

**EVALUATION OF PROMISING ACCESSIONS OF
PAPAYA (*Carica papaya* L.) FOR CULTIVATION IN
NORTH KERALA**

AKHIL P

(2017-12-023)



**DEPARTMENT OF FRUIT SCIENCE
COLLEGE OF AGRICULTURE
PADANNAKKAD, KASARGOD 671 314
KERALA, INDIA**

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PAPAYA (*Carica papaya* L.) FOR CULTIVATION IN
NORTH KERALA**

**By
AKHIL P
(2017-12-023)**

THESIS

**Submitted in partial fulfillment of the
requirements for the degree of**

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**DEPARTMENT OF FRUIT SCIENCE
COLLEGE OF AGRICULTURE
PADANNAKKAD, KASARGOD 671 314
KERALA, INDIA**

2020

DECLARATION

I hereby declare that this thesis entitled '**Evaluation of promising accessions of papaya (*Carica papaya* L.) for cultivation in North Kerala**' is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

Padannakkad
Date

Akhil P
2017-12-023

CERTIFICATE

Certified that this thesis entitled '**Evaluation of promising accessions of papaya (*Carica papaya* L.) for cultivation in North Kerala**' is a record of research work done independently by Mr. Akhil P (2017-12-023) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

Padannakkad,

Date.

Dr. Satheeshan K. N

(Major Advisor, Advisory Committee)
Professor and ADR,
RARS Pilicode,
Kasaragod

CERTIFICATE

We, the undersigned members of the advisory committee of Mr. Akhil P., a candidate for the degree of **Master of Science in Horticulture** with major in Pomology, agree that the thesis entitled “**Evaluation of promising accessions of papaya (*Carica papaya* L.) for cultivation in North Kerala**” may be submitted by Mr. Akhil P, in partial fulfillment of the requirement for the degree.

Dr. Satheeshan K. N.

(Chairman, Advisory Committee)
Professor (Horticulture) and ADR,
RARS, Pilicode

Ms. Reshmika P.K.

(Member, Advisory Committee)
Assistant Professor, Department of
Pomology and Floriculture, College of
Agriculture, Padannakkad

Dr. Meera Manjusha A. V.

(Member, Advisory Committee)
Assistant Professor (Horticulture)
RARS, Pilicode

Dr. Sudarsana Rao G. V.

(Member, Advisory Committee)
Professor and Head
Department of Plant Physiology
College of Agriculture, Padannakkad

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LIST OF ABBREVIATIONS

%	-	Per cent
Acc	-	Accessions
B	-	Beta
B	-	Boron
Ca	-	Calcium
CD	-	Critical Difference
Cm	-	Centimeter
cm ²	-	Centimeter Square
CO	-	Coimbatore
Cu	-	Copper
CV	-	Coefficient of Variation
DAP	-	Days After Planting
<i>et al</i>	-	And others
FYM	-	Farm yard manure
G		Gram
H ₂ SO ₄		Sulphuric Acid
HCl	-	Hydrochloric Acid
hrs.	-	Hours
IARI	-	Indian Agricultural Research Institute
IBPGR	-	International Bureau of Plant genetic resources
IIHR	-	Indian Institute Of Horticultural Research
IU	-	International units
K ₂ O	-	Potash
KAU	-	Kerala Agricultural University
Kg	-	Kilogram
LDL	-	Low Density Lipoprotein

M	-	Meter
MAP	-	Months After Planting
Min	-	Minute
Mg	-	Magnesium
Mg	-	Milligram
ml	-	Milliliter
mm	-	Millimeter
Mn	-	Manganese
MT	-	Metric tones
N	-	Nitrogen
NaOH	-	Sodium Hydroxide
Nm	-	Nanometer
N,P,K	-	Nitrogen, Phosphorus, Potassium
NS	-	Not significant
OC	-	Organic carbon
°C	-	Degree Celsius
°E	-	Degree East
°N	-	Degree North
P ₂ O ₅	-	Phosphorous Pentoxide
p ^H	-	Potential of Hydrogen
Ppm	-	Parts per million
Ppm	-	Parts per million
RARS	-	Regional Agricultural Research Station
RBD	-	Randomised block design
t	-	Tons
TNAU	-	Tamil Nadu Agricultural University
TSS	-	Total Soluble Salts
viz.	-	Namely
Zn	-	Zinc

INTRODUCTION

1. INTRODUCTION

Papaya (*Carica papaya* L.) is one of the delicious fruit in the tropics. It is believed to have originated in southern Mexico and Costa Rica (Purseglove, 1977) and later during the 16th century, papaya got introduced into India from Malacca. Papaya has gained the popularity among the fruits due to its quick growth, high yield, long fruiting period and high nutrient value. In addition to that it has been used as vegetable, for processing and value addition and for papain production. It can be cultivated as a highly profitable crop nowadays by utilizing its full potential.

India is the highest papaya producing country in the world with an area of 1.38 lakh ha and production of 59.89 lakh tones (NHB, 2018). The major papaya growing states in India are Tamil Nadu, Karnataka, Maharashtra, Gujarat, West Bengal and Kerala. In Kerala papaya is grown as homestead crop. The area and the production in the state are 19188 ha and 113439 MT respectively (NHB, 2018).

Papaya fruits have good demand due to high palatability, lower price, and nutritional and medicinal benefits (Azad *et al.*, 2012). The fruits are an excellent source of beta carotene (2020 IU/100 g) and essential nutrients such as Iron, Calcium, Vitamin B and C (Aravind *et al.*, 2013). Fruits are also utilized in the pharmaceutical and cosmetic industries (Retuta *et al.*, 2012). The proteolytic enzyme “papain” obtained from raw fruit is used for tenderizing meat, preparation of chewing gum, preshrinking of wool and degumming natural silk (Tulasigeri *et al.*, 2017). Papaya leaf juice has the capability to increase white blood cells and platelets and this property is widely exploited in the treatment of dengue fever (Noriko *et al.*, 2010).

Recently, red coloured papaya varieties are preferred for consumption, as they contain lycopene. It is a powerful antioxidant that has shown to neutralise free radicals, thereby give protection against prostate cancer, breast cancer and

atherosclerosis. It reduces LDL (low density lipoprotein) oxidation and helps to reduce cholesterol levels in the blood (Harini and Sumathy, 2016).

The papaya plants are polygamous in nature. There are monoecious, dioecious and gynodioecious (female and bisexual plants) in papaya. Only gynodioecious varieties are preferred for cultivation, since all seedlings will bear fruits.

