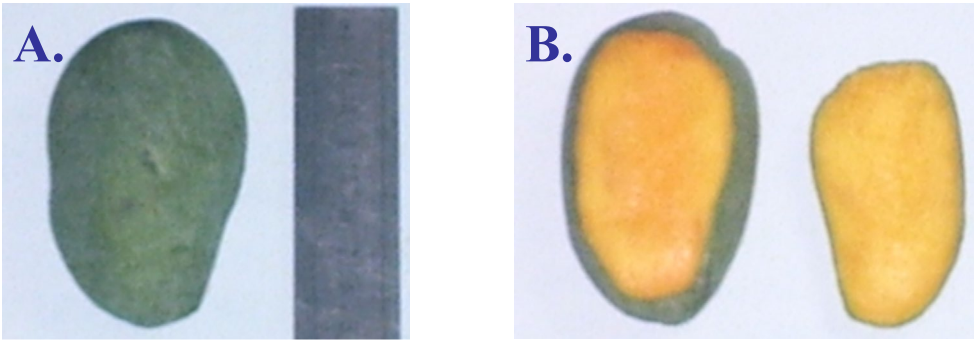


Fig. App II.27 Single fruit (A) and fruit showing pulp (B) of *Gutee*-27

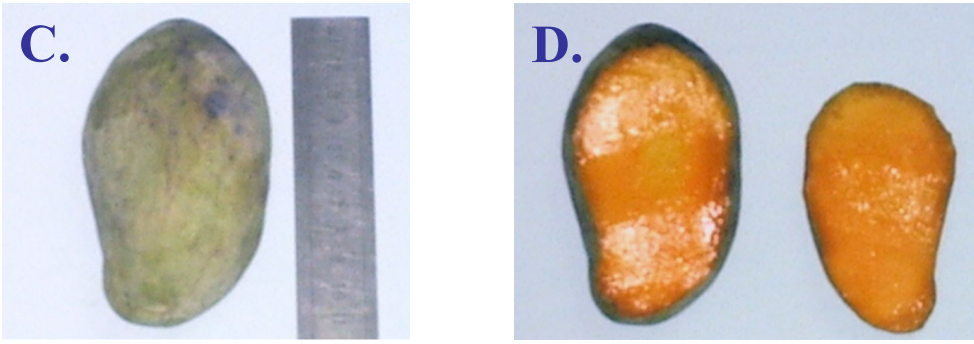


Fig. App II.28 Single fruit (C) and fruit showing pulp (D) of *Gutee*-28

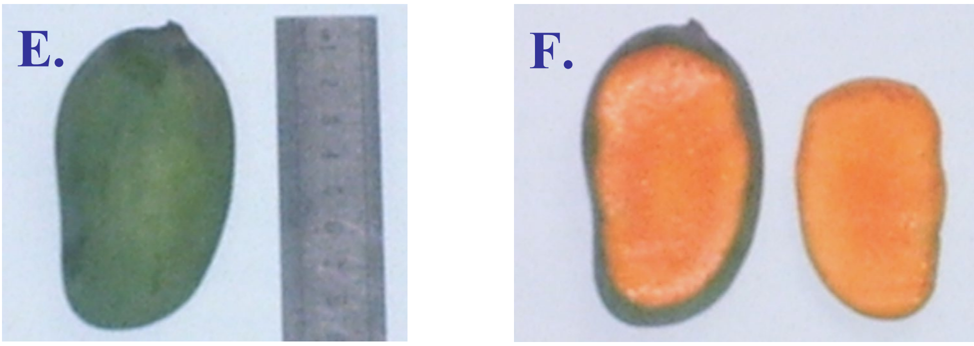


Fig. App II.29 Single fruit (E) and fruit showing pulp (F) of *Gutee*-29

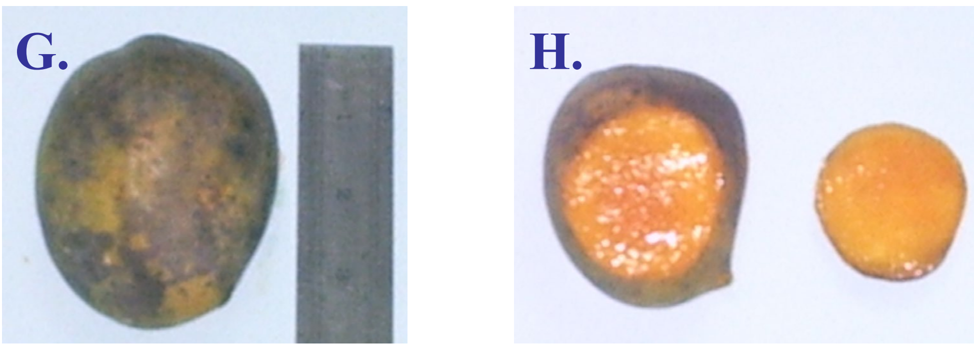


Fig. App II.30 Single fruit (G) and fruit showing pulp (H) of *Gutee*-30

II.31. *Gutee*- 31

The 'gutee' matures at mid season, productivity intermediate, size medium, shape oblong elliptic, skin type non glassy, skin color green with yellow slash, pulp color light orange, flavor pleasant, texture soft, taste fair, fiber medium, beak and basal cavity absent, sinus present and apex acute. The average weight of this fruit is 213 g, the average length is 10.16 cm, the average width is 6.86 cm and average diameter is 22.6 cm. The stone size is medium and average stone weight is 26 g. After ripening the fruit can be stored for twelve days and fruit bearing habit is alternative. This 'gutee' was collected from Shaheb gram.

II.32. *Gutee*- 32

The fruit of the 'gutee' is small in size, obliquely oval, skin non glassy and green with yellow slash and pulp is yellow. The flavor is pleasant, texture soft, fiber medium and taste is sour. The beak and sinus is absent, apex obtuse and basal cavity is present. The average weight, length, breadth and diameter of the fruit are 128 g, 7.96 cm, 5.48 cm and 17.9 cm respectively. The stone size is medium and average stone weight is 28 g. The productivity of fruit is high, matures at early season; fruit bearing is alternative and can be stored at least 13 days. This 'gutee' was collected from Shaheb gram.

II.33 *Gutee*- 33

The production of the 'gutee' is intermediate, fruit matures at late season and fruit bearing is alternative with twelve days storage quality. The large sized fruit is ovate oblong with non glassy green skin, deep yellow pulp and good taste. The flavor is pleasant, texture firm, fiber high, beak pointed, sinus absent, apex obtuse and basal cavity present. The average weight of this fruit is 374 g, the average length is 13.04 cm, the average width is 7.72 cm and the average diameter is 24.8 cm. The stone size is large, average weight is 51 g. This 'gutee' was collected from Shaheb gram.

II.34. *Gutee*- 34

The 'gutee' is high productive and matures at mid season, fruit bearing is regular and can be stored for 13 days. The fruit is medium in size, oblong oblique with non glassy green skin, light orange pulp and good taste. The flavor is pleasant, texture soft, fiber low, beak and sinus absent, apex obtuse and basal cavity present. The average weight, length, width and diameter of this fruit are 149 g, 8.5 cm, 5.66 cm and 17.38 cm respectively. The stone size is medium and average weight is 26g. This 'gutee' was collected from Shaheb gram.

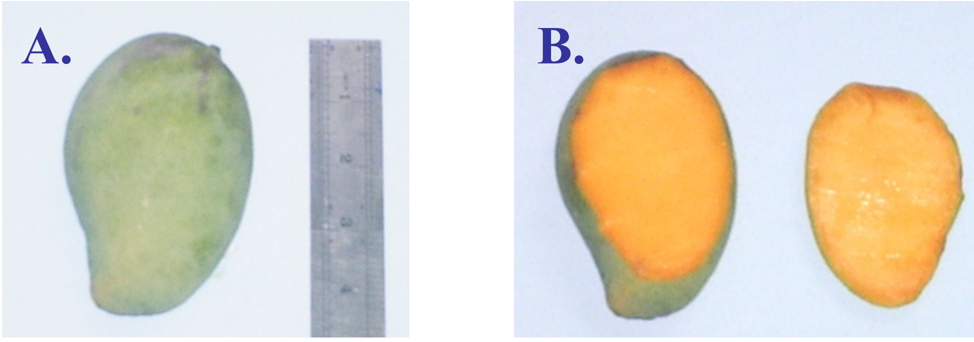


Fig. App II.31 Single fruit (A) and fruit showing pulp (B) of *Gutee*-31

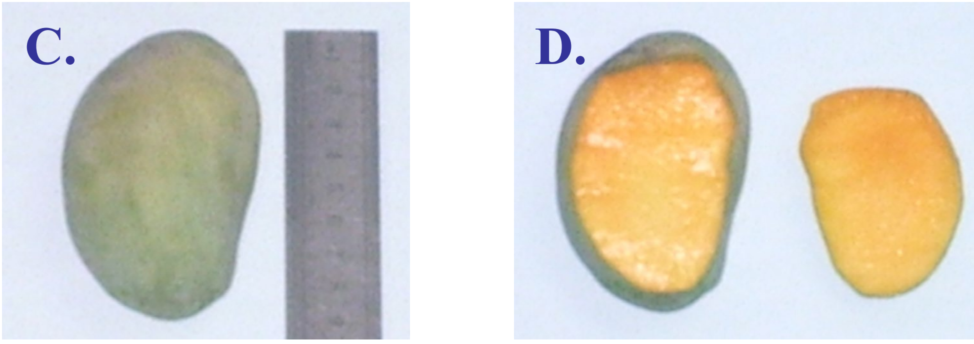


Fig. App II.32 Single fruit (C) and fruit showing pulp (D) of *Gutee*-32

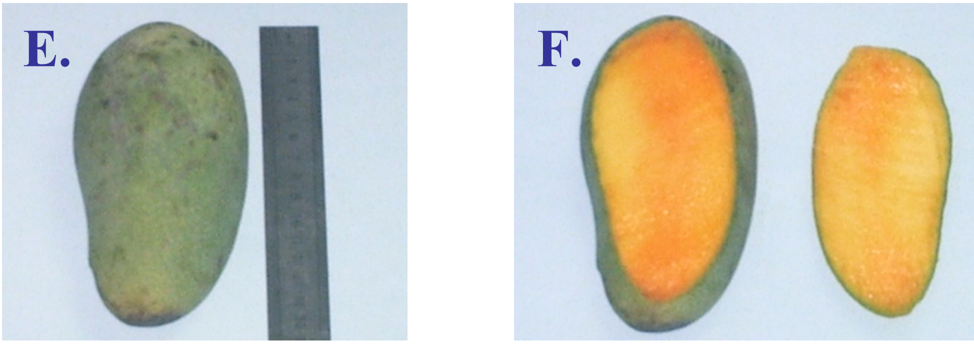


Fig. App II.33 Single fruit (E) and fruit showing pulp (F) of *Gutee*-33

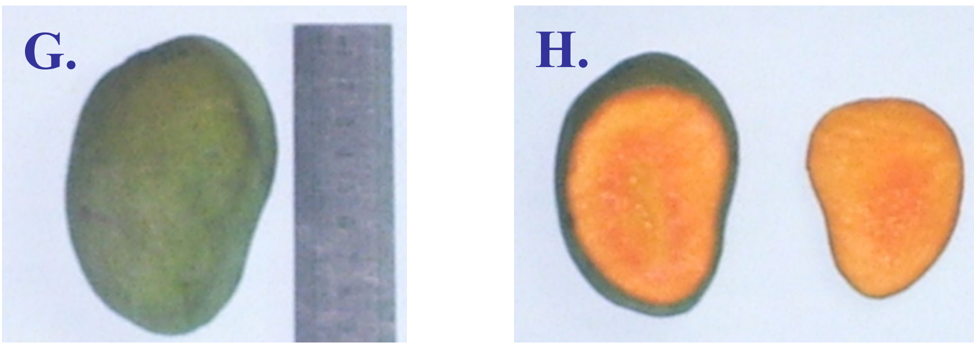


Fig. App II.34 Single fruit (G) and fruit showing pulp (H) of *Gutee*-34

II.35. *Gutee*- 35

The 'gutee' is small in size, oblong oval, skin non glassy and green and pulp is light orange. The flavor of fruit is pleasant, texture firm, fiber low and taste is fair. The beak is pointed, apex round, sinus and basal cavity is absent. The average weight, length, breadth and diameter of the fruit are 123 g, 8.0 cm, 5.54 cm and 17.46 cm respectively. The stone size is medium and average stone weight is 22 g. The productivity of the 'gutee' is intermediate, matures at mid season; fruit bearing is regular and can be stored at least 14 days. This 'gutee' was collected from Shaheb gram.

II.36. *Gutee*- 36

The fruit matures at mid season, productivity intermediate, fruit bearing habit alternative and storage quality 15 days. The fruit is medium in size, obliquely oval with non glassy green skin, yellow pulp and sour taste. The flavor is pleasant, texture soft, fiber medium, beak and sinus absent but basal cavity present, apex obtuse. The average weight, length, width and diameter of fruit are 165 g, 8.36 cm, 6.08 cm and 19.58 cm respectively. The stone size is medium, average weight is 24 g. The 'gutee' was collected from Shaheb gram.

II.37. *Gutee*- 37

The productivity of this mid season 'gutee' is low and fruit bearing is alternative with at least 16 days storage quality. The fruit is medium in size, oblong, skin of ripe fruit is non glassy and green with yellow slash, pulp is light yellow and taste is good. The flavor is pleasant, texture soft and quantity of fiber is low. The Beak, sinus and basal cavity is absent while apex is obtuse. The average weight, length, width and diameter of this fruit are 223 g, 10.62 cm, 6.06 cm and 21.74 cm respectively. The average weight of large sized stone is 30 g. This 'gutee' was collected from Shaheb gram.

II.38. *Gutee*- 38

The 'gutee' was collected from the Shaheb gram village. The fruit is medium in size, ovate oblong, skin non glassy, skin color of ripe fruit is green, pulp color deep orange, flavor pleasant, texture soft, taste good, fiber low, beak absent, sinus absent, apex obtuse and basal cavity present. The average weight of this fruit is 155 g, the average length is 8.1 cm, the average width is 6.04 cm and diameter is 18.94 cm. The stone size is small and average stone weight is 19 g. After ripening the fruit can be stored for 17 days. The 'gutee' matures at mid season, fruit bearing is alternative and productivity is intermediate.

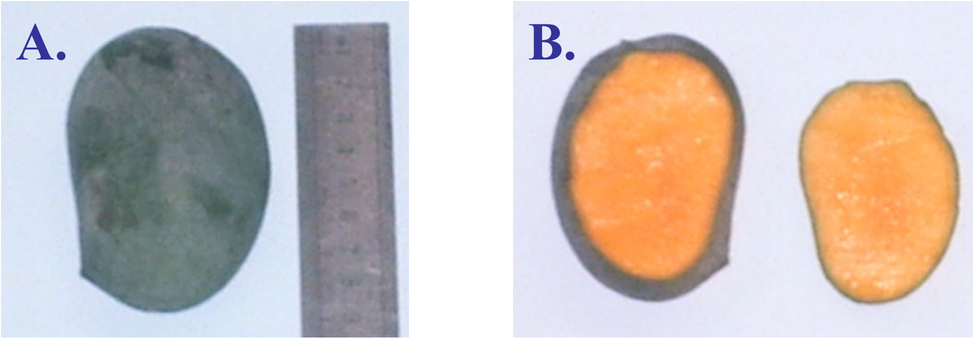


Fig. App II.35 Single fruit (A) and fruit showing pulp (B) of *Gutee*-35

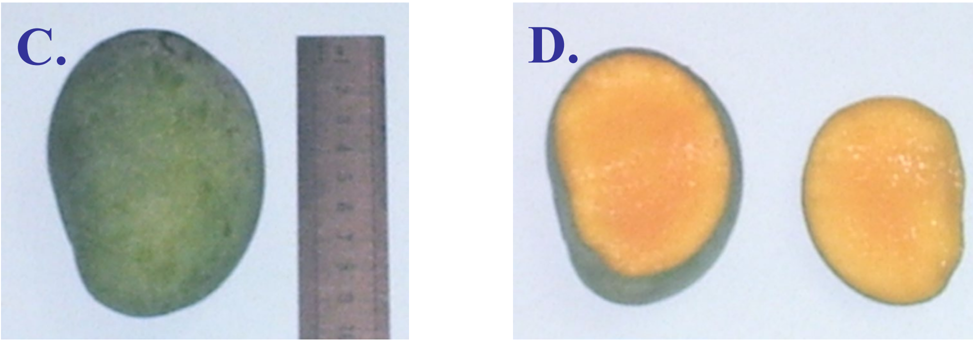


Fig. App II.36 Single fruit (C) and fruit showing pulp (D) of *Gutee*-36

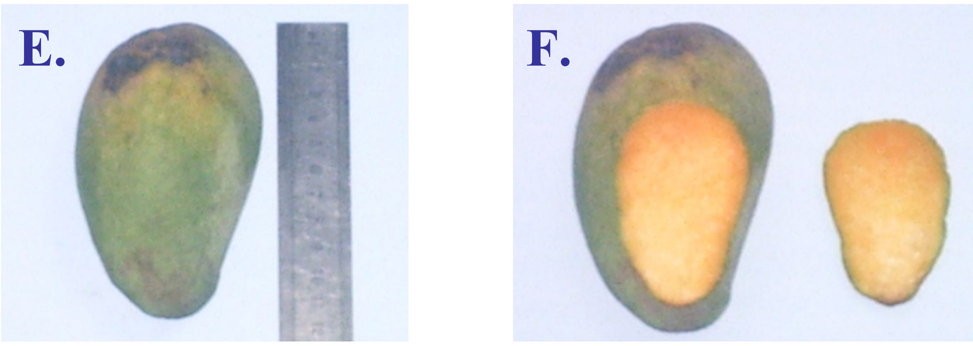


Fig. App II.37 Single fruit (E) and fruit showing pulp (F) of *Gutee*-37

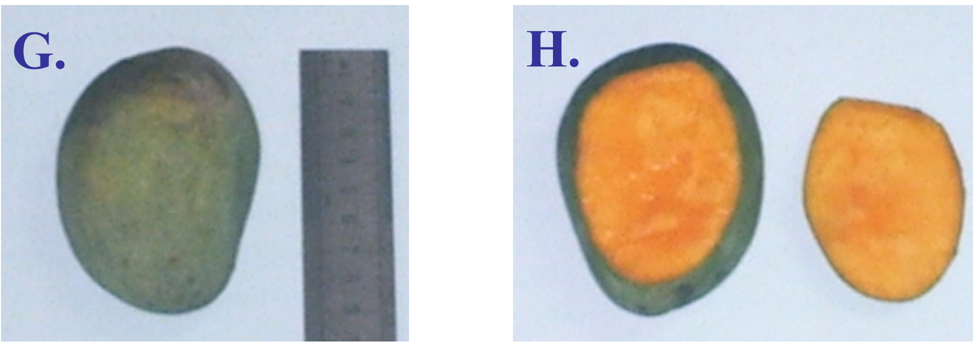


Fig. App II.38 Single fruit (G) and fruit showing pulp (H) of *Gutee*-38

II.39. *Gutee*- 39

The shape of the medium sized 'gutee' is oblong oval and productivity is intermediate which matures at mid season. The skin of the ripe fruit is green and non glassy, the pulp is deep orange, flavor pleasant, texture moderate, taste is fair, fiber medium, beak prominent, sinus is absent, apex round and basal cavity is absent. The fruit bearing habit is alternative and storage quality is about nine days. The average weight of the fruit is 155 g, average length is 8.1 cm, average width is 6.04 cm and average diameter is 18.94 cm. The stone is large and average weight is 40 g. This 'gutee' was collected from Shaheb gram village.