There is a wide range of variability in plant height, fruiting height, fruit size, and quality of fruit in papaya. There is high diversity in papaya due to the compatibility between several genera and species of the family which leads to the production of natural hybrids. Such a complex hybrid population is the reason for morphological and genetic variability. Cultivar differences and geographic effects on yield and quality parameters have been reported in papaya (Kimura et al., 1991) which points out to the relevance of screening types/varieties suitable to geographical locations. For selection of improved genotypes of papaya with superior quality, physicochemical characters play a vital role. As such, investigation on the physicochemical and yield characters of local cultivars and varieties will throw light on their suitability for commercial cultivation. Further, they could be exploited as breeding material for future improvement.

The major limiting factors for commercial cultivation in Kerala are high rainfall and severe drought in summer. The roots are often invaded by fungal pathogens and are also prone to many viral diseases and pests like mealy bugs and whiteflies. Another limiting factor for commercial cultivation of papaya is the unavailability of high yielding varieties/types adapted to climatic conditions in Kerala, incidence of virus diseases and lack of disease resistant varieties. Currently, the farmers rely on varieties from private sector outside the state as well as on those released by institutes across India which are constrained by low availability and high seed cost.

Practically very little attempt has been made for short listing papaya varieties/types suitable for commercial cultivation in North Kerala region. In this

context, the present investigation entitled ‘Evaluation of promising accessions of papaya (*Carica papaya* L.) for cultivation in North Kerala’ was proposed with the following objective:

To evaluate the selected papaya accessions, released varieties and hybrids in order to identify best papaya genotypes for yield and quality, suitable for cultivation in North Kerala.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Papaya is one of the important delicious fruit crop grown in tropical and subtropical areas. In Kerala, papaya is mainly grown as a homestead crop and is often used as a vegetable for cooking. However, interest is growing among farmers recently, for raising commercial scale plantations owing to good local demand for fruits which at present is mainly catered by neighbouring states. Being a short duration, remunerative fruit crop with excellent nutritional qualities, it has a tremendous impact on economic and health propitiations (Saran and Choudhary, 2013). More over papaya is suitable for cultivation as a mixed crop in coconut garden which could provide additional returns to the Kerala farmer. In this context, investigation on evaluation of selected papaya genotypes is proposed with an objective of identifying suitable genotypes for Northern zone of Kerala. The literatures relevant to the study are reviewed hereunder.

2.1 EVALUATION OF VARIETIES

The different gynodioecious papaya lines evaluated for yield and quality results showed that CP 30, CP 48, CP 56 and CP 33 varieties yielded more than 50 kg of fruits/ tree (Auxcilia and Sathiamoorthy, 1996). According to Nirujogi and Dinesh (2012) different variations were found in plant and fruit characters among selfed progenies from gynodioecious papaya varieties Arka Surya and Arka Prabhath, while evaluating under Maharashtra conditions. These variations may be due to the different genetic constitution of female and hermaphrodite plants. In a varietal evaluation study conducted by Das (2013) with eight varieties and hybrids of papaya, the varieties Coorg Honeydew, Pusa Majesty and local types were found to be performing excellent with respect to yield and quality parameters.

The performance of papaya varieties Sunrise Solo and Washington were compared for their performance by Das *et al.* (2014). It was seen that the variety Sunrise Solo was superior to Washington with a seed germination of 63.33 %, fruit maturity of 154 days and percentage fruit set of 76.09 %.

The anther derived papaya plants were assessed to determine their usefulness in breeding and commercial fruit production by Rimberia *et al.*, (2009). It was observed that all the plants derived from microspore were female, with triploids (87.5 %) being the major. Among the thirty triploid strains evaluated, three were found to be dwarfs with less than 100 cm, four were medium height with 110 to 150 cm and all the others were found to be tall with more than 200 cm of length. The dwarf triploids and tall triploids were recorded with highest fruit yield per tree (27.4 kg) and lowest yield (7.0 kg) respectively.

At IARI, New Delhi, 16 papaya genotypes were selected and screened against the papaya ring spot and leaf curl virus diseases under field conditions. It was found that the five genotypes *viz.*, P-7-9, Sinta, Pune Selection-3, P-7-2 and RCTP-1 showed tolerance to papaya ring spot and leaf curl virus diseases (Prakash and Singh, 2013). Reddy *et al.* (2011) reported that the papaya variety Red lady has the minimum disease incidence of 8.33% and with maximum of 26 days for PRSV symptom expressions.

Rodge and Yadlod (2009) attempted ripening papaya employing different ripening media and the same was used for the preparation of the jam. The fruit ripening was good when the straw is used as the media with more sugar, carotenoid and ascorbic acid. The organoleptic score was recorded highest in the jam prepared from the Solo papaya compared with the Washington papaya.

2.2 GROWTH CHARACTERS

Papaya is a small typically unbranched quick growing soft wooded tree. It is almost a herb with latex vessels in all the parts. Morphologically, the stem is hollow between the nodes except in young plants, consisting mainly of wood parenchyma and bear large triangular scars. The hollow stems are light green to tan brown in colour with diameter of 8 inches (Aravind *et al.*, 2013).

The variation in the plant height (mean 2.09 m), collar girth (0.33m) and canopy spread (1.81m EW/ 1.83m NS) was reported by Singh *et al.* (2006). According to Singh and Kumar (2010) the wide range of variability was observed

in plant height and plant girth, which ranged from 138.4 to 240.6 cm and 28.02 to 36.8 cm respectively.

The variation in number of leaves was reported in papaya varieties, where in Arka Surya it varied between 18 to 31 and in Arka Prabhath the variation was between 20 to 33 (Nirujogi and Dinesh 2012). There was notable difference in the morphological characters among the progenies of different sex types.

2.2.1 Plant height

Five varieties of papaya namely Pusa Delicious, PusaNanha, Pant Papaya-1, Madhu Bindu and Arka Surya were evaluated under North Gujarat during 2007-08. The variety Pant Papaya-1 recorded the tallest plant during all growth stages (Meena *et al.*, 2012).

Nirujogi and Dinesh (2012) under Bangalore condition evaluated the gynodioecious papaya varieties *viz.*, Arka Surya and Arka Prabhath. The plant height at first flowering recorded in Arka Surya and Arka Prabhath varied from 93.50 to 116.90 cm and 54.50 to 86.45 cm respectively.

Das (2013) evaluated eight varieties and hybrids of papaya *viz.*, Coorg Honey Dew, Pusa Dwarf, Pusa Majesty, Pusa Nanha, Washington, Arka Surya, RCTP-1 and local dwarf types at Lembucherra condition (Tripura). The highest and lowest plant height was observed in case of high yielding selection RCTP-1(293.55cm) and new local dwarf gynodioecious type (91.33 cm) respectively.

Seventeen genotypes of papaya were evaluated by Kumar *et al.* (2015) under field experiment during 2010 and 2011 in Meerut (Gujarat) condition. It was observed that the plant height was strongly influenced by environmental fluctuations and ranged from 120 to 185.33 cm.

Under the Pune condition, nine papaya cultivars were grown and evaluated for growth, yield, quality and PRSV incidence by Chalak *et al.* (2016). The maximum plant height of 75.00 cm was recorded for the cv. CO-2 at the first flowering and lowest of 53.3 cm in Pusa Nanha.

2.2.2 Collar girth

Meena *et al.* (2012) evaluated five varieties of papaya *viz.* Pusa Delicious, Pusa Nanha, Pant Papaya-1, Madhu Bindu and Arka Surya under north Gujarat during 2007-08. The highest stem girth at 240 days after planting was recorded in Pant Papaya-1 (6.92 cm) but at 60 (0.89 cm), 120 (2.21 cm) and 180 (3.85 cm) DAP, the highest stem girth observed in Pusa Delicious.

Nirujogi and Dinesh (2012) evaluated gynodioecious papaya varieties *viz.* Arka Surya and Arka Prabhath under Bengaluru condition. The stem diameter at first flowering for the Arka Surya varied from 5.86 to 8.24 cm and for Arka Prabhath it varied from 3.91 to 4.95 cm.

Das (2013) evaluated eight varieties and hybrids of papaya *viz.* Coorg Honey Dew, Pusa Dwarf, Pusa Majesty, Pusa Nanha, Washington, Arka Surya, RCTP-1 and Local Dwarf types at Lembucherra condition (Tripura). The cv. Surya was recorded with the highest plant girth.

2.2.3 Length of petiole

Samson (1986) reported that the leaves are very large (up to 75 cm wide), palmately lobed or deeply incised with entire margins and petioles of 30 to 90 cm in length. These peltate leaves are arranged in a 2/5 spiral with large long hollow petioles and large, deeply lobed blades except in some cultivars. A positive correlation was observed between the petiole length and the number of fruits (Ram, 2005).

The colour of mature leaf petioles are mainly of three types and the pale green leaf petiole being the most dominant. The reddish purple and pale yellow leaf petiole was observed only in Hinan and Si thong papaya respectively (Sompack *et al.*, 2014).

2.2.4 Number of fully developed leaves

Anh *et al.* (2011) evaluated twelve local papaya varieties that had been collected in Vietnam in 2008. The results showed that the collection of papaya varieties had number of leaves of from 17.6 to 21.8.

Nirujogi and Dinesh (2012) evaluated gynodioecious papaya varieties Arka Surya and Arka Prabhath under Bengaluru condition. The number of leaves at first flowering within the Arka Surya was varied from 18 to 31 and for Arka Prabhath number of leaves varied from 20 to 33. The Arka Surya, number of nodes varied from 27 to 32 and for Arka Prabhath, number of nodes varied from 23 to 36.

Prakash *et al.* (2015) studied papaya var. Pusa Nanha grown in two locations *viz.* polyhouse and open field conditions at New Delhi. The higher number of leaves at flowering (18.33) was observed in poly house.

2.3 FLOWERING AND FRUITING CHARACTERS

2.3.1 Days to first flowering

Kumar *et al.* (2015) evaluated seventeen genotypes of papaya under field experiment during 2010 and 2011 in Meerut (Gujarat) condition. The results indicated that plant flower initiation start from 212.93 to 228.83 days and flowering days start from 230.83 to 242.27 and these characters was highly influenced by environmental fluctuations.

Prakash *et al.* (2015) studied papaya var. Pusa Nanha grown in two locations *viz.* polyhouse and open field conditions at New Delhi. The result revealed that papaya under polyhouse showed early flower initiation (64.67 days).

Chalak *et al.* (2016) evaluated nine papaya cultivars grown under Pune conditions for growth, yield, quality and PRSV incidence. The cv. Red lady showed early flowering (70.4 DAP) which was at par with cv. CO-2 (73.5 DAP), Pusa Nanha (73.7 DAP) and Pusa Dwarf (73.6 DAP) and maximum days was

taken in cv. Pusa Gaint (85.4 DAP). The trial was conducted at Pune, with nine papaya cultivars for growth, yield, quality and PRSV incidence. It was observed that the early flowering was shown by cv. Red lady (70.4 DAP) followed by cv. CO 2 (73.5 DAP), Pusa Nanha (73.7 DAP) and Pusa Dwarf (73.6 DAP).

2.3.2 Sex expression

Papaya is also known as trioecious plant which implies that the separate plants bear male, female or bisexual flowers. The flowers are waxy, ivory white and borne on short peduncles in leaf axils along the main stem in case of female and bisexual flowers. The female flowers of papaya are pear shaped when unopened whereas, bisexual flowers they are cylindrical (Aravind *et al.*, 2013). The male papaya can be distinguished by the smaller flowers borne on long stalks.

The genetic and environmental factors greatly influence the sex expression in papaya. The female plant was observed to be stable and more productive compared to the hermaphrodite and sex reversing male plants. Awada (1958) reported that the per cent of carpelloidic flowers was significantly correlated with minimum temperature and growth rate of the plants. The higher female fertility of 8.17 per cent was observed at the maximum temperature of 29.5°C during March, whereas lowest fertility of 0.22 per cent was observed during December at a maximum temperature of 12.2°C in sex reversing male. The rapid growth in papaya was seen during the hot summer months, but the fruit set will be arrested during the cold winter months and with fruits maturing the following spring and summer. At the minimum air temperatures below 11°C and minimum soil temperature below 19 °C the performance of papaya was found to be poor (Allan, 2002).

2.3.3 Fruit length and fruit width

The length of fruits of papaya was studied by Desikan (1972) in the varieties namely CO-1, Coorg Honeydew and Washington and it was found that the mean length was 17.50 cm, 26.57 cm and 18.70 cm respectively.

The twelve local papaya varieties collected from the Vietnam was evaluated for fruit length and diameter by Anh *et al.* (2011). It was seen that the average fruit length and fruit diameter varied between 9.67- 17.33 and 6.67 -14.17 respectively.

Meena *et al.* (2012) under north Gujarat conditions evaluated five varieties of papaya, *viz.* Pusa Delicious, Pusa Nanha, Pant Papaya-1, Madhu Bindu and hybrid Surya during 2007-08. The Pusa Nanha had discernibly highest fruit diameter, fruit length and pulp thickness.