II.40. *Gutee*- 40

The productivity of the 'gutee' is intermediate which matures mid season and fruit bearing is regular with at least 8 days storage quality. The small sized fruit is ovate oblong with non glassy green colored skin, deep orange pulp and fair taste with pleasant flavor. The fruit texture is soft, fiber low; apex obtuse but beak and sinus is absent and basal cavity is present. The average weight, length, width and diameter of fruit are 56 g; 6.74 cm, 5.4 cm and 16.18 cm respectively. The stone is small with average weight 17 g. This 'gutee' was collected from Shaheb gram.

II.41. *Gutee*- 41

The fruit is small, ovate oblong, skin non glassy and green, pulp color deep orange, flavor pleasant, texture soft, taste good and fiber low which matures at mid season. The beak and sinus absent, apex obtuse, basal cavity is present. The fruit bearing is alternative and can be stored for 11 days. The average weight of fruit is 132 g, the average length is 7.52 cm, the average width is 6.0 cm and average diameter is 17.94 cm. The stone is medium, average weight is 22 g. This low productive mid season 'gutee' was collected from Shaheb gram.

II.42. *Gutee*- 42

The productivity of the mid season 'gutee' is intermediate and fruit bearing is alternative with about fourteen days storage quality. The large sized fruit is ovate oblique with non glassy green skin, deep yellow pulp and fair taste. The flavor is pleasant, texture moderate, fiber moderate, beak and sinus absent, apex obtuse and basal cavity present. The average weight of this fruit is 325 g, the average length is 11.14 cm, the average width is 8.02 cm and the average diameter is 24.44 cm. The stone size is large, average weight is 32 g. This 'gutee' was also collected from Shaheb gram.

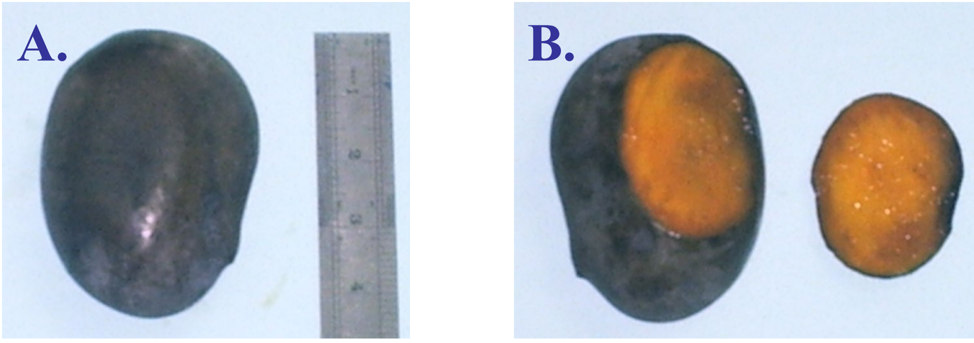


Fig. App II.39 Single fruit (A) and fruit showing pulp (B) of *Gutee*-39

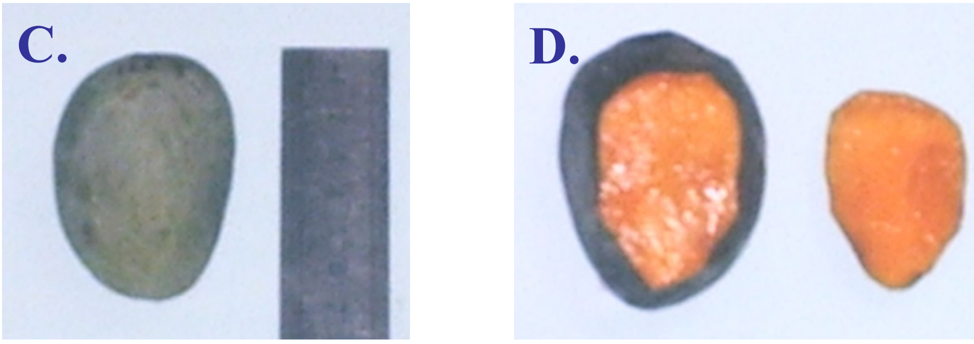


Fig. App II.40 Single fruit (C) and fruit showing pulp (D) of *Gutee*-40

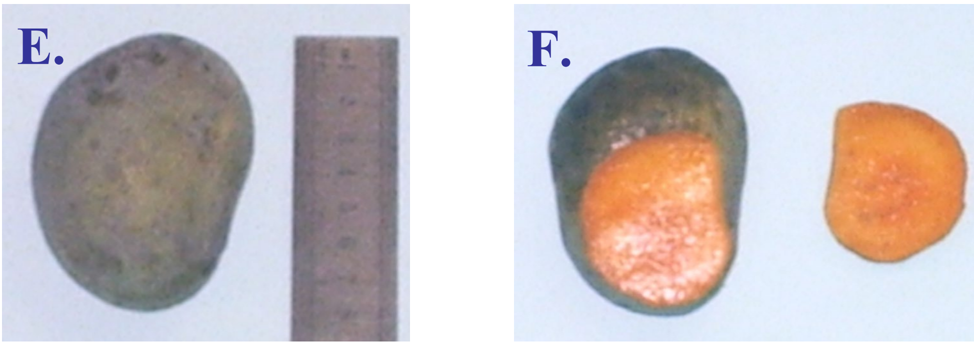


Fig. App II.41 Single fruit (E) and fruit showing pulp (F) of *Gutee*-41

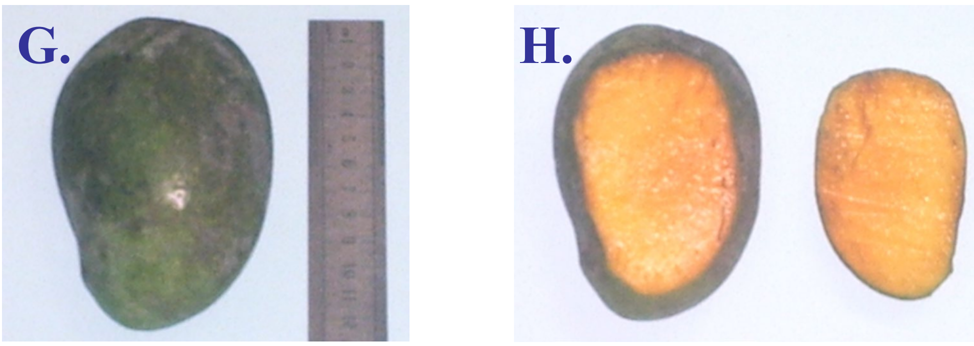


Fig. App II.42 Single fruit (G) and fruit showing pulp (H) of *Gutee*-42

II.43. *Gutee*- 43

The fruit of this 'gutee' was small in size, the shape is ovate, skin non glassy, skin color green, pulp color light orange, flavor pleasant, texture soft, taste good, fiber low, apex round and beak, sinus and basal cavity was absent. The average weight of fruit is 108 g, the average length is 7.56 cm, the average width is 5.5 cm and the average diameter is 17.46 cm. The stone size is small and average weight is 26 g. After ripening the fruit can be stored for 15 days. The productivity of this mid season 'gutee' is intermediate with alternative bearing and was collected from Shaheb gram village.

II.44. *Gutee*- 44

The fruit size of the 'gutee' is large, ovate oblong, skin non glassy, skin color of ripe fruit green, pulp color deep orange, flavor pleasant, texture moderate, taste fair, fiber medium, beak absent, sinus absent, apex obtuse and basal cavity absent. The average weight of this fruit is 316 g, the average length is 11.92 cm, the average width is 8.08 cm and the average diameter is 23.02 cm. The stone size is large, average weight is 23 g. After ripening the fruit can be stored for about thirteen days. It is a mid season variety which fruit bearing is alternative and productivity is intermediate. The fruit was collected from Shaheb gram.

II.45. *Gutee*- 45

The productivity of this early season, medium sized, alternative bearing 'gutee' is low and collected from Shaheb gram village. Storage quality of fruit is 15 days. The fruit is ovate oblong, skin non glassy, skin color green with yellow slash, pulp light orange and taste fair. The flavor is pleasant, texture soft, fiber medium, beak absent, sinus present, apex obtuse and basal cavity absent. The average weight, length, width and diameter of fruit are 237 g., 9.88 cm, 7.6 cm and 21.74 cm respectively. The stone is large, average weight is 47 g.

II.46. *Gutee*- 46

The productivity of this mid season 'gutee' is low and fruit bearing is regular with 18 days storage quality. The fruit is small in size, ovate, skin of ripe fruit is non glassy and green with light yellow pulp and fair taste. The flavor is pleasant, texture moderate but quantity of fiber is medium. The Beak pointed, sinus and basal cavity is absent while apex is acute. The average weight, length, width and diameter of this fruit are 117 g, 8.06 cm, 5.52 cm and 18.1 cm respectively. The average weight of medium sized stone is 25 g. This 'gutee' was collected from Shaheb gram.

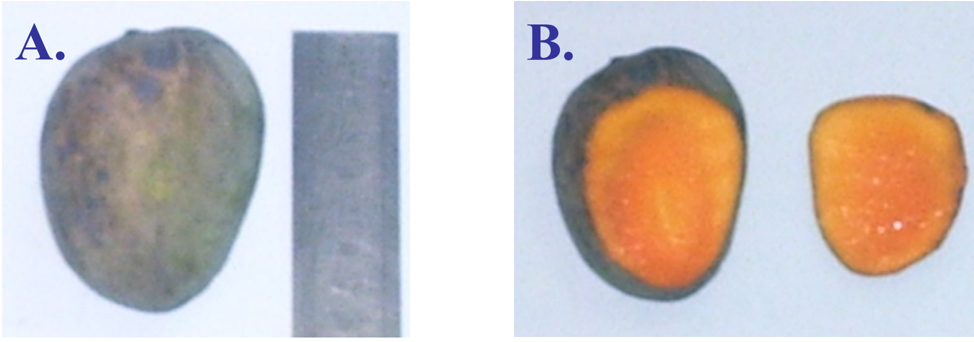


Fig. App II.43 Single fruit (A) and fruit showing pulp (B) of *Gutee*-43

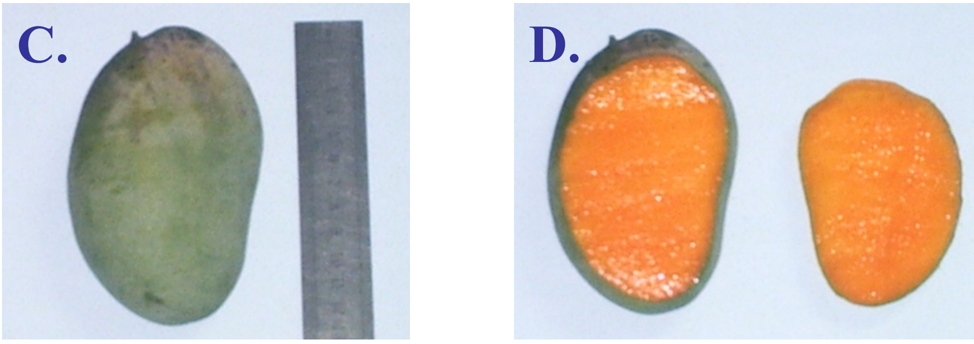


Fig. App II.44 Single fruit (C) and fruit showing pulp (D) of *Gutee*-44

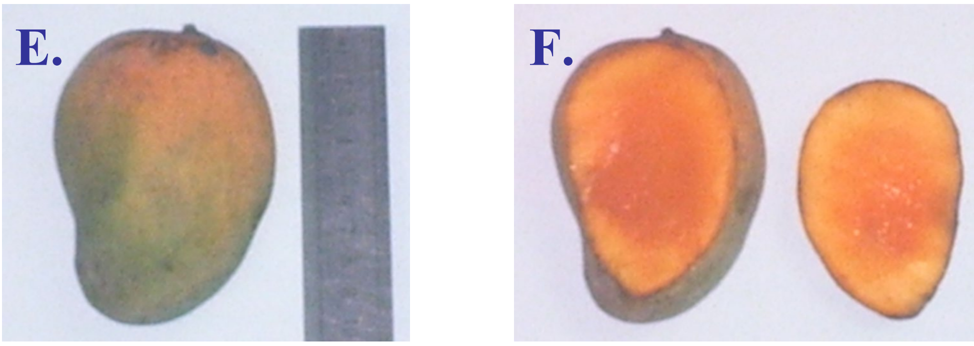


Fig. App II.45 Single fruit (E) and fruit showing pulp (F) of *Gutee*-45

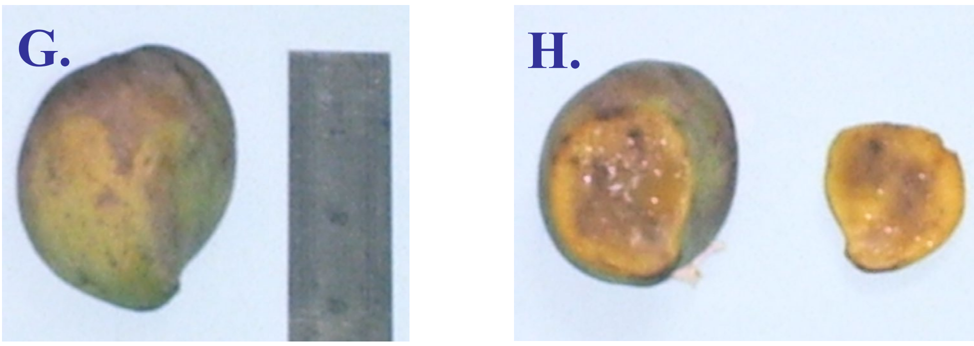


Fig. App II.46 Single fruit (G) and fruit showing pulp (H) of *Gutee*-46

II.47. *Gutee*- 47

The shape of the medium sized 'gutee' is oblong oval and productivity is intermediate which matures at mid season. The skin of the ripe fruit is green and non glassy, the pulp is yellow, flavor pleasant, texture soft, taste is fair, fiber low, beak and sinus is absent, apex obtuse and basal cavity is present. The fruit bearing habit is alternative and storage quality is 12 days. The average weight of the fruit is 134 g, average length is 8.4 cm, average width 5.48 cm and the average diameter is 18.48 cm. The stone is small and average weight is 20 g. This 'gutee' was collected from Shaheb gram.

II.48. *Gutee*- 48

The productivity of the 'gutee' is intermediate which matures at mid season and fruit bearing is alternative with 10 days storage quality. The small sized fruit is oblong with non glassy green colored skin, light orange pulp and fair taste with pleasant flavor. The fruit texture is soft, fiber low, beak prominent, apex obtuse sinus and basal cavity is absent. The average weight of this fruit is 99 g, the average length is 7.86 cm, the average width is 5.06 cm and the average diameter is 16.46 cm. The stone is medium with average weight 18 g. This 'gutee' was also collected from Shaheb gram village.

II.49. *Gutee*- 49

The fruit is medium, oblong oval, skin non glassy and green, pulp color light orange, flavor pleasant, texture soft, taste fair and fiber medium, matures at mid season and productivity is high. The beak, sinus and basal cavity is absent and apex acute. The fruit bearing is alternative and can be stored for 12 days. The average weight of fruit is 240 g, the average length is 12.5 cm, the average width is 7.5 cm and diameter is 22.48 cm. The stone size is large, average weight is 39 g. This 'gutee' was collected from Shaheb gram.