Das (2013) evaluated eight varieties and hybrids of papaya *viz.*, Coorg Honey Dew, Pusa Dwarf, Pusa Majesty, Pusa Nanha, Washington, Arka Surya, RCTP-1 and local dwarf types grown in Tripura condition. According to Das (2013) the maximum fruit length and fruit breadth were recorded in cv. RCTP-1 (23.57 cm) and Pusa Dwarf (15.20 cm) respectively.

2.3.4 Shape of fruits

In papaya, fruit shape is a sex-linked trait. The fruit of female trees are spherical to ovoid while fruits from hermaphrodite trees are elongate, cylindrical to pear shaped (Chan and Paull, 2008; Paull *et al.*, 2008). The fruit bearing in plants initiates in 6-12 months and the maturity of individual fruit is influenced by the cultivar and temperature and usually occurs within 5-9 months (Aravind *et al.*, 2013). The colour of ripe fruits and flesh varied from yellow to salmon red.

Storey (1937) studied the primary type of papaya and reported that the fruit produced by each type of flower has a characteristic shape. The fruit shapes in papaya reported were spherical or slightly obovoid, obovoid and long cylindrical to ellipsoid with a more or less bulbous apex. In the CO-2 variety the fruits were medium to large with oblong shape (Rao *et al.*, 1974). Singh (1990) reported the shape of Washington to be round to ovate oblong, CO-2 to be ridged at the apex and oblong, Solo to be pyriform and ribbed and Pusa Nanha to be ovate.

The weight, volume and the shape of specific variety of papaya fruits were found to be constant when grown under similar agro ecological conditions. Hofmeyr (1938) made some crosses using two different female parents and one male plant and studied the progenies for the fruit shape. It was found that in one cross the fruit shape was oblong whereas in all others it was round. He also concluded that the shape of the fruit is a sex linked character. All hermaphrodite plants produce usually long shaped fruits, while pistillate plants produce round or oblong shaped fruits.

2.3.5 Fruit cavity index

Nirujogi and Dinesh (2012) evaluated gynodioecious hybrids of papaya namely Arka Surya and Arka Prabhath under the Bengaluru condition for fruit cavity index. It was observed that among the progenies of Arka Surya the fruit cavity varied between 16.22 to 24.25 per cent and for Arka Prabhath it varied between 12.09 to 27.01 percent.

2.4 YIELD CHARACTERS

Papaya fruits are called as berries and resemble melon with a central seed cavity and shows high diversity in size, shape and colour. Fruit size can range from less than 100 g in some wild accession to over 10 kg in certain landraces. It was reported by Samson (1986) that the weight of the fruit varied from 0.5 to 2.0 kg. Discernible variation in fruit length (26.19 cm), width (42.28 cm) and fruit cavity (15.34 cm) was reported by Singh *et al.* (2006).

2.4.1 Number of fruits per plant

The yield of the papaya plant is expressed as the number of fruits per plant. The fruits per plant in the popular varieties of papaya namely, Washington, CO-2 and Coorg Honeydew was 43, 39 and 10 respectively (Ram, 1981).

According to Bose and Mitra (1985) number of fruits per plant in varieties namely Washington, CO-2, CO-3, CO-4, Solo, Coorg Honeydew and Pusa Dwarf was observed to be 11, 30-40, 35-40, 40,50-60, 20 and 40 respectively. The

papaya varieties *viz.*, Pusa Dwarf, Pusa Nanha, CO-2 Washington, Coorg Honeydew and CO-5 were evaluated for growth and yield under Tripura conditions and recorded that number of fruits per plant to be 27.83, 16.73, 21.42, 7.65, 21.33, 15.99 respectively.

Jana *et al.* (2010) evaluated fifteen papaya hybrids/selections grown in Subtropical plateau region of eastern India. The variety 'CO-3' accounted for the maximum fruit number (51.0) per plant.

Anh *et al.* (2011) evaluated twelve local papaya varieties collected from Vietnam in 2008. The total number of fruits ranged from 12 to 24 numbers among the different varieties.

Kumar *et al.* (2015) evaluated seventeen genotypes of papaya under field experiment grown in Meerut (Gujarat) condition during 2010 and 2011. The results indicated that fruits per plant ranged from 19.67 to 60.73 and this character was highly influenced by environmental fluctuations.

Chalak *et al.* (2016) evaluated nine papaya cultivars for growth, yield, quality and PRSV incidence under Pune conditions. The maximum numbers of fruits per plant were recorded in cv. Pusa Nanha (33.4).

Tyagi *et al.* (2015) evaluated five papaya varieties namely, Surya, Madhu, Arka Prabhath, Pusa Dwarf and Red lady 786 under poly-nethouse in 2012 at Ludhiana (Punjab). The results revealed that there was a discernible variation observed in fruit number (20.67-46.00). The highest and lowest number of fruits was found in cv. Red lady (46.00) and Arka Prabhath (20.67) respectively.

2.4.2 Yield per plant

Empirical evidences on the evaluation of papaya types/varieties suitable for cultivation in Kerala are scanty except for a few attempts. Reni (1997) screened twelve papaya varieties for yield, quality and post-harvest attributes under Vellanikkara conditions. Among the cultivars, CO-6 recorded the maximum yield (52.5 kg) while Solo has highest number of fruits.

Evaluation of Papaya varieties for dessert purpose was carried out for cultivation in Kerala (Lakshmi, 2000). Among the varieties, Pusa Nanha possessed highest fruit weight while the fruit yield was the highest in CO-2.

Jana *et al.* (2010) in the Subtropical plateau region of eastern India evaluated fifteen papaya hybrids or selections. The maximum individual fruit weight (2.04 kg) and yield (34.92 kg per plant) was observed in variety 'Ranchi'.

Prakash *et al.* (2015) studied papaya var. Pusa Nanha grown in two locations viz. polyhouse and open field conditions at New Delhi. The papaya under poly house showed high fruit yield (34.56 kg per plant) compared with open field.

Tyagi *et al.* (2015) evaluated five papaya varieties namely, Arka Surya, Madhu, Arka Prabhat, Pusa Dwarf and Red lady- 786 under poly house in 2012 at Ludhiana (Punjab). A significant variation was observed in yield (10.49-38.84 kg) and fruit weight (508.00-841.67 g). The Red lady had maximum fruit yield (38.84 kg) and fruit weight (841.67 g).

A trial was conducted with nine papaya cultivars for the assessing the growth, yield, quality and PRSV incidence at Pune. Chalak *et al.* (2016) observed that the maximum number of fruits/plants was recorded in cv. Pusa Nanha (33.4) and in the cv. Pusa Giant maximum fruit weight (2.1 kg) and fruit yield/plant (66.1 kg) were recorded.