II.50. *Gutee*- 50

The productivity of the mid season 'gutee' is intermediate and fruit bearing is alternative with seventeen days storage quality. The medium sized fruit is roundish with non glassy green skin, deep orange pulp and excellent taste. The flavor is pleasant, texture moderate, fiber low, beak and sinus absent, apex obtuse and basal cavity present. The average weight of this fruit is 167 g, the average length is 8.08 cm, the average width is 6.52 cm and the average diameter is 20.08 cm. The stone size is medium, average weight is 25 g. This 'gutee' was also collected from Shaheb gram.

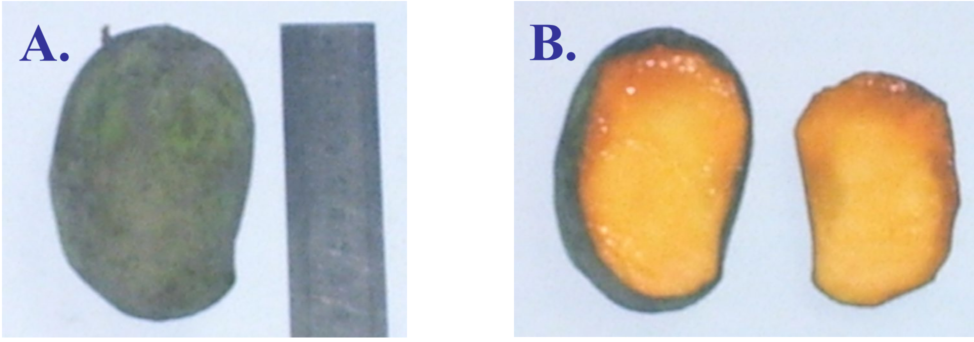


Fig. App II.47 Single fruit (A) and fruit showing pulp (B) of *Gutee*-47

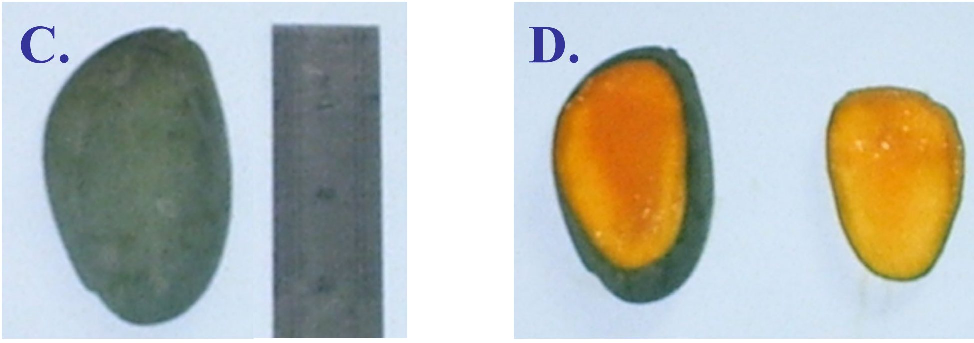


Fig. App II.48 Single fruit (C) and fruit showing pulp (D) of *Gutee*-48

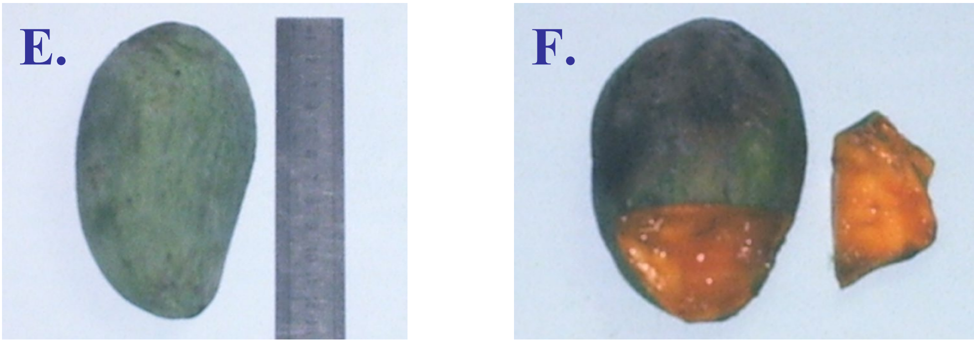


Fig. App II.49 Single fruit (E) and fruit showing pulp (F) of *Gutee*-49

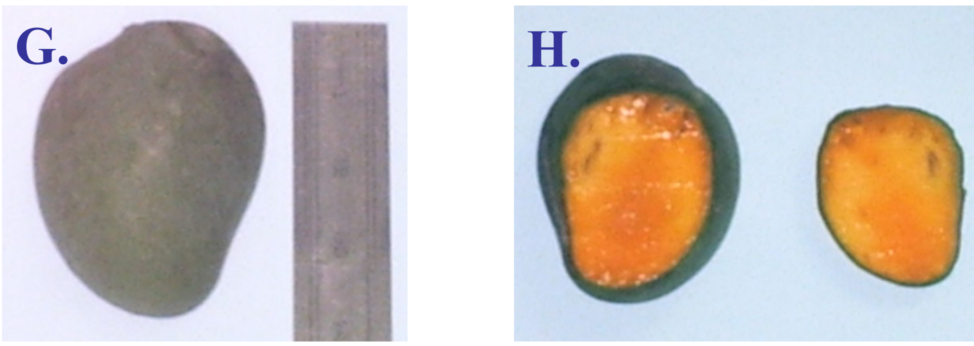


Fig. App II.50 Single fruit (G) and fruit showing pulp (H) of *Gutee*-50

II.51. *Gutee*- 51

The productivity of the mid season 'gutee' is intermediate with regular fruit bearing and collected from Shaheb gram. The small sized fruit is oblong oval with non glassy green with yellow slash skin, deep yellow pulp and good taste. The flavor is pleasant, texture soft, fiber low, apex obtuse and beak, sinus and basal cavity absent. The average weight, length, width and diameter are 82 g, 8.4 cm, 4.8 cm and 15.3 cm respectively. The stone size is medium, average weight is 16 g. After ripening the fruit can be stored for 13 days.

II.52. *Gutee*- 52

The productivity of this mid season 'gutee' is intermediate and fruit bearing is alternative with at least fifteen days storage quality. The fruit is medium in size, oblong, skin of ripe fruit is non glassy and green, pulp color deep yellow and taste is fair. The flavor is pleasant, texture soft and quantity of fiber is low. The beak is pointed, sinus and basal cavity is absent while apex is round. The average weight, length, width and diameter of this fruit are 160 g, 7.12 cm, 4.42 cm and 18.14 cm respectively. The average weight of medium sized stone is 21g. This 'gutee' was also collected from Shaheb gram village.

II.53. *Gutee*- 53

The shape of the medium sized 'gutee' is ovate and productivity is high and matures at late season. The skin of the ripe fruit is green with orange slash and non glassy, the pulp is deep yellow, flavor pleasant, texture moderate, taste is excellent, fiber high, beak and sinus is absent, apex round and basal cavity is present. The fruit bearing habit is alternative with 15 days storage quality. The average weight of the fruit is 218 g, average length is 8.1 cm, average width 6.04 cm and the average diameter is 20.66 cm. The stone is medium and average weight is 26 g. The 'gutee' was collected from Shaheb gram.

II.54. *Gutee*- 54

The fruit is medium sized, oblong, skin non glassy and green with yellow slashed; pulp is light yellow. The flavor of fruit is pleasant, texture soft, fiber low and taste is excellent. The beak is pointed, apex acute, sinus and basal cavity is absent. The average weight, length, width and diameter of the fruit are 179 g, 10.7 cm, 6.2 cm and 19.34 cm respectively. The stone size is large and average weight is 26 g. The productivity of fruit is intermediate, matures at mid season; fruit bearing is alternative and can be stored for at least 12 days. This 'gutee' was collected from Shaheb gram.

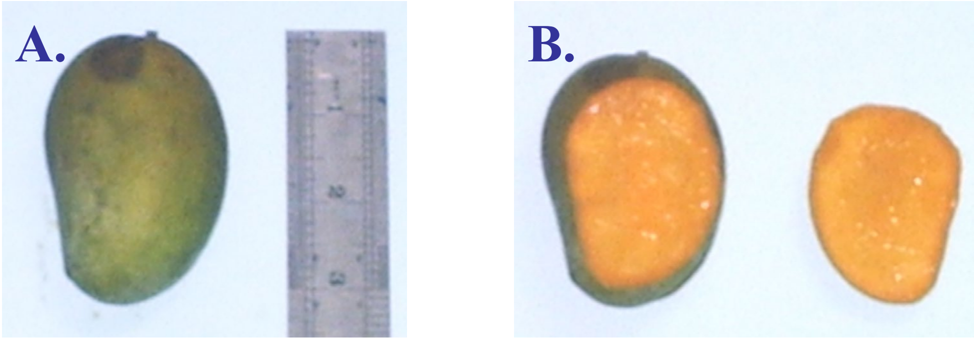


Fig. App II.51 Single fruit (A) and fruit showing pulp (B) of *Gutee*-51

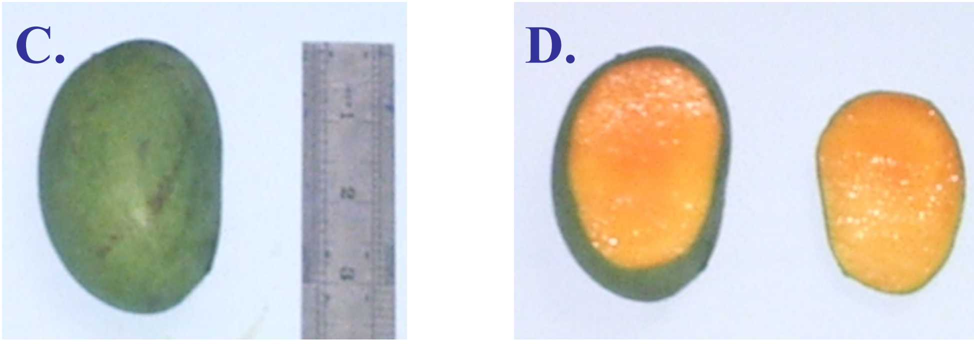


Fig. App II.52 Single fruit (C) and fruit showing pulp (D) of *Gutee*-52

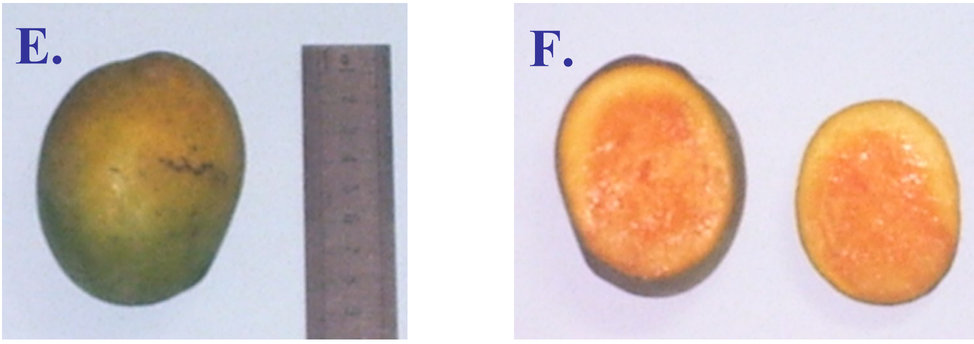


Fig. App II.53 Single fruit (E) and fruit showing pulp (F) of *Gutee*-53

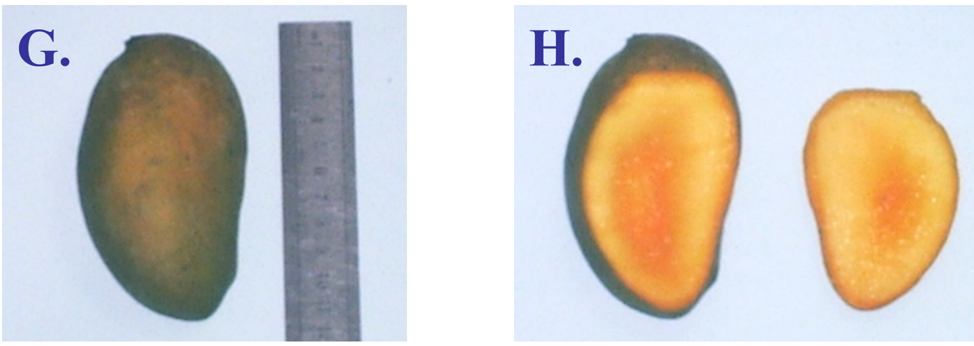


Fig. App II.54 Single fruit (G) and fruit showing pulp (H) of *Gutee*-54

II.55. *Gutee*- 55

The mid season medium sized 'gutee' is high productive with alternative fruit bearing and 16 days storage quality. The fruit is oblong with non glassy green with yellow slash skin, deep yellow pulp and excellent taste. The flavor is pleasant, texture soft, fiber medium, sinus present, apex obtuse, beak and basal cavity absent. The average weight, length, width and diameter of fruit are 207 g, 10.3 cm, 6.42 cm and 20.62 cm respectively. The stone size is large and average weight is 38 g. The 'gutee' was collected from Shaheb gram.

II.56. *Gutee*- 56

The productivity of the 'gutee' is high with alternative fruit bearing and fruit matures at early season. The small sized fruit is oblong oval with non glassy yellow skin, deep orange pulp and fair taste. The flavor is pleasant, texture soft, fiber medium, sinus present, apex round, beak and basal cavity absent. The average weight of this fruit is 77 g, the average length is 8.02 cm, the average width is 5.18 cm and the average diameter is 15.26 cm. The stone size is small, average weight is 20 g. After ripening the fruit can be stored for 15 days. This 'gutee' was collected from Noya lavanga.

II.57. *Gutee*- 57

The fruit production of the 'gutee' is high, fruit matures at mid season and fruit bearing is alternative. The fruit is small in size, ovate oblique with non glassy green skin, deep yellow pulp and good taste. The flavor is pleasant; texture soft; fiber medium; beak, sinus and basal cavity absent while apex is round. The average weight of this fruit is 103 g, the average length is 6.76 cm, the average width is 5.12 cm and the average diameter is 17.84 cm. The stone size is small, average weight is 14 g. After ripening the fruit can be stored for eighteen days. This 'gutee' was also collected from Shaheb gram.

II.58. *Gutee*- 58

The 'gutee' matures at mid season, productivity intermediate, size medium, shape obliquely oval, skin type non glassy, skin color green with yellow slash, pulp color deep yellow, flavor pleasant, texture moderate, taste excellent, fiber low, beak absent, apex obtuse, sinus and basal cavity absent. The average weight of fruit is 256 g, the average length is 10.64 cm, the average width is 7.02 cm and the average diameter is 21.6 cm. The stone size is medium and average weight is 25 g. After ripening the fruit can be stored for 16 days and fruit bearing is alternative. This 'gutee' was collected from Shaheb gram.

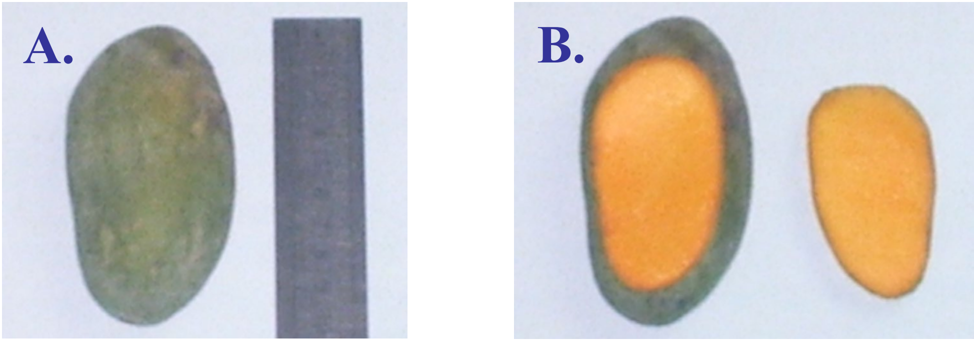


Fig. App II.55 Single fruit (A) and fruit showing pulp (B) of *Gutee*-55

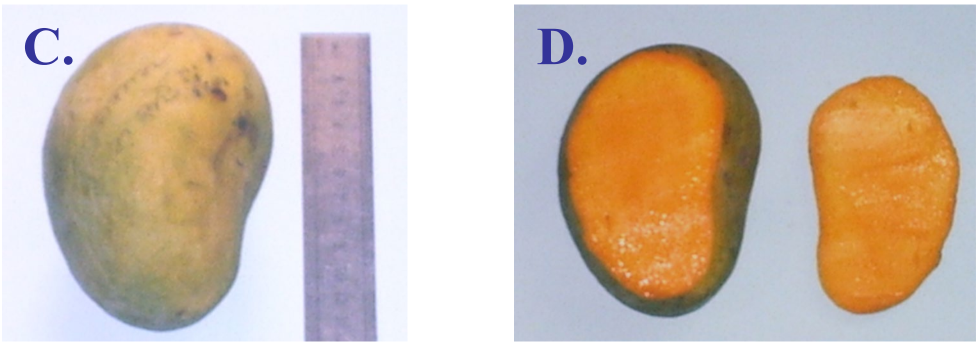


Fig. App II.56 Single fruit (C) and fruit showing pulp (D) of *Gutee*-56

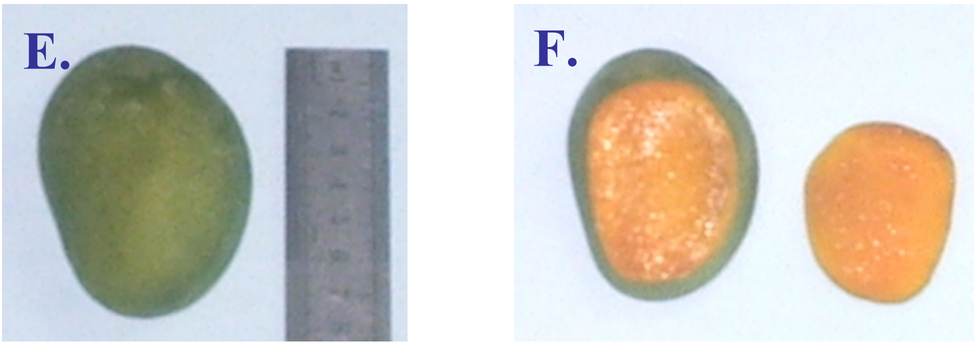


Fig. App II.57 Single fruit (E) and fruit showing pulp (F) of *Gutee*-57

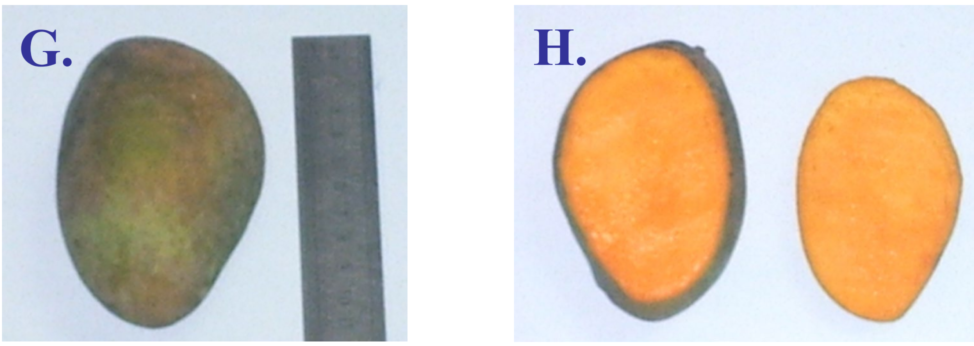


Fig. App II.58 Single fruit (G) and fruit showing pulp (H) of *Gutee*-58

II.59. *Gutee*- 59

The fruit of the 'gutee' is medium in size, oblong, skin non glassy and green and pulp is light yellow. The flavor of fruit is pleasant, texture soft, fiber low and taste is sour and sweet. The beak and sinus is absent, apex obtuse and basal cavity is absent. The average weight, length, breadth and diameter of the fruit are 228 g, 9.32 cm, 6.34 cm and 20.3 cm respectively. The stone size is medium and average weight is 28 g. The productivity of the 'gutee' is intermediate, matures at mid season; fruit bearing is alternative and can be stored for at least fifteen days. This 'gutee' was also collected from Shaheb gram.

II.60. *Gutee*- 60

The 'gutee' is medium, oblong, skin non glassy and green with yellow slash and pulp is light yellow. The flavor of fruit is pleasant, texture soft, fiber low and taste is good. The beak and sinus is absent, apex obtuse and basal cavity is present. The average weight, length, breadth and diameter of the fruit are 157 g, 8.24 cm, 5.78 cm and 18.98 cm respectively. The stone size is small and average stone weight is 20 g. The productivity of the 'gutee' is intermediate with alternative fruit bearing, matures at mid season, can be stored for at least 13 days and collected from Shaheb gram.

II.61. *Gutee*- 61

The 'gutee' is high productive with alternative fruit bearing, fruit matures at mid season and was collected from Noya lavanga village. The fruit is small in size, ovate oblique with non glassy green with yellow slash skin, yellow pulp and good taste. The flavor is pleasant, texture moderate, fiber medium, beak absent, sinus present, apex obtuse and basal cavity present. The average weight of fruit is 102 g, the average length is 7.88 cm, the average width is 5.54 cm and the average diameter is 16.92 cm. The stone size is small, average weight is 17 g. The fruit can be stored for 13 days.

II.62. *Gutee*- 62

The productivity of the 'gutee' is intermediate, matures at mid season; fruit bearing is alternative and was collected from Noya lavanga. The small sized fruit is obliquely oval with non glassy green skin, light orange pulp and excellent taste. The flavor is unpleasant, texture soft, fiber low, beak and sinus absent, apex obtuse and basal cavity present. The average weight, length, width and diameter of fruit are 79 g, 7.6 cm, 5.26 cm and 15.66 cm respectively. The stone is small, average weight is 17 g. The fruit can be stored for 13 days.

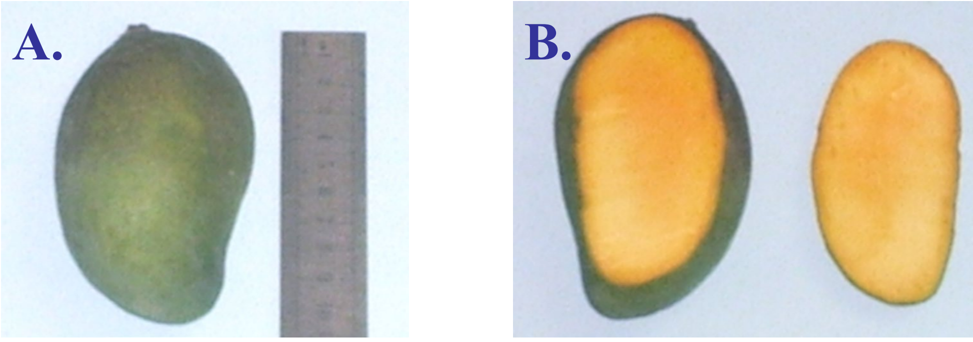


Fig. App II.59 Single fruit (A) and fruit showing pulp (B) of *Gutee*-59

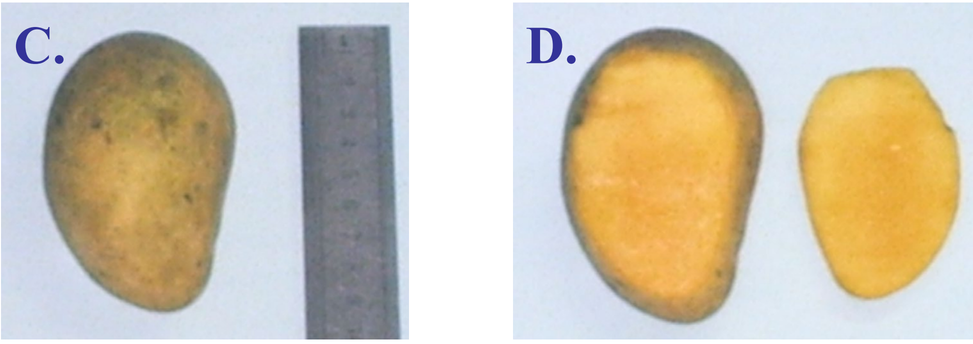


Fig. App II.60 Single fruit (C) and fruit showing pulp (D) of *Gutee*-60

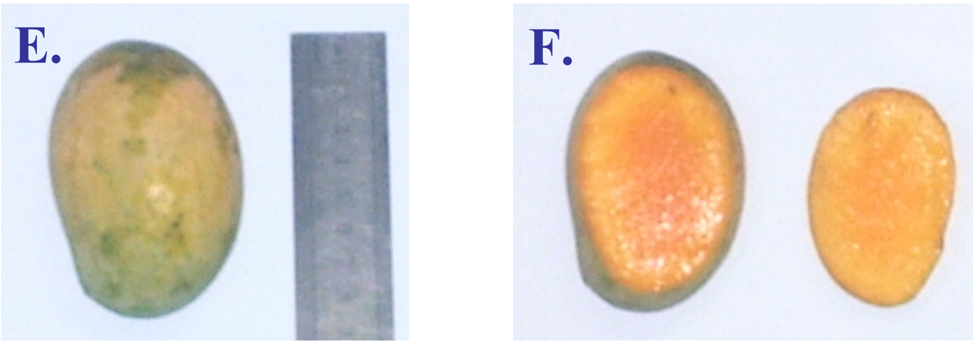


Fig. App II.61 Single fruit (E) and fruit showing pulp (F) of *Gutee*-61

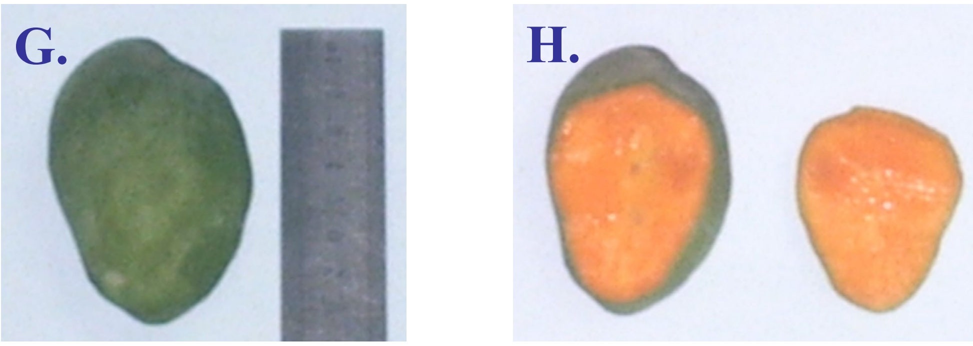


Fig. App II.62 Single fruit (G) and fruit showing pulp (H) of *Gutee*-62

II.63. *Gutee*- 63

The shape of the medium sized 'gutee' is oblong and productivity is intermediate which matures at mid season. The skin of the ripe fruit is green and non glassy, the pulp is yellow, flavor pleasant, texture moderate, taste is good, fiber medium; beak, sinus and basal cavity is absent and apex obtuse. The fruit bearing habit is alternative and storage quality is 8 days. The average weight of the fruit is 155 g, average length is 9.68 cm, average width 5.58 cm and the average diameter is 18.0 cm. The stone is medium and average weight is 21 g. This 'gutee' was collected from Noya lavanga.

II.64. *Gutee*- 64

The productivity of the 'gutee' is high, fruit bearing alternative, matures at mid season and can be stored for at least 15 days. The medium sized fruit is ovate oblong with non glassy green colored skin, pulp is yellow and taste is good with pleasant flavor. The fruit texture is moderate, fiber medium, apex obtuse, beak and sinus is absent but basal cavity is present. The average weight of this fruit is 216 g, the average length is 9.6 cm, the average width is 6.42 cm and the average diameter is 20.76 cm. The stone is large with average weight 37 g. This 'gutee' was collected from Noya lavanga.

II.65. *Gutee*- 65

The fruit is small, ovate oblong, skin non glassy and green with yellow slash, pulp color deep yellow, flavor pleasant, texture moderate, taste good and fiber medium. The beak, sinus and basal cavity is absent and apex obtuse. The fruit bearing is alternative and can be stored for 16 days. The average weight, length, width and diameter of fruit are 115 g, 8.26 cm, 5.4 cm and 17.08 cm respectively. The stone is medium and average weight is 13 g. This high productive early season 'gutee' was collected from Noya lavanga.

II.66. *Gutee*- 66

The shape of the small sized 'gutee' is ovate oblong and productivity is low which matures at mid season. The skin of the ripe fruit is green and non glassy, the pulp is light orange, flavor pleasant, texture soft, taste is sour and sweet, fiber low, beak and sinus is absent, apex obtuse and basal cavity is absent. The fruit bearing habit is alternative and storage quality is nine days. The average weight of the fruit is 115 g, average length is 8.26 cm, average width 5.46 cm and the average diameter is 17.26 cm. The stone is small and average weight is 18 g. This 'gutee' was also collected from Noya lavanga village.

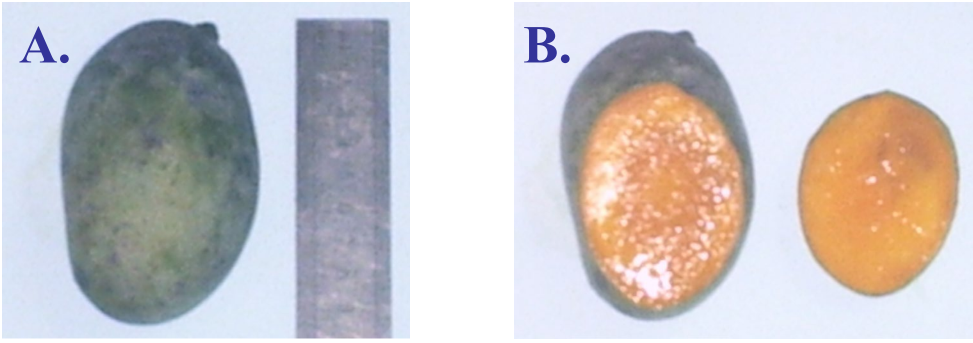


Fig. App II.63 Single fruit (A) and fruit showing pulp (B) of *Gutee*-63

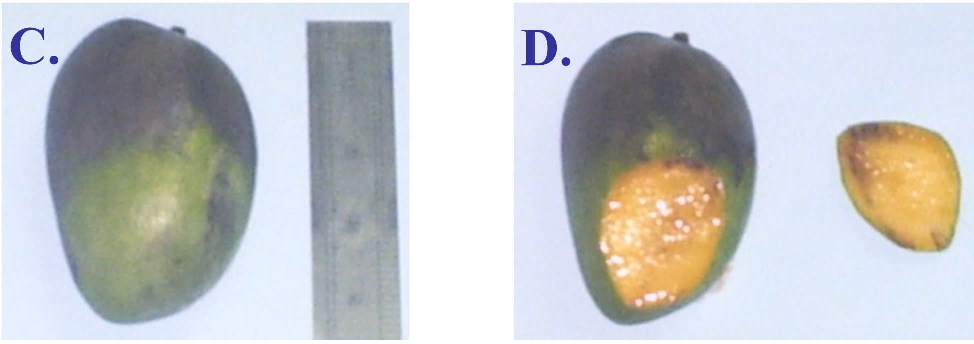


Fig. App II.64 Single fruit (C) and fruit showing pulp (D) of *Gutee*-64

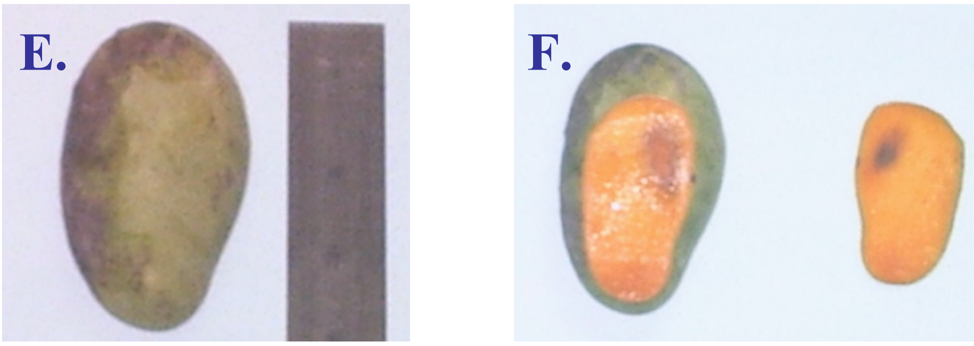


Fig. App II.65 Single fruit (E) and fruit showing pulp (F) of *Gutee*-65

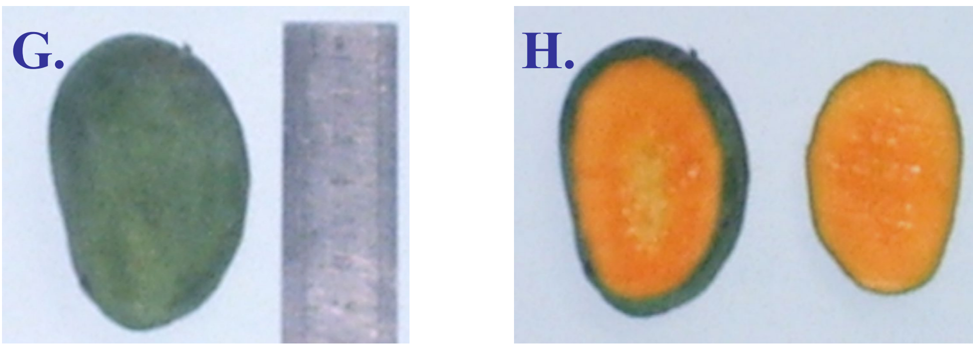


Fig. App II.66 Single fruit (G) and fruit showing pulp (H) of *Gutee*-66

II.67. *Gutee*- 67

The productivity of the 'gutee' is intermediate which matures at mid season and fruit bearing is alternative with at least twelve days storage quality. The small sized fruit is ovate oblong with non glassy green colored skin, light orange pulp and excellent taste with pleasant flavor. The fruit texture is soft, fiber low; apex obtuse but beak, sinus and basal cavity is absent. The average weight of this fruit is 141 g, the average length is 7.7 cm, the average width is 5.6 cm and the average diameter is 18.2 cm. The stone is small with average weight 21 g. This 'gutee' was also collected from Noya lavanga.

II.68. *Gutee*- 68

The fruit is small, ovate, skin non glassy and yellow, pulp color light orange, flavor pleasant, texture soft, taste excellent and fiber low. The beak and sinus is absent, apex obtuse and basal cavity present. The fruit bearing is alternative and storage quality 10 days. The average weight of this fruit is 101 g, the average length is 7.32 cm, the average width is 5.7 cm and the average diameter is 18.18 cm. The stone size is medium, average weight is 20 g. This high productive mid season 'gutee' was collected from Noya lavanga.