The evaluation to find out the promising types/ varieties of papaya suitable for Kerala condition was carried out by Reshma *et al.* (2016). Highest fruit weight (1830 g) was recorded in Acc. 15 followed by CO-8 (1770 g). Yield per plant was maximum in Acc. 25 (31.50 kg) followed by Acc. 6 (27.63 kg/ plant), Acc.1 (26.57 kg/plant). Acc.25 produced higher number of fruits per plant (35.11) followed by Acc.1 (32.66), Acc.5 (32.33), Acc.6 (30.11).

2.5 QUALITY PARAMETERS

2.5.1 Organoleptic test

Meena *et al.* (2012) evaluated the performance of papaya varieties with respect to yield, quality and organoleptic properties of fruits under North Gujarat conditions and reported that Pusa Nanha was the best variety of papaya for getting higher yield, while Pusa Delicious was better with respect to organoleptic properties

2.5.2 Shelf life

Nirujogi and Dinesh (2012) evaluated gynodioecious varieties of papaya namely Arka Surya and Arka Prabhath under Bengaluru condition. In the both hybrids, Arka Surya and Arka Prabhath, the pulp colour was deep pink, but Arka Surya was superior in the keeping quality with 3.56-7.12 days compared with Arka Prabhath with 5.92-10.02 days.

2.6 BIOCHEMICAL PARAMETERS

Papaya is a rich source of several natural compounds like vitamins, minerals plant pigments, alkaloids, pectins, volatile compounds, proteolytic enzymes and growth inhibitors. The bioactive compounds such as phenolic compounds, vitamin C and carotenoids were found to be highest in ripened fruits. Ferulic, p-coumaric, and caffeic acids are the most abundant acids in papaya skin. The major alkaloids are carpaine, choline, piperidine and caricacin. USDA (2014) reported that the total dietary value of ripe fruits varied from 11.9 to 21.5 g/100 g/ dry matter.

The carotenoids are responsible for the flesh colour of the fruit's mesocarp. Carotenoids like β -cryptoxanthin and β -carotene were found in all types of papaya cultivars leading to orange and yellow coloured flesh (Wall, 2006). During the ripening process the carotenoids get integrated more quickly into the membranes due to the increased content of esterified carotenoids which gradually increases the colour intensity of the fruits, and is accumulated in chromoplasts (Andersson *et al.*, (2008).

Red fleshed cultivars generally had excellent flavour but the outer shape and appearance is very poor, whereas yellow-fleshed cultivars had very good appearance and flavour (Drew, 2005). According to Schweiggert *et al.* (2011) total lycopene content of red fleshed papaya was discernibly higher than that of yellow fleshed fruit. Papaya as considered as a good source of lycopene, which ranges from 0.36 to 3.4 mg/100g fresh weight and the fruit was ranked number four after red guava, water melon and tomatoes.

According to (Wall 2006; Sancho *et al.* 2011) the chemical composition of papaya fruit was greatly influenced by cultivar variation, growing location, sunlight exposure, agricultural practices, stage of ripeness and postharvest handling.

2.6.1 Titrable acidity

Das (2013) evaluated eight varieties and hybrids of papaya *viz.*, Coorg Honey Dew, Pusa Dwarf, Pusa Majesty, Pusa Nanha, Washington, Arka Surya, RCTP-1 and local dwarf types grown in Tripura condition. The maximum and minimum titrable acidity was recorded in cv. Washington (0.22%) and cv. Arka Surya (0.13%) respectively.

Das *et al.* (2014) evaluated ten varieties of papaya from the 26 gene bank along with two hybrids, 39 and 57 grown in Bengaluru condition. The maximum titrable acidity was recorded in cv. Waimonalo (0.33%) and minimum in hybrids H-39 and H-57 (0.13%).

Five papaya varieties namely, Surya, Madhu, Arka Prabhath, Pusa Dwarf and Red lady 786 was evaluated by Tyagi *et al.* (2015) under poly house during 2012 at Ludhiana (Punjab). The result revealed that there was no significant variation observed in terms of titrable acidity.

2.6.2 Total soluble solids

Meena *et al.* (2012) evaluated five varieties of papaya viz., Pusa Delicious, Pusa Nanha, Pant Papaya-1, Madhu Bindu and Arka Surya under north Gujarat during 2007-08. The Pusa Delicious was recorded with the highest TSS.

Nirujogi and Dinesh (2012) evaluated gynodioecious papaya hybrids Arka Surya and Arka Prabhath grown in Bengaluru condition. The TSS among the progenies of Arka Surya varied between 8.64 to 13.94° Brix and in case of Arka Prabhath, it varied between 10.70 to 13.50° Brix.

Das and Dinesh (2014) evaluated ten varieties of papaya from the 26 gene bank along with two hybrids 39 and 57 under Bengaluru condition. The maximum and minimum TSS was recorded in the hybrid H-39 (14.83°Brix) and Pusa Dwarf (9.53°Brix) respectively.

Tyagi *et al.* (2015) evaluated five papaya varieties namely, Arka Surya, Madhu, Arka Prabhath, Pusa Dwarf and Red lady 786 under poly-net house during 2012 at Ludhiana (Punjab). The variety Red lady was found to have maximum TSS (13.0%°Brix) and total sugars (7.9%°Brix).

Chalak *et al.* (2016) evaluated nine varieties and hybrids namely Coorg Honey Dew, Pusa Dwarf, Pusa Majesty, Pusa Nanha, Washington, Arka Surya, RCTP-1 and Local Dwarf types grown in Pune condition. The highest and lowest TSS was observed in case of hybrid Surya (14.67 ° Brix) and Pusa Nanha (8.13 ° Brix) respectively.

2.6.3 Ascorbic acid content

The average vitamin C content for papaya fruit recorded was 51.2 mg/100g, whereas the vitamin E content of papaya was undetectable or in low concentration 0.3mg/100g fresh weight (Charoensiri *et al.*, 2009; USDA, 2014). Vitamin C content was low (21.2 to 36.9 mg/ 100 ml) during 91 to 133 days after anthesis, then increased and reached the peak at 161 DAA (77.8 mg/100 ml). The sunlight

had no effect on soluble solids content (SSC), dry matter and vitamin C contents whereas the lycopene and β - carotene contents were higher when grown in the shady side compared to that grown in the light exposed side.

Eight varieties and hybrids of papaya *viz.*, Coorg Honey Dew, Pusa Dwarf, Pusa Majesty, Pusa Nanha, Washington, Arka Surya, RCTP-1 and Local Dwarf types were evaluated by Das (2013) by growing under Tripura condition. The maximum and minimum ascorbic acid content was found in cv. Coorg Honey Dew (67.37mg per100gm) and cv.Arka Surya (59.63mg per 100gm).