II.69. *Gutee*- 69

The shape of the medium sized 'gutee' is oblong oval, productivity intermediate which matures at mid season. The skin of the ripe fruit is green and non glassy, the pulp is light yellow, flavor pleasant, texture soft, taste is excellent, fiber low, apex obtuse, beak, sinus and basal cavity is absent. The fruit bearing habit is alternative and storage quality is 15 days. The average weight of the fruit is 154 g, average length is 9.06 cm, average width 6.12 cm and the average diameter is 17.46 cm. The stone is small and average weight is 21 g. This 'gutee' was also collected from Noya lavanga.

II.70. *Gutee*- 70

The productivity of the 'gutee' is high which matures at mid season and fruit bearing is alternative with at least eleven days storage quality. The medium sized fruit is ovate oblong with non glassy green colored skin, light orange pulp and fair taste with pleasant flavor. The fruit texture is moderate, fiber medium, beak absent, apex obtuse, sinus and basal cavity present. The average weight of this fruit is 175 g, the average length is 9.8 cm, the average width is 5.34 cm and diameter is 18.2 cm. The stone is medium with average weight 35 g. This 'gutee' was collected from Noya lavanga.

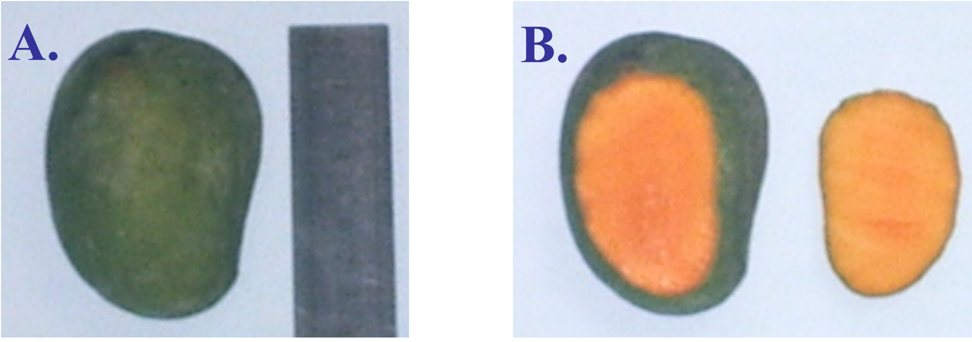


Fig. App II.67 Single fruit (A) and fruit showing pulp (B) of *Gutee*-67

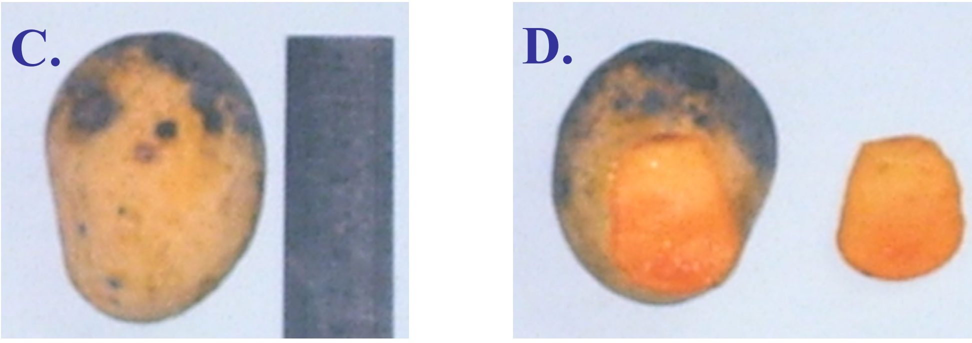


Fig. App II.68 Single fruit (C) and fruit showing pulp (D) of *Gutee*-68

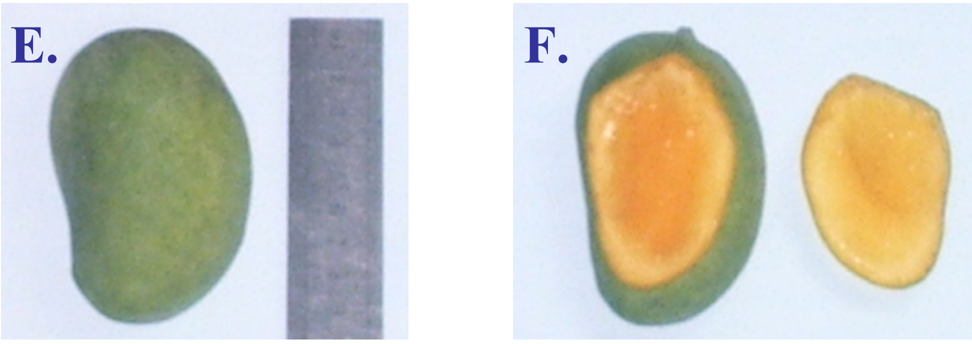


Fig. App II.69 Single fruit (E) and fruit showing pulp (F) of *Gutee*-69

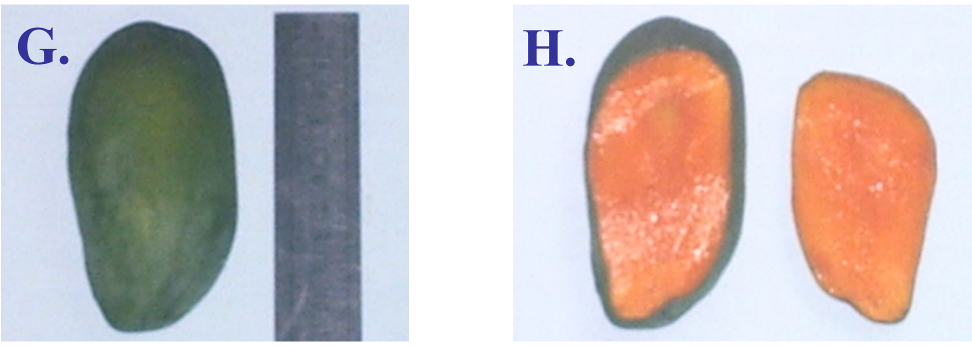


Fig. App II.70 Single fruit (G) and fruit showing pulp (H) of *Gutee*-70

II.71. *Gutee*- 71

The fruit is medium, oval, skin non glassy and green, pulp color yellow, flavor pleasant, texture moderate, taste fair and fiber low. The beak, sinus and basal cavity is absent and apex obtuse. The fruit bearing is alternative and can be stored for 16 days. The average weight of this fruit is 155 g, the average length is 8.32 cm, the average width is 6.04 cm and the average diameter is 17.82 cm. The stone size is medium, average weight is 35 g. This high productive late season 'gutee' was collected from Noya lavanga.

II.72. *Gutee*- 72

The shape of the medium sized 'gutee' is oval and productivity is low which matures at mid season. The skin of the ripe fruit is green and non glassy, the pulp is deep yellow, flavor pleasant, texture soft, taste is good, fiber low, beak and sinus is absent, apex obtuse and basal cavity is also absent. The fruit bearing habit is alternative and storage quality is fifteen days. The average weight of the fruit is 176 g, average length is 8.66 cm, average width 6.66 cm and average diameter is 19.56 cm. The stone is medium and average weight is 25 g. The 'gutee' was collected from Noya lavanga.

II.73. *Gutee*- 73

The productivity of the 'gutee' is intermediate which matures at mid season and fruit bearing is alternative with at least sixteen days storage quality. The medium sized fruit is oblong oval with non glassy green with yellow slashed skin, yellow pulp and excellent taste with pleasant flavor. The fruit texture is soft, fiber low; apex obtuse, beak and sinus is absent while basal cavity is present. The average weight of fruit is 218 g., the average length is 10.28 cm, the average width is 7.22 cm and the average diameter is 21.2 cm. The stone is medium with average weight 27 g. This 'gutee' was also collected from Noya lavanga.

II.74. *Gutee*- 74

The fruit is large, oblong, skin non glassy and green, pulp color light orange, flavor pleasant, texture moderate, taste good and fiber medium. The beak, sinus and basal cavity are absent and apex is obtuse. The fruit bearing is regular and can be stored for 12 days. The average weight of fruit is 325 g, the average length is 12.24 cm, the average width is 8.22 cm and the average diameter is 23.14 cm. The stone size is large, average weight is 38 g. This high productive late season 'gutee' was collected from Noya lavanga.

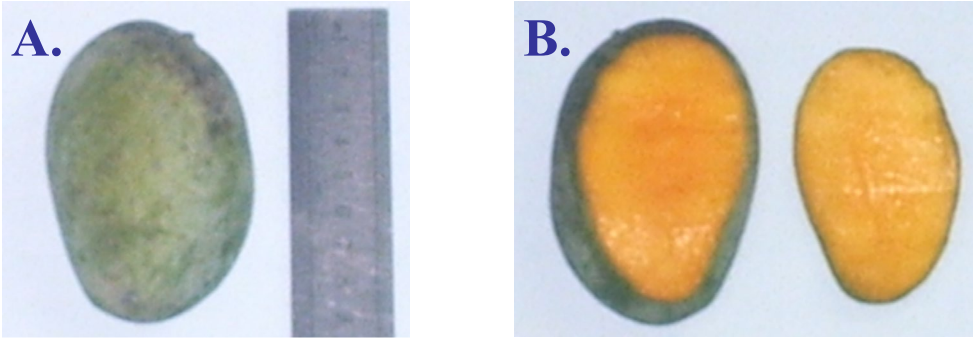


Fig. App II.71 Single fruit (A) and fruit showing pulp (B) of *Gutee*-71

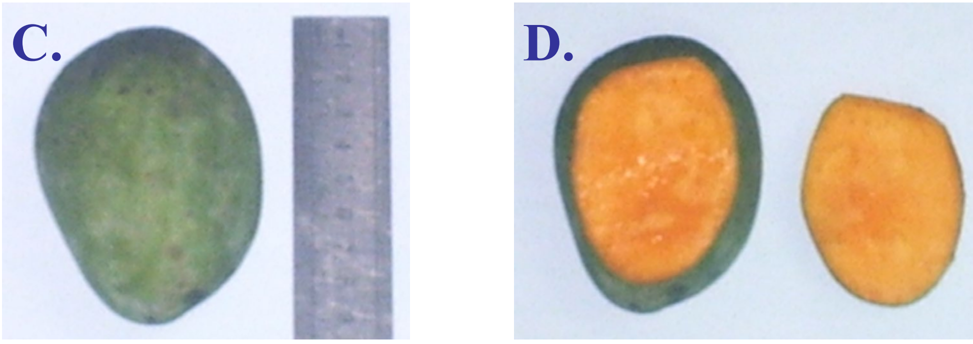


Fig. App II.72 Single fruit (C) and fruit showing pulp (D) of *Gutee*-72

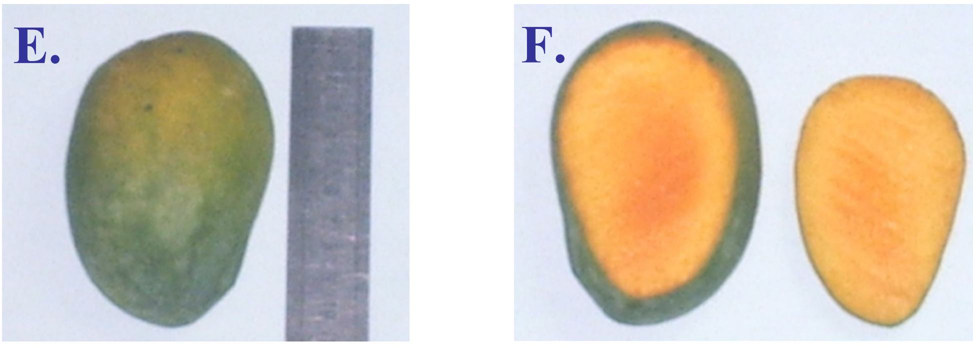


Fig. App II.73 Single fruit (E) and fruit showing pulp (F) of *Gutee*-73

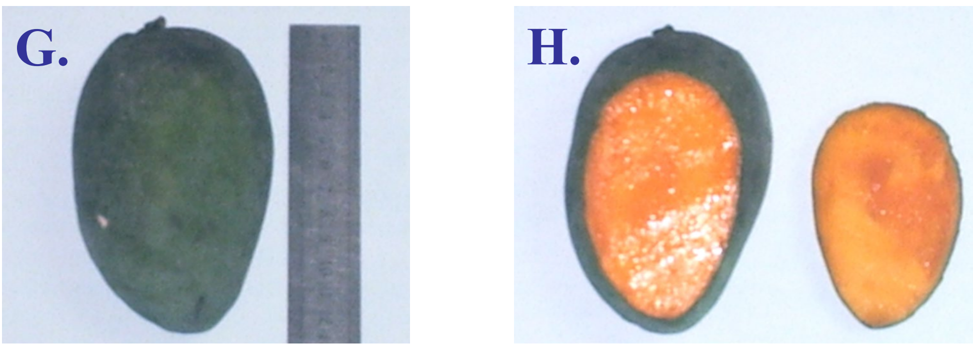


Fig. App II.74 Single fruit (G) and fruit showing pulp (H) of *Gutee*-74

II.75. *Gutee*- 75

The 'gutee' is medium in size, obliquely oval; skin non glassy and green, pulp is light orange. The flavor of fruit is pleasant, texture firm, fiber medium and taste is fair. The beak is prominent, sinus absent, apex obtuse and basal cavity is present. The average weight, length, breadth and diameter of the fruit are 173 g, 9.18 cm, 6.2 cm and 18.72 cm respectively. The stone size medium and average stone weight is 20 g. The productivity of the 'gutee' is intermediate, matures at mid season; fruit bearing is alternative and can be stored for 11 days. This 'gutee' was collected from Noya lavanga.

II.76. *Gutee*- 76

This low productive mid season 'gutee' was collected from Noya lavanga. The fruit is medium, oblong, skin non glassy and green, pulp color deep yellow, flavor pleasant, texture firm, fiber medium and taste sour and sweet. The beak is pointed, sinus absent, apex acute and basal cavity absent. The fruit bearing is alternative and can be stored for 13 days. The average weight of fruit is 252 g, the average length is 10.94 cm, the average width is 7.12 cm and diameter is 21.38 cm. The stone is medium and average weight is 29 g.

II.77. *Gutee*- 77

The productivity of the 'gutee' is intermediate, matures at mid season and fruit bearing is alternative with fifteen days storage quality. The fruit is medium, oblong with glassy green with yellow slash skin, light yellow pulp and good taste. The flavor is pleasant, texture firm, fiber medium, beak and sinus absent, apex obtuse and basal cavity present. The average weight of this fruit is 249 g, the average length is 10.68 cm, the average width is 7.06 cm and the average diameter is 21.36 cm. The stone size is medium, average weight is 27 g. This 'gutee' was collected from Noya lavanga village.

II.78. *Gutee*- 78

The shape of the small sized 'gutee' is ovate oblong and productivity is intermediate which matures at mid season. The skin of the ripe fruit is green with yellow slash and non glassy, the pulp is light orange, flavor pleasant, texture moderate, taste is good, fiber low, beak and sinus is absent, apex obtuse and basal cavity is present. The fruit bearing habit is regular and storage quality is ten days. The average weight of the fruit is 139 g, average length is 7.5 cm, average width 5.26 cm and average diameter is 18.66 cm. The stone is small and average weight is 21 g. This 'gutee' was collected from Noya lavanga village.

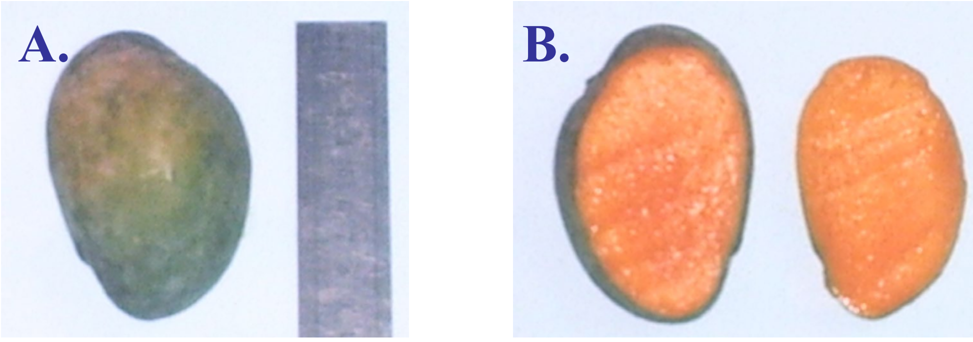


Fig. App II.75 Single fruit (A) and fruit showing pulp (B) of *Gutee*-75

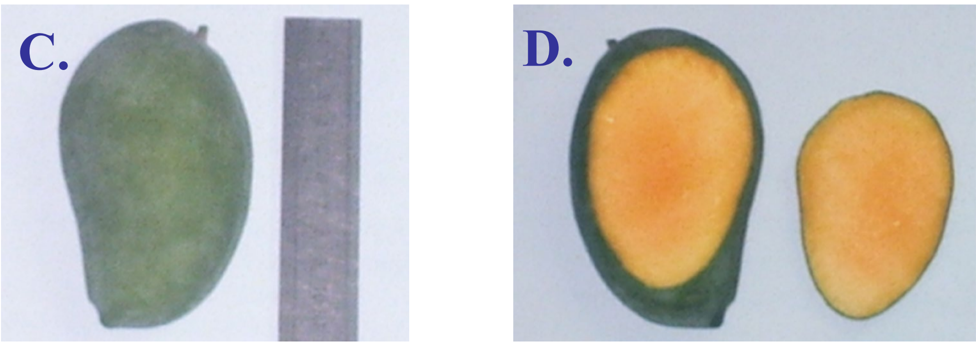


Fig. App II.76 Single fruit (C) and fruit showing pulp (D) of *Gutee*-76

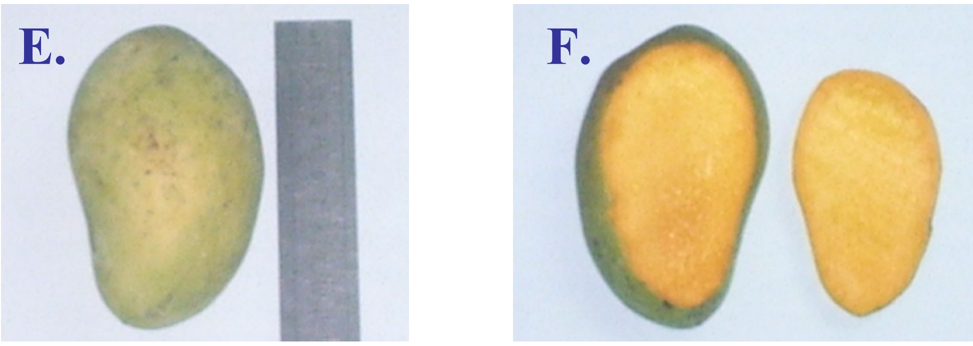


Fig. App II.77 Single fruit (E) and fruit showing pulp (F) of *Gutee*-77

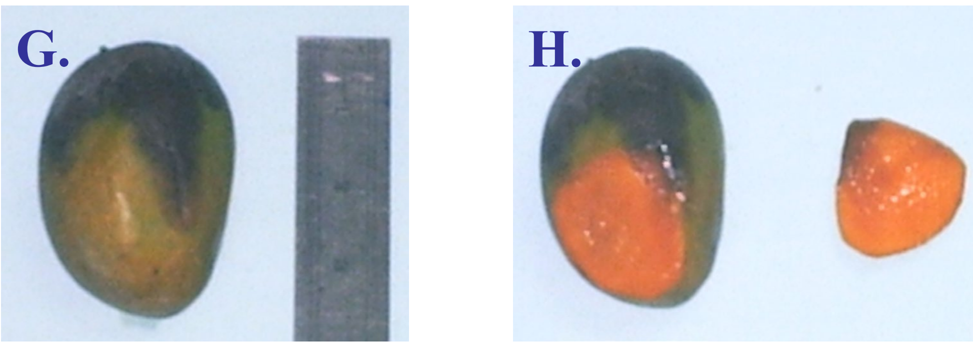


Fig. App II.78 Single fruit (G) and fruit showing pulp (H) of *Gutee*-78

II.79. *Gutee*- 79

The productivity of the 'gutee' is high which matures at mid season and fruit bearing is regular with at least nine days storage quality. The small sized fruit is oblong oval with non glassy green colored skin, light orange pulp and fair taste with pleasant flavor. The fruit texture is moderate, fiber low; apex obtuse, beak and sinus absent but basal cavity is present. The average weight of this fruit is 149 g, the average length is 9 cm, the average width is 5.94 cm and the average diameter is 21 cm. The stone is medium with average weight 29 g. This 'gutee' was also collected from Noya lavanga village.

II.80. *Gutee*- 80

The fruit is medium, productivity intermediate, ovate oblong, skin non glassy and green, pulp color deep orange, flavor pleasant, texture moderate, taste fair and fiber high. The beak, sinus and basal cavity is absent and apex obtuse. The fruit bearing is alternative and can be stored for 16 days. The average weight, length, width and diameter of this fruit are 194 g, 10.76 cm, 7.46 cm and 20.32 cm respectively. The stone size is medium, average weight is 41 g. This mid season 'gutee' was collected from Shaheb gram.

II.81. *Gutee*- 81

The productivity of the 'gutee' is high, matures at late season and fruit bearing is regular. The medium sized fruit is roundish with non glassy green skin, yellow pulp and good taste. The flavor is pleasant, texture moderate, fiber medium, apex round; beak, sinus and basal cavity absent. The average weight of fruit is 176 g, the average length is 8.36 cm, the average width is 6.48 cm and the average diameter is 20.42 cm. The stone size is large, average weight is 37 g. The gutee was collected from Noya lavanga. After ripening the fruit can be stored for fourteen days.

II.82. *Gutee*- 82

The productivity of this early season 'gutee' is high and fruit bearing is alternative with at least sixteen days storage quality. The fruit is small in size, oblong, skin of ripe fruit is non glassy and yellow with light yellow pulp and taste is excellent. The flavor is pleasant, texture moderate but quantity of fiber is low. The Beak, sinus and basal cavity is absent while apex is obtuse. The average weight, length, width and diameter of fruit are 132 g, 8.36 cm, 6.68 cm and 17.84 cm respectively. The average weight of medium sized stone is 21 g. This 'gutee' was collected from Noya lavanga.

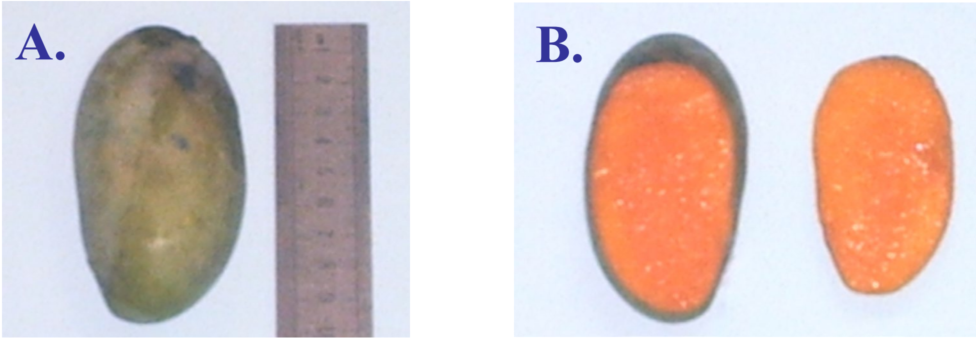


Fig. App II.79 Single fruit (A) and fruit showing pulp (B) of *Gutee*-79

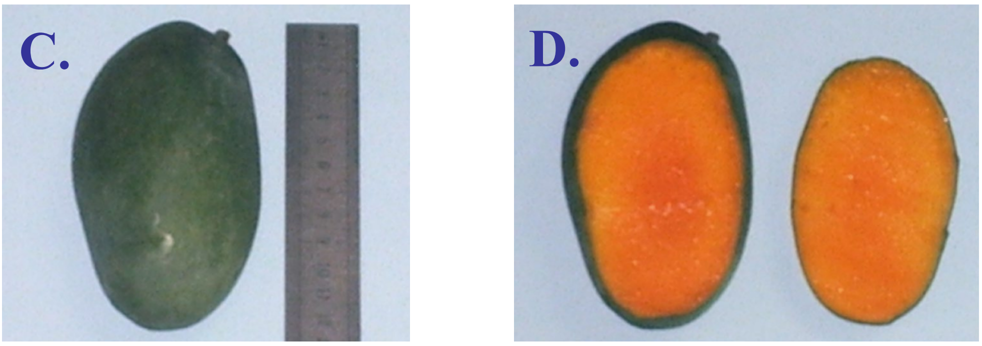


Fig. App II.80 Single fruit (C) and fruit showing pulp (D) of *Gutee*-80

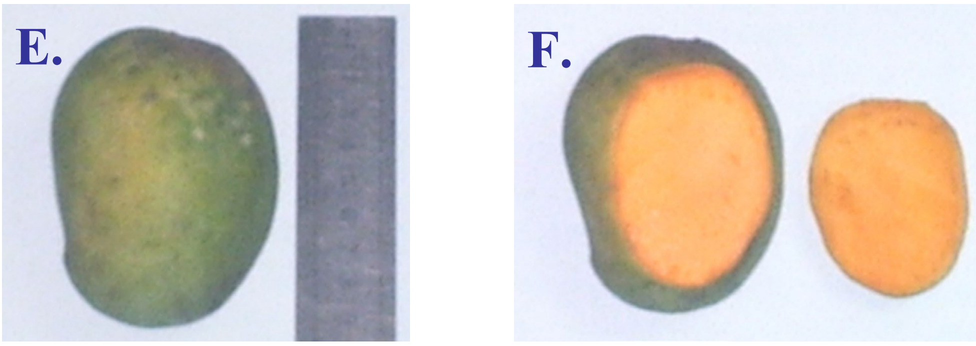


Fig. App II.81 Single fruit (E) and fruit showing pulp (F) of *Gutee*-81

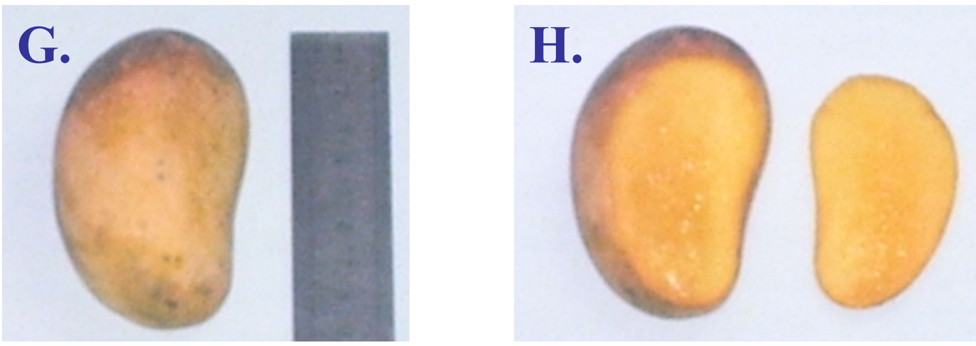


Fig. App II.82 Single fruit (G) and fruit showing pulp (H) of *Gutee*-82

II.83. *Gutee*- 83

The shape of the small sized 'gutee' is oblong and productivity is low which matures at mid season. The skin of the ripe fruit is yellow and glassy; the pulp is deep orange, flavor pleasant, texture moderate, taste is sour, fiber medium, apex obtuse. The beak, sinus and basal cavity are absent. The fruit bearing habit is regular and storage quality is sixteen days. The average weight of the fruit is 102 g, average length is 8.98 cm, average width is 5.32 cm and average diameter is 16.92 cm. The stone is small and average weight is 17 g. This 'gutee' was also collected from Noya lavanga village.

II.84. *Gutee*- 84

The production of the 'gutee' is intermediate, fruit matures at mid season and fruit bearing is alternative. The fruit is small in size, ovate oblong with non glassy green with yellow slash skin, deep yellow pulp and fair taste. The flavor is pleasant, texture moderate, fiber medium, apex obtuse; beak, sinus and basal cavity absent. The average weight of this fruit is 121 g, the average length is 7.74 cm, the average width is 5.7 cm and the average diameter is 17.38 cm. The stone size is medium and average weight is 27 g. After ripening the fruit can be stored for 16 days. The 'gutee' was collected from Noya lavanga.

II.85. *Gutee*- 85

The 'gutee' matures at mid season, productivity high, size small, shape oblong oval, skin type non glassy, skin color green with yellow slash, pulp color deep yellow, flavor pleasant, texture soft, taste sour and sweet, fiber high, apex obtuse, beak, sinus and basal cavity absent. The average weight of this fruit is 51 g, the average length is 6.38 cm, the average width is 4.46 cm and the average diameter is 14.52 cm. The stone size is small and average stone weight is 16 g. After ripening the fruit can be stored for 16 days and fruit production is regular. This 'gutee' was also collected from Shaheb gram.

II.86. *Gutee*- 86

The fruit of this high productive mid season medium sized 'gutee' is oblong, skin non glassy and green with light yellow pulp. The flavor of fruit is pleasant, texture moderate, fiber low and taste is fair. The apex is obtuse; beak, sinus and basal cavity are absent. The average weight, length, breadth and diameter of the fruit are 235 g, 10.74 cm, 6.32 cm and 19.56 cm respectively. The average weight of large sized stone is 43 g. Fruit bearing is alternative and can be stored for 15 days. This 'gutee' was collected from Shaheb gram.

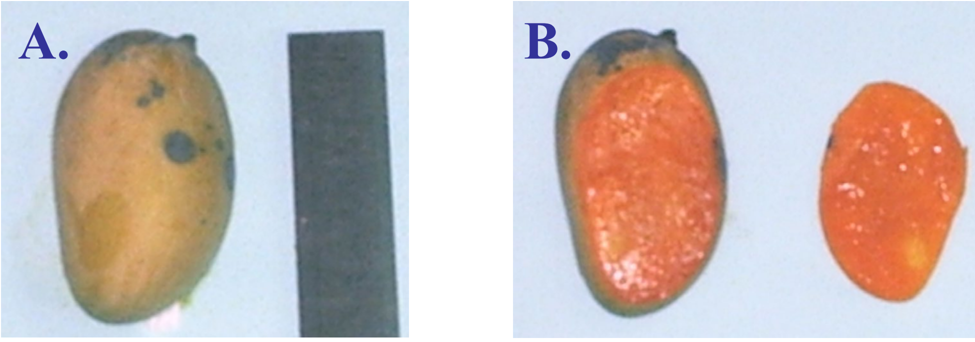


Fig. App II.83 Single fruit (A) and fruit showing pulp (B) of *Gutee*-83

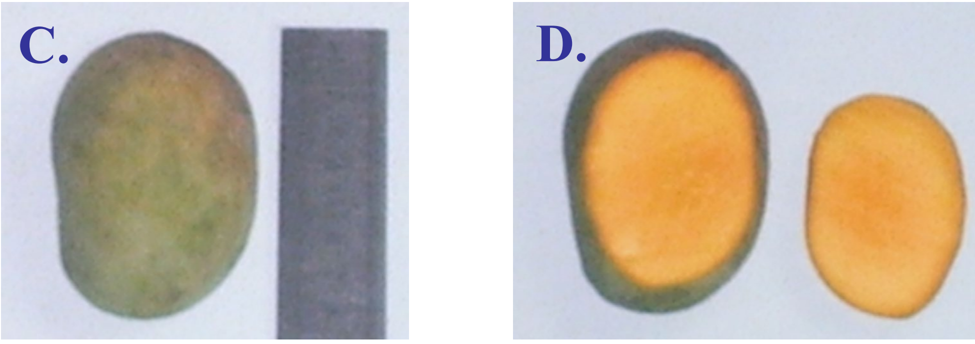


Fig. App II.84 Single fruit (C) and fruit showing pulp (D) of *Gutee*-84

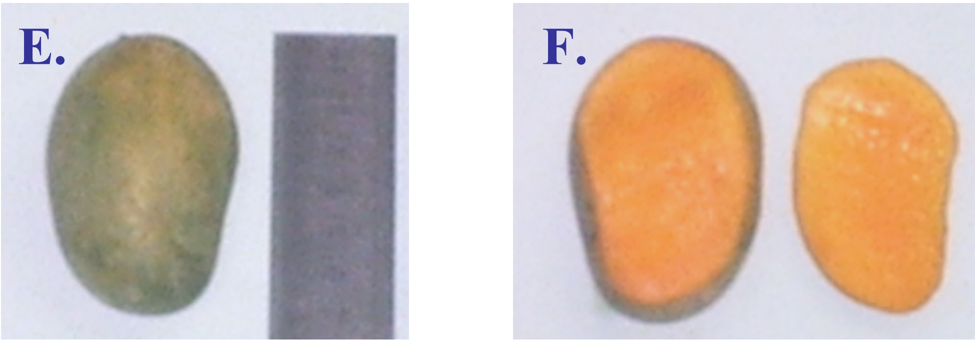


Fig. App II.85 Single fruit (E) and fruit showing pulp (F) of *Gutee*-85

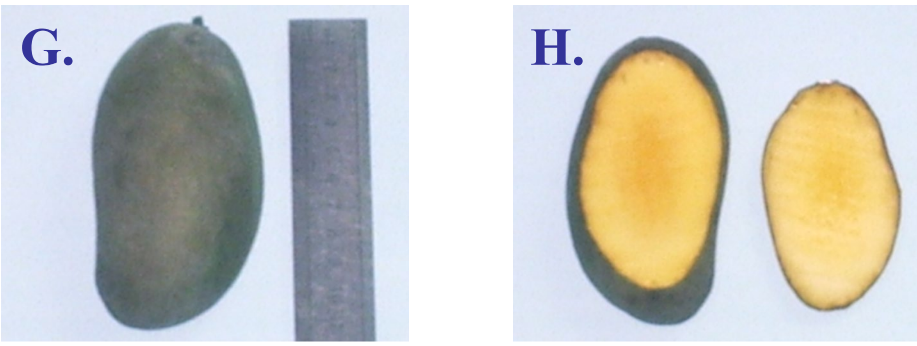


Fig. App II.86 Single fruit (G) and fruit showing pulp (H) of *Gutee*-86

II.87. *Gutee*- 87

The fruit size of the 'gutee' is large, ovate oblique, skin non glassy, skin color of ripe fruit green, pulp color yellow, flavor pleasant, texture moderate, taste fair, fiber medium, beak and sinus absent, apex round and basal cavity present. The average weight of this fruit is 453 g, the average length is 11.66 cm, the average width is 8.82 cm and the average diameter is 27.24 cm. The stone size is large, average weight is 48 g. After ripening the fruit can be stored for twelve days. It is a mid season 'gutee' which fruit bearing is alternative and productivity is intermediate. The fruit was collected from Shaheb gram.

II.88. *Gutee*- 88

The productivity of the 'gutee' is high, mid season and fruit bearing is alternative. The small sized fruit is obliquely oval with non glassy green skin, light orange pulp and sour and sweet taste. The flavor is pleasant, texture soft, fiber low, beak and sinus absent, apex obtuse and basal cavity present. The average weight of this fruit is 90 g, the average length is 7.18 cm, the average width is 5.42 cm and the average diameter is 17.2 cm. The stone size is small, average weight is 15 g. After ripening the fruit can be stored for ten days. This 'gutee' was collected from Bohalabari village.