Das *et al.* (2014) evaluated ten varieties of papaya from the 26 gene bank along with two hybrids, 39 and 57 grown in Bengaluru condition. The higher ascorbic acids and titratable acids were found in the hybrids H-39 and H-57.

2.6.7 Carotenoid and Lycopene content

Carotenoid pigments are crucial for photosynthesis in plants. In many species of papaya, carotenoids accumulate as secondary metabolites in chromoplasts of flowers, fruits or seeds to provide distinct coloration, ranging from yellow to orange and red. The fruit flesh color of papaya is determined mostly by the carotenoid content (Devitt *et al.*, 2009). The major carotenoids found were lutein and β -carotene in the peel, while lycopene in the flesh of papaya. The change in the color of peel from green to yellow is because of the fast degradation of chlorophyll and the appearance of carotenoids such as lutein and β -carotene. There are two types of papaya, red-fleshed and yellow-fleshed. The major carotenoid in the pulp of red-fleshed papaya is lycopene, while the major carotenoids in the yellow-fleshed papaya are β -carotene and β -cryptoxanthin (Saengmanee *et al.*, 2018)

Carotenoids are most essential components for humans due to their pro-vitamin A and antioxidant proportion. Since humans are not able to synthesize carotenoids and depend entirely on natural sources or dietary supplements. The papaya is the fruit with large carotenoid content and one can rely on it (Shen *et al.*, 2019).

Lycopene is a major carotenoid in the fruits of papaya and it is believed to have many health benefits including the anticancerous properties (Rahmat *et al.*, 2002).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The research entitled “Evaluation of promising accessions of papaya (*Carica papaya* L.) for cultivation in North Kerala.” was conducted at the Department of Pomology and Floriculture, College of Agriculture, Padannakkad, Kasargod and Regional Agricultural Research Station, Pilicode during the period of 2017 to 2019. The field experiment was conducted at RARS Pilicode. The details regarding the experimental materials used and methodology adopted are described below.

3.1 CLIMATIC CONDITIONS

The monthly mean values of temperature, humidity, rainfall and sunshine were recorded in the Agromet observatory and the data was collected from the records maintained at RARS pilicode (Appendix I)

3.2 SOIL CHARACTERISTICS

The soil of the experimental site was laterite. The soil had a pH of 4.89, organic carbon content 1.17 per cent, available N 125.5 Kg/ha, available P₂O₅ 32.32 Kg/ha and available K₂O 295.57 Kg/ha. (Appendix II)

3.3 EXPERIMENTAL SITE AND CROPPING PERIOD

The field experiment was laid out and conducted at Regional Agricultural Research Station, Pilicode during the period of June 2018– July 2019.

3.4 EXPERIMENTAL MATERIALS

Six promising papaya genotypes selected from the Kasaragod district, one accession already found to be promising from the KAU main campus, Vellanikkara., four released varieties namely Pusa Nanha, Arka Prabhath, CO-8, CO-2 and Red lady (F1 hybrid) from private breeder company were included in the study.

3.5 LAYOUT OF EXPERIMENT

Design of experiment : RBD

Replications : 3

No of plants / replication : 6

Treatments : 12

T₁ - Acc. 1

T₂ - Acc. 2

T₃ - Acc. 3

T₄ - Acc. 4

T₅ - Acc. 5

T₆ - Acc. 6

T₇ - KAU Acc.1

T₈ - Pusa Nanha (IARI)

T₉ - Arka Prabhath (IIHR hybrid)

T₁₀ - CO 8 (TNAU)

T₁₁ - Red lady (Known you seeds- F1 hybrid)

T₁₂ - CO 2 (TNAU) - Control

3.6 NURSERY TECHNIQUES

The seeds were sown in pot trays filled with coir pith compost. Seeds were sown in the month of July (2018). The tray was irrigated daily using a rose can. Two seeds were sown in each tray and after two weeks, the seeds germinated. At three to four leaf stage, the seedlings were transferred into a polythene bag of 20 cm x 15 cm size and 150-gauge thickness filled with a mixture of FYM, soil and sand in equal proportions.

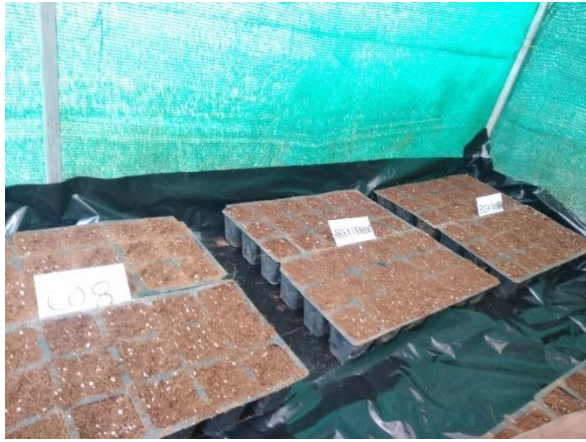


Plate 1. Preparation of nursery



Plate 2. Transplanting of papaya seedlings in the field



Plate 3. General view of the plot

3.7 PLANTING AND AFTERCARE

Two month old seedlings were transplanted to the main field during August, 2018 at a spacing of 2 m x 2 m. Pits of size 50 cm x 50 cm x 50 cm were taken and filled with top soil. Seedlings were shaded to protect them from excessive sunlight until they establish. FYM was applied @10 kg / plant / year as basal dose in basins around the plant. Recommended dose of N,P,K were applied in the form of Urea, Factomphos, Murate of Potash according to Package of Practices recommendations of KAU (2016). The plants were irrigated during summer months and the field was kept free of weeds.

3.8 OBSERVATIONS

3.8.1 GROWTH CHARACTERS

Observations on growth characters were taken at bi-monthly intervals from 2nd month to 12th month after planting.

(a) Plant height

Height of the plant was measured from the ground level up to the growing point using a graduated pole and expressed in metre.

(b) Collar girth

Collar girth at 10cm above the ground level was taken using a standard measuring tape and expressed in cm.

(c) Number of fully developed leaves

The total number of fully developed leaves was recorded.

(d) Leaf area

Leaf area was calculated using the equation described by Karikari (1973).

$$Y = 106 X - 2028$$

where,

X represents the length of the median midrib of fifth leaf from the top in cm.

Y represents the leaf area of the plant and expressed in cm^2

(e) Petiole length

Petiole length of the fifth leaf from the top was measured and expressed in cm.

(f) Number of lobes per leaf

Number of lobes per leaf was recorded.

3.8.2 FLOWERING AND FRUITING CHARACTERS

(a) Days to first flowering (earliness)

Number of days taken from transplanting to opening of first flower was record

(b) Height of first flowering (cm)

Height at which first flowering occurred was measured and expressed in cm.