II.89. *Gutee*- 89

The productivity of this mid season 'gutee' is intermediate and fruit bearing is regular with at least 12 days storage quality. The fruit is medium in size, oblong oblique, skin of ripe fruit is non glassy and green with yellow pulp and fair taste. The flavor is pleasant, texture soft and quantity of fiber is low. The Beak is pointed, apex obtuse, sinus and basal cavity is absent. The average weight, length, width and diameter of fruit are 196 g, 11.14 cm, 6.54 cm and 18.5 cm respectively. The average weight of medium sized stone is 23 g. This 'gutee' was collected from Bohalabari village.

II.90. *Gutee*- 90

The 'gutee' was collected from the Bohalabari village. The fruit is medium in size; obliquely oval, skin non glassy, skin color of ripe fruit is green with yellow slash, pulp color light orange, flavor pleasant, texture soft, taste fair, fiber low, apex obtuse, beak, sinus and basal cavity is absent. The average weight of fruit is 181g, the average length is 7.84 cm, the average width is 6.56 cm and average diameter is 20.1 cm. The stone size is medium and average weight is 26 g. After ripening the fruit can be stored for 15 days. The fruit bearing of this mid season 'gutee' is alternative and productivity is intermediate.

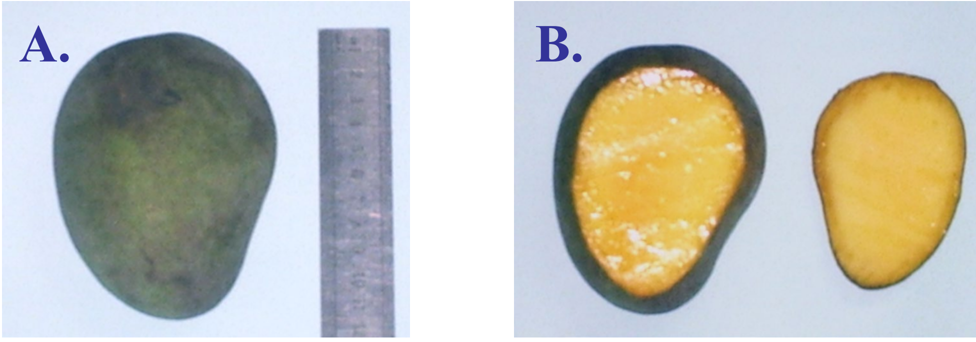


Fig. App II.87 Single fruit (A) and fruit showing pulp (B) of *Gutee*-87

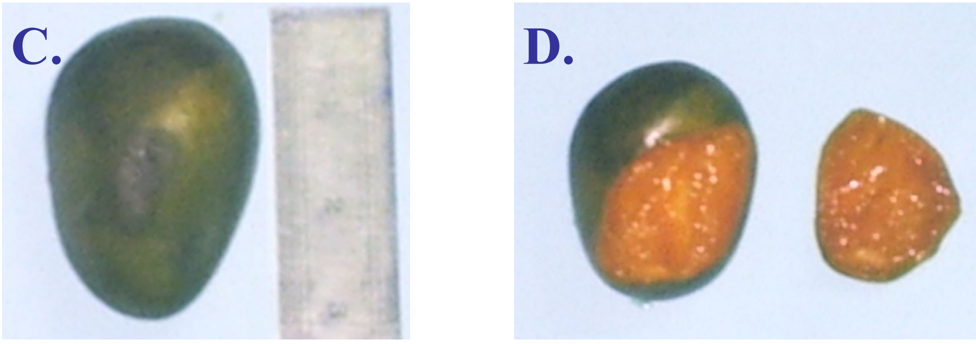


Fig. App II.88 Single fruit (C) and fruit showing pulp (D) of *Gutee*-88

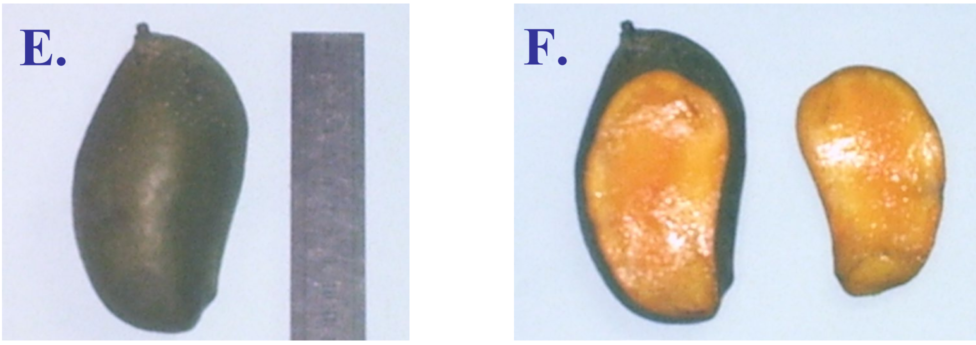


Fig. App II.89 Single fruit (E) and fruit showing pulp (F) of *Gutee*-89

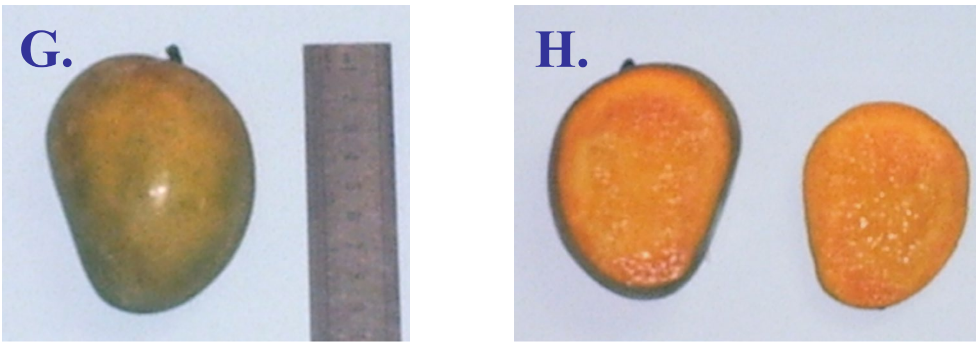


Fig. App II.90 Single fruit (G) and fruit showing pulp (H) of *Gutee*-90

II.91. *Gutee*- 91

This mid season alternative fruit bearing 'gutee' was collected from the Bohalabari village. The productivity of fruit is intermediate, size medium, shape oblong, skin non glassy, skin color of ripe fruit is green with yellow slash, pulp color deep yellow, flavor pleasant, texture soft, taste excellent, fiber medium, beak absent, sinus present, apex obtuse and basal cavity absent. The average weight of this fruit is 207 g, the average length is 10.3 cm, the average width is 6.42 cm and the average diameter is 20.1 cm. The stone size is large and average weight is 38 g. The mature fruit can be stored for 16 days.

II.92. *Gutee*- 92

The fruit of this 'gutee' was small and collected from the Bohalabari village. The fruit is oblong, skin non glassy, skin color of ripe fruit is yellow, pulp color deep orange, flavor pleasant, texture soft, taste fair, fiber medium, beak mummiform, sinus present, apex obtuse and basal cavity absent. The average fruit weight, length, width and diameter are 77 g, 8.02 cm, 5.18 cm and 15.5 cm respectively. The stone size is medium and average stone weight is 20 g. The storage quality of ripe fruit is 15 days and productivity intermediate, fruit bearing alternative and matures at mid season.

II.93. *Gutee*- 93

The productivity of this mid season, alternative bearing 'gutee' is intermediate. The medium sized fruit is oval with non glassy green skin, deep orange pulp and good taste. The flavor is pleasant, texture moderate, fiber medium, apex obtuse, beak and sinus absent and basal cavity present. The average weight of this fruit is 223 g, the average length is 10.54 cm, the average width is 6.6 cm and the average diameter is 21.5 cm. The stone size is medium, average weight is 29 g. The fruit can be stored for 9 days. This 'gutee' was collected from Bohalabri village.

II.94. *Gutee* - 94

The productivity of this mid season 'gutee' is intermediate and fruit bearing is alternative with at least 15 days storage quality. The fruit is medium in size, ovate oblong, skin of ripe fruit is non glassy and green with deep yellow pulp and taste is excellent. The flavor is pleasant, texture soft and fiber is low. The beak absent, sinus present, apex acute and basal cavity is present. The average weight, average length, average width and average diameter of this fruit are 254 g, 10.04 cm, 7.28 cm and 21.5 cm respectively. The average weight of medium sized stone is 26 g. This 'gutee' was also collected from Bohalabari.

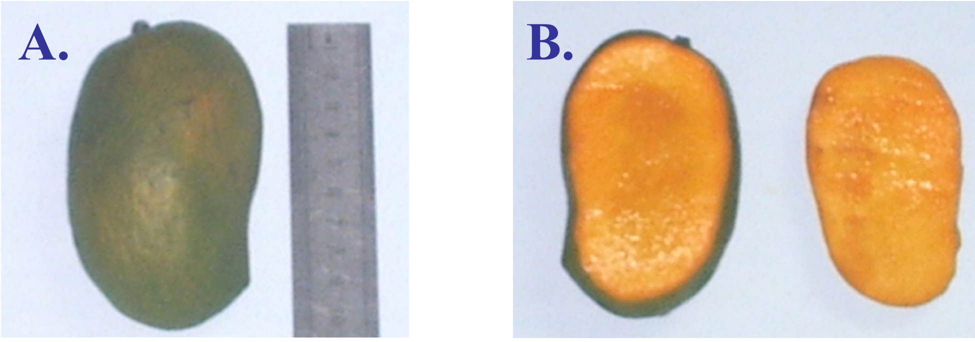


Fig. App II.91 Single fruit (A) and fruit showing pulp (B) of *Gutee*-91

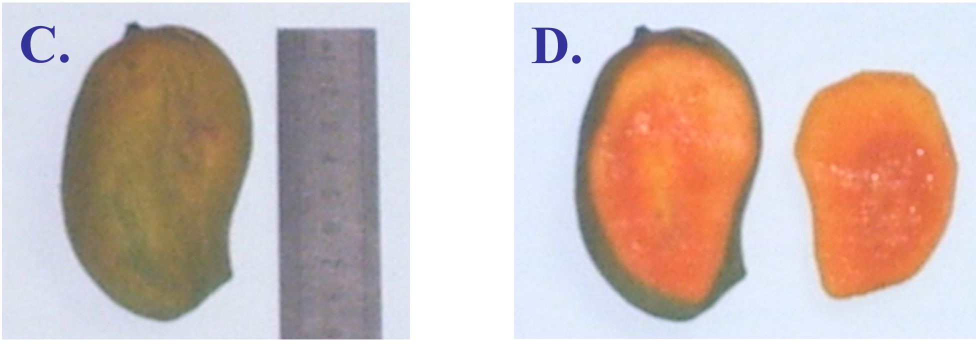


Fig. App II.92 Single fruit (C) and fruit showing pulp (D) of *Gutee*-92

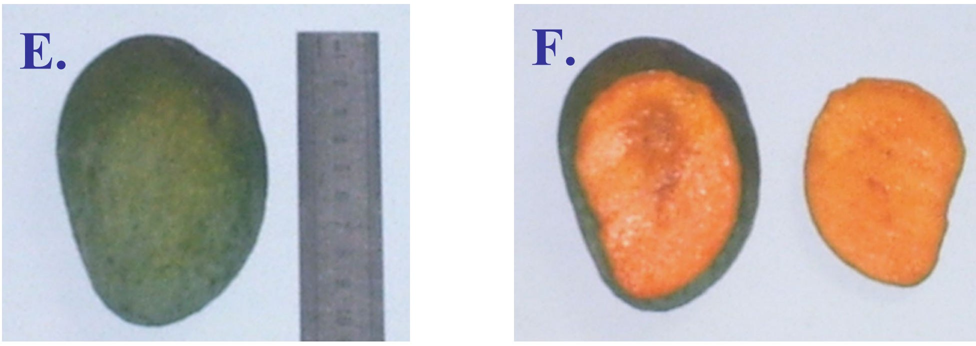


Fig. App II.93 Single fruit (E) and fruit showing pulp (F) of *Gutee*-93

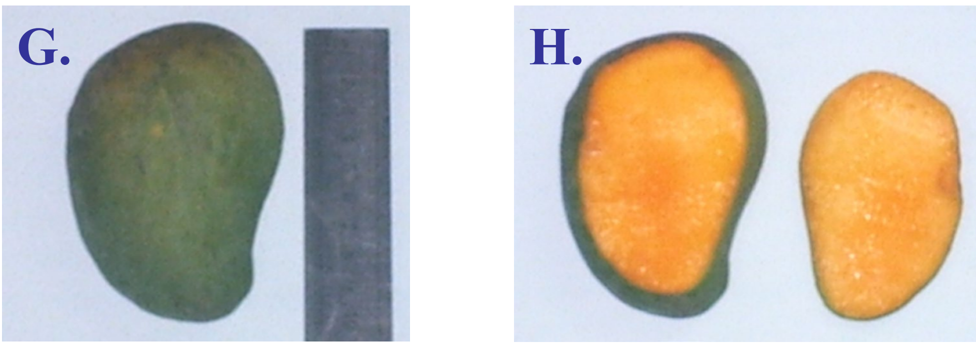


Fig. App II.94 Single fruit (G) and fruit showing pulp (H) of *Gutee*-94

II.95. *Gutee*- 95

The medium size 'gutee' is ovate oblong, alternative bearing, intermediate productive, and matures at mid season. The skin of the ripe fruit is non glassy and green with deep yellow pulp, flavor pleasant, texture soft, taste excellent, fiber low, apex obtuse; beak, sinus and basal cavity are absent. The storage quality is 13 days. The average weight, length, width and diameter of the fruit are 206 g, 9.18 cm, 6.92 cm and 20.84 cm. The stone is medium and average weight is 25 g. The 'gutee' was collected from Bohalabari.

II.96. *Gutee*- 96

The 'gutee' is medium in size, oblong oval, skin non glassy and green and pulp is deep orange. The flavor of fruit is pleasant, texture firm, fiber high and taste is fair. The apex is obtuse, sinus present, beak and basal cavity is absent. The average weight, length, width and diameter of the fruit are 194 g, 10.76 cm, 7.46 cm and 20.32 cm respectively. The stone size is large and average stone weight is 46 g. The productivity of the 'gutee' is intermediate, matures at mid season; fruit bearing is alternative and can be stored for 16 days. This 'gutee' was collected from Bohalabari.

II.97. *Gutee*- 97

The 'gutee' is high productive, fruits mature at mid season and fruit bearing is alternative. The fruit is small in size, obliquely oval with non glassy green with yellow slash skin, yellow pulp and fair taste. The flavor is pleasant, texture moderate, fiber high, beak and sinus absent but basal cavity present, apex round. The average weight of fruit is 134 g, the average length is 8.1 cm, the average width is 6.02 cm and diameter is 18 cm. The stone size is small and average weight is 25 g. After ripening the fruit can be stored for sixteen days. This 'gutee' was also collected from Bohalabari.

II.98. *Gutee*- 98

The productivity of the 'gutee' is intermediate, maturation period mid season and fruit bearing is alternative. The medium sized fruit is oblong with glassy green with yellow slash skin, deep yellow pulp and sour and sweet taste. The flavor is pleasant, texture firm, fiber high, beak absent, sinus present, apex obtuse and basal cavity absent. The average weight of this fruit is 134 g, the average length is 8.1 cm, the average width is 6.02 cm and the average diameter is 18 cm. The stone size is small, average weight is 25 g. After ripening the fruit can be stored for 16 days. This 'gutee' was collected from Bohalabari.

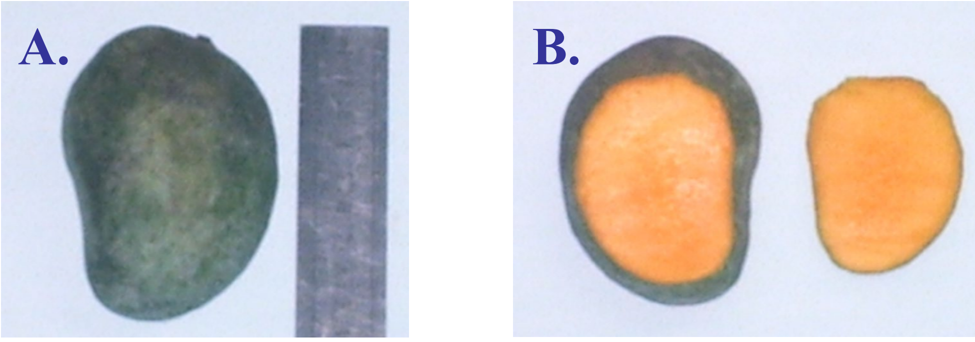


Fig. App II.95 Single fruit (A) and fruit showing pulp (B) of *Gutee*-95

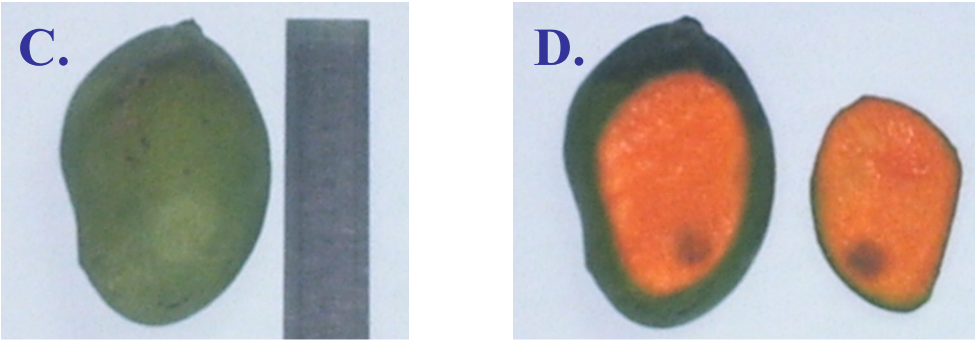


Fig. App II.96 Single fruit (C) and fruit showing pulp (D) of *Gutee*-96

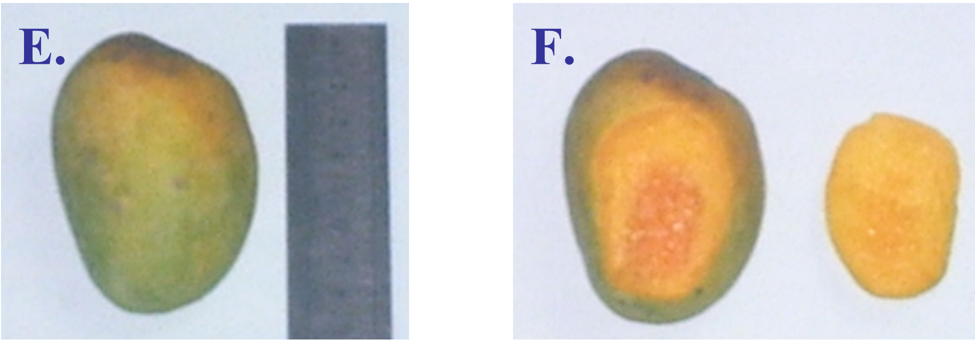


Fig. App II.97 Single fruit (E) and fruit showing pulp (F) of *Gutee*-97

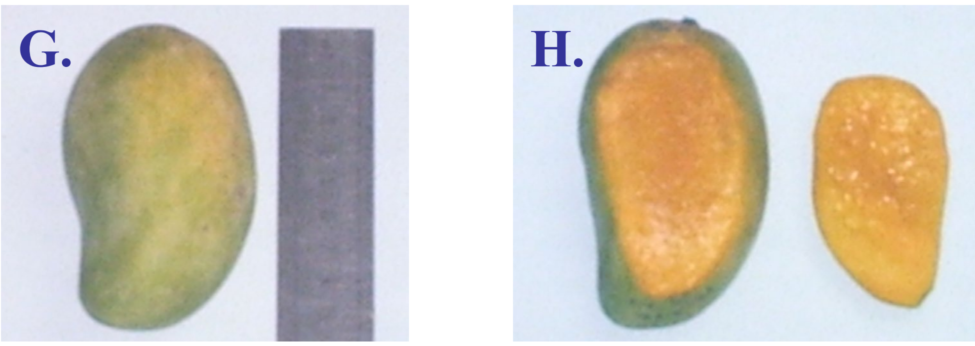


Fig. App II.98 Single fruit (G) and fruit showing pulp (H) of *Gutee*-98

II.99. *Gutee*- 99

The 'gutee' was collected from the Bohalabari village. The fruit is medium in size, roundish, skin non glassy, skin color of ripe fruit is green, pulp color light orange, flavor pleasant, texture soft, taste excellent, fiber low, apex round; beak, sinus and basal cavity absent. The average weight of this fruit is 175 g, the average length is 8.54 cm, the average width is 6.88 cm and diameter is 19.88 cm. The stone size is medium and average stone weight is 30 g. After ripening the fruit can be stored for fifteen days. It is a mid season 'gutee' which fruit bearing is alternative and productivity is intermediate.

II.100. *Gutee*- 100

The fruit of this 'gutee' was medium and collected from the Bohalabari village. The fruit is ovate, skin glassy, skin color of ripe fruit is yellow, pulp color deep yellow, flavor pleasant, texture soft, taste fair, fiber medium, beak absent, apex obtuse, sinus and basal cavity absent. The average weight, length, width and diameter of fruit are 124 g, 7.96 cm, 5.36 cm and 17.2 cm respectively. The stone size is small and average weight is 27 g. The storage quality of ripe fruit is twelve days and matures at mid season. The fruit bearing is alternative and productivity is intermediate.

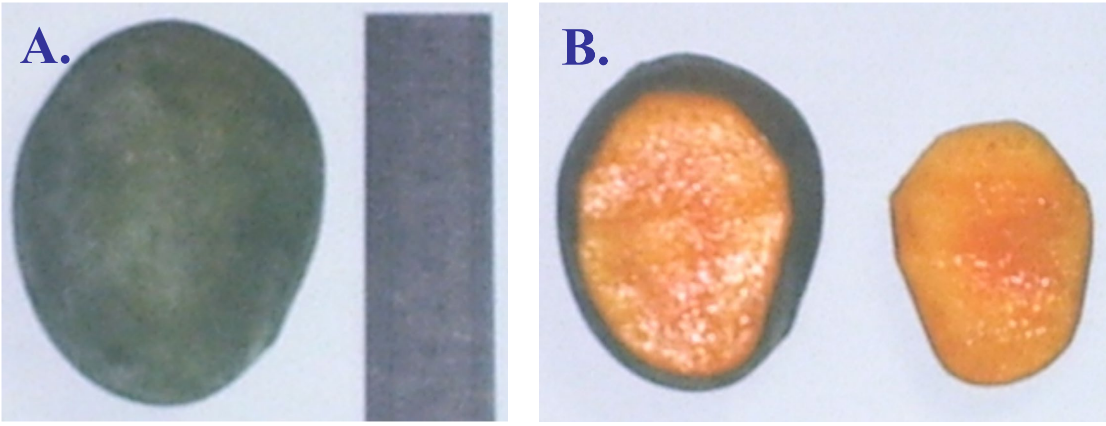


Fig. App II.99 Single fruit (A) and fruit showing pulp (B) of *Gutee*-99

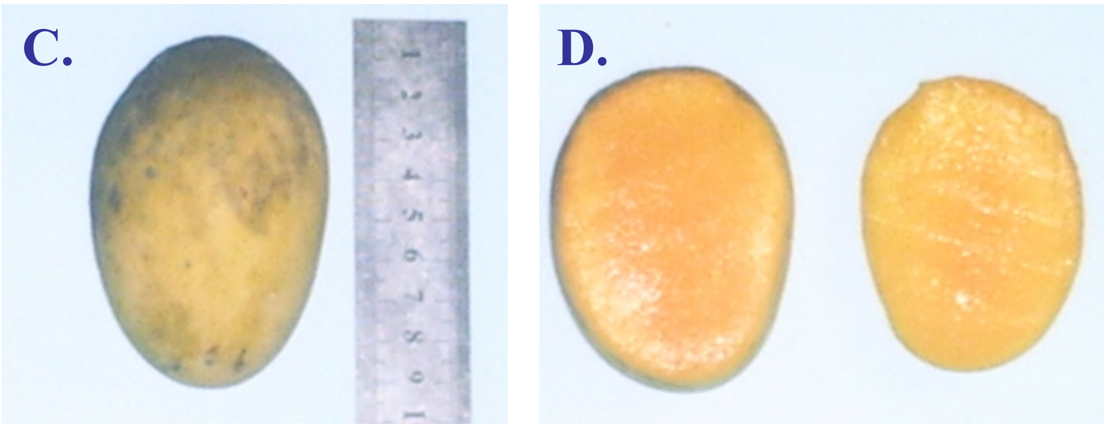


Fig. App II.100 Single fruit (C) and fruit showing pulp (D) of *Gutee*-100

APPENDIX-III: Collection List of *Gutee* Trees

1. Collection serial: *Gutee*- 1 Local name: Nokkani Owner's name: Sanaul Haque Location: Sanaul's kanta Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	9. Collection serial: *Gutee*- 9 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj
2. Collection serial: *Gutee*- 2 Local name: Khatashe Owner's name: Badal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	10. Collection serial: *Gutee*- 10 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj
3. Collection serial: *Gutee*- 3 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	11. Collection serial: *Gutee*- 11 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj
4. Collection serial: *Gutee*- 4 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	12. Collection serial: *Gutee*- 12 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj
5. Collection serial: *Gutee*- 5 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	13. Collection serial: *Gutee*- 13 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj
6. Collection serial: *Gutee*- 6 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	14. Collection serial: *Gutee*- 14 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj
7. Collection serial: *Gutee*- 7 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	15. Collection serial: *Gutee*- 15 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj
8. Collection serial: *Gutee*- 8 Local name: Unknown Owner's name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	16. Collection serial: *Gutee*- 16 Local name: Unknown Owner's name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur

17. Collection serial: *Gutee*- 17 Local name: Unknown Owner’s name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	25. Collection serial: *Gutee*- 25 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
18. Collection serial: *Gutee*- 18 Local name: Unknown Owner’s name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	26. Collection serial: *Gutee*- 26 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
19. Collection serial: *Gutee*- 19 Local name: Unknown Owner’s name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	27. Collection serial: *Gutee*- 27 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
20. Collection serial: *Gutee*- 20 Local name: Unknown Owner’s name: Sadequl Mia Location: Mango orchard near dam Village: Kamalakantapur Union: Sattajitpur Upozilla: Shibganj	28. Collection serial: *Gutee*- 28 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
21. Collection serial: *Gutee*- 21 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	29. Collection serial: *Gutee*- 29 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
22. Collection serial: *Gutee*- 22 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	30. Collection serial: *Gutee*- 30 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
23. Collection serial: *Gutee*- 23 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	31. Collection serial: *Gutee*- 31 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
24. Collection serial: *Gutee*- 24 Local name: Unknown Owner’s name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	32. Collection serial: *Gutee*- 32 Local name: Unknown Owner’s name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur

33. Collection serial: *Gutee*- 33 Local name: Unknown Owner's name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	41. Collection serial: *Gutee*- 41 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
34. Collection serial: *Gutee*- 34 Local name: Unknown Owner's name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	42. Collection serial: *Gutee*- 42 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
35. Collection serial: *Gutee*- 35 Local name: Unknown Owner's name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	43. Collection serial: *Gutee*- 43 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
36. Collection serial: *Gutee*- 36 Local name: Unknown Owner's name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	44. Collection serial: *Gutee*- 44 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
37. Collection serial: *Gutee*- 37 Local name: Unknown Owner's name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	45. Collection serial: *Gutee*- 45 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
38. Collection serial: *Gutee*- 38 Local name: Unknown Owner's name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	46. Collection serial: *Gutee*- 46 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
39. Collection serial: *Gutee*- 39 Local name: Unknown Owner's name: Marjuk Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	47. Collection serial: *Gutee*- 47 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
40. Collection serial: *Gutee*- 40 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	48. Collection serial: *Gutee*- 48 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur

49. Collection serial: *Gutee*- 49 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	57. Collection serial: *Gutee*- 57 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
50. Collection serial: *Gutee*- 50 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	58. Collection serial: *Gutee*- 58 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
51. Collection serial: *Gutee*- 51 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	59. Collection serial: *Gutee*- 59 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
52. Collection serial: *Gutee*- 52 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	60. Collection serial: *Gutee*- 60 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur
53. Collection serial: *Gutee*- 53 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	61. Collection serial: *Gutee*- 61 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
54. Collection serial: *Gutee*- 54 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	62. Collection serial: *Gutee*- 62 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
55. Collection serial: *Gutee*- 55 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	63. Collection serial: *Gutee*- 63 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
56. Collection serial: *Gutee*- 56 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	64. Collection serial: *Gutee*- 64 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj

65. Collection serial: *Gutee*- 65 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	73. Collection serial: *Gutee*- 73 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
66. Collection serial: *Gutee*- 66 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	74. Collection serial: *Gutee*- 74 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
67. Collection serial: *Gutee*- 67 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	75. Collection serial: *Gutee*- 75 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
68. Collection serial: *Gutee*- 68 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	76. Collection serial: *Gutee*- 76 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
69. Collection serial: *Gutee*- 69 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	77. Collection serial: *Gutee*- 77 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
70. Collection serial: *Gutee*- 70 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	78. Collection serial: *Gutee*- 78 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
71. Collection serial: *Gutee*- 71 Local name: Unknown Owner's name: Mainul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	79. Collection serial: *Gutee*- 79 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj
72. Collection serial: *Gutee*- 72 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	80. Collection serial: *Gutee*- 80 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur

81. Collection serial: *Gutee*- 81 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	89. Collection serial: *Gutee*- 89 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
82. Collection serial: *Gutee*- 82 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	90. Collection serial: *Gutee*- 90 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
83. Collection serial: *Gutee*- 83 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	91. Collection serial: *Gutee*- 91 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
84. Collection serial: *Gutee*- 84 Local name: Unknown Owner's name: Zobdul Haque Location: Mango orchard Village: Noya lavanga Union: Noya lavanga Upozilla: Shibganj	92. Collection serial: *Gutee*- 92 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
85. Collection serial: *Gutee*- 85 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	93. Collection serial: *Gutee*- 93 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
86. Collection serial: *Gutee*- 86 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	94. Collection serial: *Gutee*- 94 Local name: Gutee Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
87. Collection serial: *Gutee*- 87 Local name: Unknown Owner's name: Manwar Ahmed Location: Mango orchard Village: Shaheb gram Union: Choudala Upozilla: Gomostapur	95. Collection serial: *Gutee*- 95 Local name: Unknown Owner' name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
88. Collection serial: *Gutee*- 88 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	96. Collection serial: *Gutee*- 96 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj

97. Collection serial: *Gutee*- 97 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	99. Collection serial: *Gutee*-99 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
98. Collection serial: *Gutee*- 98 Local name: Unknown Owner's name: Selim Mia Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	100. Collection serial: *Gutee*- 100 Local name: Unknown Owner's name: Sanaul Haque Location: Dhalpur mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj

APPENDIX-IV: Collection List of Cultivated Varieties (Local cultivars)

1. Local name: *Sathiarerkera* Owner's name: Badal Mia Location: Bash bagan Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	9. Local name: *Mirabhog* Owner's name: Badal Mia Location: Delur kanta Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
2. Local name: *Kalua* Owner's name: Sanaul Haque Location: Back side of the owner's house Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	10. Local name: *Danadar* Owner's name: Noor Chasham Bibi Location: Mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
3. Local name: *Gulli* Owner's name: Golam Mohammad Mia Location: Gorosthan Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	11. Local name: *Golapbas* Owner's name: Selim Mia Location: Dhalpur Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
4. Local name: *Lugnee* Owner's name: Shafiul Alam Location: Bash bagan Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	12. Local name: *Mohonbhog* Owner's name: Shaju Haque Location: Mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
5. Local name: *Kancha mitha* Owner's name: Badal Mia Location: Tal ghera Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	13. Local name: *Kalibhog* Owner's name: Shafiul Alam Location: Gorostan Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
6. Local name: *Chal guti* Owner's name: Badal Mia Location: Tal ghera Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	14. Local name: *Kalimeghi* Owner's name: Golam Mohammad Mia Location: Gorostan Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
7. Local name: *Kumapahari* Owner's name: Badal Mia Location: Mango orchard Village: Bohalabari Union: Sattatajitpur Upozilla: Shibganj	15. Local name: *Khudi Khirshapat* Owner's name: Lal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj
8. Local name: *Narkel phaki* Owner's name: Badal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	16. Local name: *Poichchha* Owner's name: Noor Chasham Bibi Location: Owner's house Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj

17. Local name: *Bira* Owner's name: Parvin Shirin Location: Owner's house Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	25. Local name: *Abidbhog* Owner's name: Moshu Biswas Location: Mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
18. Local name: *Champa* Owner's name: Parvin Shirin Location: Owner's house Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	26. Local name: *Sindura* Owner's name: Moshu Biswas Location: Mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
19. Local name: *Dofola* Owner's name: Shafiul Alam Location: Mango orchard Village: Bohalabari Union: Sattatajitpur Upozilla: Shibganj	27. Local name: *Chosha* Owner's name: Moshu Biswas Location: Mango orchard Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
20. Local name: *Totapuri* Owner's name: Lal Mia Location: Owner's house Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	28. Local name: *Shantu* Owner's name: Lal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj
21. Local name: *Alam shahi* Owner's name: Lal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	29. Local name: *Lamba guti* Owner's name: Badal Mia Location: Tal ghera Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj
22. Local name: *Boishakhi* Owner's name: Shafiul Alam Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	30. Local name: *Dadbhog* Owner's name: Lal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj
23. Local name: *RI* Owner's name: Hira Bibi Location: Delur kanta Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	31. Local name: *Pherdous pasand* Owner's name: Shafiul Alam Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj
24. Local name: *Dilshad* Owner's name: Muga Biswas Location: Beside pond of the house Village: Bohalabari Union: Sattajitpur Upozilla: Shibganj	32. Local name: *Brindaboni* Owner's name: Shafiul Alam Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj

33. Local name: *Jhurki* Owner's name: Badal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	40. Local name: *Chock choke* Owner's name: Badal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj
34. Local name: *Khejura* Owner's name: Lal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	41. Local name: *Nazim Pasand* Owner's name: Lal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj
35. Local name: *Larua* Owner's name: Lal Mia Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	
36. Local name: *Choto kalua* Owner's name: Noor Chasham Bibi Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	
37. Local name: *Hayati* Owner's name: Noor Chasham Bibi Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	
38. Local name: *Sipia* Owner's name: Noor Chasham Bibi Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	
39. Local name: *Batasha* Owner's name: Noor Chasham Bibi Location: Mango orchard Village: Chondipur Union: Noya lavanga Upozilla: Shibganj	

APPENDIX-V: List of Tables and Figures

LIST OF FIGURES