(c) Sex expression

Nature of sex expression of the individual plant (male, female, hermaphrodite flowers) was noted.

(d) Height of fruiting (cm)

Height at which first fruiting occurred was measured and expressed in cm.

(e) Fruit length (cm)

The distance between the pedicel and apex of the fruit was measured as the length of the fruit and expressed in cm.

(f) Fruit width (cm)

Width of individual fruit was recorded and expressed in cm.

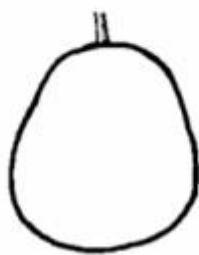
(g) Weight of fruit(g)

(h) Volume of fruit (ml)

The volume of fruit was estimated by water displacement method and expressed in ml.

(i) Shape of fruit

Fruit shape of each papaya accessions/varieties was observed visually and classified as globular, oval, elliptic, high round, acron, lengthened cylindrical, oblong, oblong ellipsoid and elongate based on IBPGR Descriptors for papaya.(IBPGR,1988)



Globular



Oval



Elliptic



High round



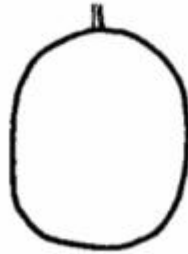
Acron



Lengthened cylindrical



Oblong



Oblong ellipsoid



Elongate

(j) Flesh thickness (cm)

Flesh thickness at ripened stage was measured using a twine and expressed in cm.

(k) Peel thickness (cm)

Fruits were peeled and the thickness of individual fruit peel was measured using Vernier scale.

(l) Fruit cavity index

Fruits were cut longitudinally followed by complete removal of the seeds. Water was poured into both the halves up to the cut end without spilling off. The amount of water required to completely fill the cavity was measured using a measuring cylinder. The volume of water was recorded and the fruit cavity index was calculated using the following formula:

$$\text{Fruit cavity index} = \frac{\text{Cavity volume}}{\text{Fruit volume}} \times 100$$

(m) Number of seeds per fruit

Number of seeds per fruit was counted.

(n) Weight of 100 seeds (dry)

Weight of 100 dry seed was taken and expressed in g.

3.8.3 YIELD CHARACTERS

(a) Number of fruits per plant

The total number of fruits was counted from each plant

(b) Yield per plant

The total fruit weight of a plant was recorded and expressed in Kg.

3.8.4 QUALITY PARAMETERS

(a) Organoleptic test

The analysis of papaya based on quality parameters, such as taste, flavour, colour and overall acceptance were done by preparing a score card. The score was prepared based on a nine-point Hedonic scale (Ranganna, 1986) ranging from one to nine, one being the poor and nine the excellent quality fruit in ascending order. The organoleptic evaluation was done by a panel of 10 semi trained persons.

(b) Shelf life of fruits

Shelf life was calculated as number of days from harvest to till the fruits remained acceptable in market with the retention of edible qualities at normal atmospheric conditions. Fruits were considered unmarketable when it shows symptoms of decay or mould growth or shriveling to the tune of 25 per cent or more.

3.8.5 BIOCHEMICAL PARAMETERS OF FRUIT

(a) Crude Fibre

Estimation of crude fibre was done by following the methods described by Mynard (1970) and Misra *et al.* (1975). Two gram of ground dry sample was boiled with 200

ml of sulphuric acid for 30 min with bumping chips. The content was filtered through muslin cloth followed by washing with boiling water until washings were no longer acidic. Then, it was boiled with 200 ml NaOH solution for 30 min. Again, filtration was done through muslin cloth and washed with 25 ml of boiling 1.25 % H₂SO₄ three 50 ml portion of water and 25 ml alcohol. The residue was removed and transferred to pre-weighed ashing dish (W₁) and then dried for 2 hrs at 130°C. The dish was cooled in a desiccator and weighed (W₂). Then, ignition was done for 30 min at 600°C, cooled in a desiccator and reweighed (W₃). The per cent of crude fibre in ground sample was calculated by using the formula,

$$\text{Crude fibre (\%)} = \frac{\text{Loss in weight on ignition}}{\text{Weight of the sample}} \times 100$$

(b) Acidity

Titration acidity was estimated as per A.O.A.C method using 0.1 N NaOH. The solution (10 ml of fruit solution + 10 ml of distilled water) was titrated against 0.1 N NaOH using phenolphthalein as indicator.

(c) Total Soluble Solids (TSS)

Total Soluble Solids was estimated directly by using a hand refractometer (rang 0- 32⁰ brix) and expressed in degree brix.

(d) Reducing, non-reducing and total sugars

Sugars were determined as per the procedure described by Ranganna (1986). To 10 grams of papaya fruit pulp 100 ml of distilled water was added and clarified with neutral lead acetate. The excess lead was removed by adding potassium oxalate solution. The volume was then made up to 250 ml. The solution was filtered by using Whatman no. 1 filter paper. Aliquot of this solution was titrated against a mixture of

Fehling's solution A and B using methylene blue as indicator. The reducing sugar was expressed as percentage on fresh weight basis.

The non-reducing sugars were estimated by subtracting the per cent of reducing sugars from the total sugars.

To 50 ml of filtrate, 10 ml HCl was added and kept it overnight, then neutralize with NaOH pellet solution and made up to 250 ml. An aliquot of this solution was titrated against a mixture of Fehling's solution A and B using methylene blue as indicator. The total sugar was expressed as percentage of fresh weight basis.

(e) Carotenoid content

Carotenoid content was estimated as per the procedure described by Jensen, 1978).

Sample extraction

Freshly ripe papaya was cut into pieces and 100 mg was ground using 20ml of distilled acetone. The extract was centrifuged at 2500 rpm for 10 minutes and the clear supernatant was made up to 10 ml with 80 % acetone and the absorbance of the extract was read at 480 nm and 510 nm in spectrophotometer.

$$C = \frac{(7.6 \times \text{OD at } 480) - (1.49 \times \text{OD at } 510) V}{1000 \times W}$$

Where,

C = Total amount of carotenoids (mg/g)

V = Final volume of supernatant in ml

W = Weight of the fruit sample taken in gram

(f) Lycopene (mg g⁻¹ fresh weight)

Lycopene is an antioxidant carotenoid occurring in papaya. This carotenoids in the sample were extracted using acetone and then taken up in the petroleum ether.

Spectrophotometric determination of lycopene was done; which shows absorption maxima at 473nm and 503 nm.

The fully ripened papaya was taken, pulped to obtain a homogenize sample and weighed out 5-10 g of this pulp. This pulp was repeatedly extracted with acetone until the residue become colourless. The acetone extract was then pooled and transferred to a separating funnel containing about 20 ml petroleum ether and mixed gently. 20 ml of 5 % sodium sulphate solution was added followed by gentle shaking of the separating funnel and added 20 ml more petroleum ether to compensate the chance of evaporation of petroleum ether during this process and obtain clear separation of two layers.

The two phases were separated out and the lower aqueous phase was re-extracted with additional 20 ml petroleum ether until the aqueous phase was colourless. The petroleum ether extracts were pooled and washed with a little distilled water. The washed petroleum ether extract was poured into a brown container containing 10 g anhydrous sodium sulphate and kept aside for 30 minutes. The petroleum ether extract was decanted into a 100 ml volumetric flask through a funnel containing cotton wool. Sodium sulphate slurry was washed with petroleum ether until it was colourless and transferred the washings to the volumetric flask. The volume was made up and absorbance was measured in spectrophotometer at 503 nm using petroleum ether as blank.

$$\text{Absorbance (1 unit)} = 3.1206 \mu\text{g lycopene/ml}$$

$$\text{mg lycopene in 100 g sample} = \frac{\text{Absorbance} \times 31.206}{\text{Weight of sample (g)}}$$

(g) Ascorbic acid content

Vitamin C content of the fruit was estimated as per the procedure described by Ranganna (1986). The procedure includes two different steps.

Standardization of dye

Dissolving 100mg of ascorbic acid in 100ml of 4 per cent oxalic acid solution stock standard was prepared. Then 10ml of this stock solution was diluted with 4 per cent oxalic acid to 100ml to prepare working standard. 5ml of this working standard solution was pipetted out to a 100ml conical flask and added 10 ml of 4 % oxalic acid titrated against the dye (2,6- Dichloro phenol indophenol dye).

Sample preparation

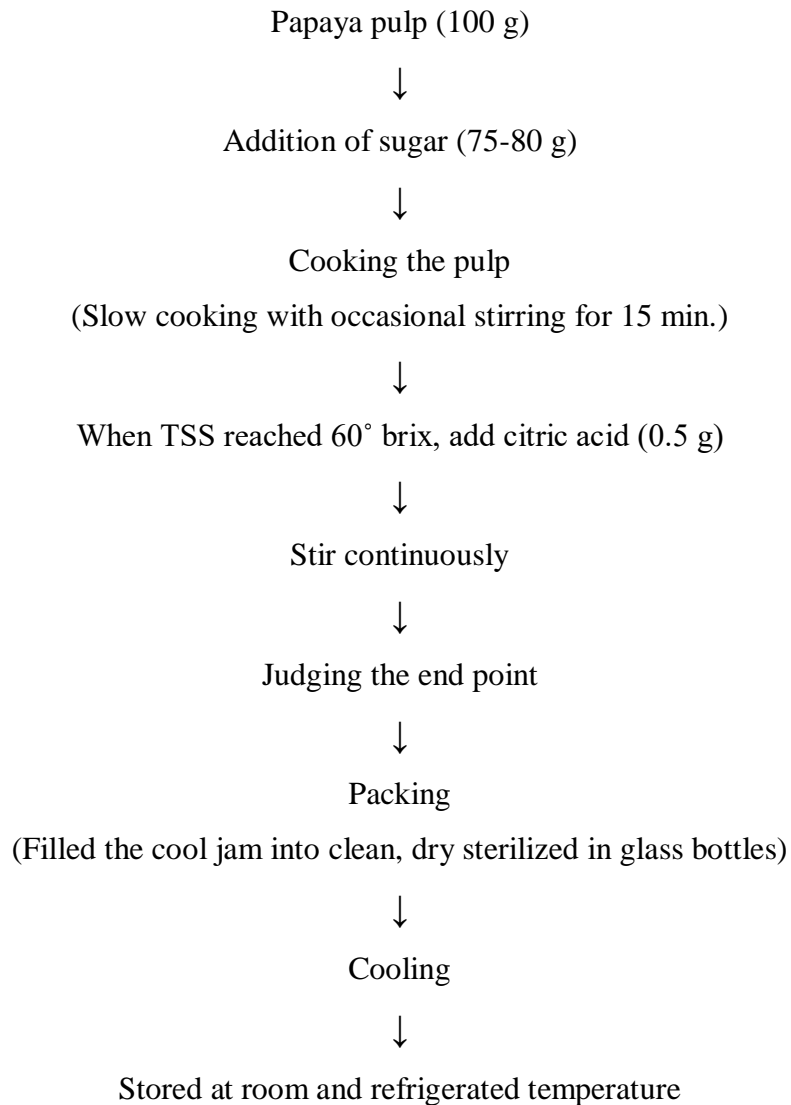
0.5 – 5 g of the sample was extracted in 4 % oxalic acid and made upto known volume and centrifuged. 5ml of the obtained supernatant was pipetted out, added 10 ml of 4 % oxalic acid and titrate against the dye (2, 6- Dichloro phenol indophenol dye).

3.9 STATISTICAL ANALYSIS

The statistical analysis was done in Randomised Block Design with twelve treatment and three replications using the software WASP. The significance was measured at 5 % and 1 %.

3.10 VALUE ADDED PRODUCTS FROM PAPAYA

(a) Papaya jam



Flow chart of papaya jam

(b) Tutti frutti

Ingredients;

Raw papaya =500 g

Sugar = 400 g

Water = 2glass

Procedure

Small pieces of raw papaya were boiled in water for 8 min initially. Simultaneously sugar syrup was prepared, till a consistency was obtained and added boiled papaya to this sugar solution, followed by further boiling of sliced papaya for another 8-10 min. Then it was cooled and different food grade colours were added and kept it for 24 hours for colour absorption and then dried.

RESULTS

4. RESULTS

The result of the experiment on “Evaluation of promising accessions of papaya (*Carica papaya* L.) for cultivation in North Kerala” conducted during 2017-2019 with the objective of evaluation papaya types and released varieties/ hybrids to identify best genotypes for yield and quality in Kasaragod district are presented in this chapter.

4.1 GROWTH CHARACTERS

4.1.1 Plant height

Height of papaya plant at 2 MAP (Months After Planting), 4 MAP, 6 MAP, 8 MAP, 10 MAP, 12 MAP are presented in Table 1. At all the stages of observation, Pusa nanha recorded minimum height and expressed its character as a dwarf variety.

At 2MAP plant height recorded was lowest in Pusa Nanha (0.43 m) and was significantly different from all other accessions followed by Acc 6. (0.54 m) and Red lady (F1 hybrid) (0.56 m) which were on par. KAU Acc.1 (T7) was significantly different from all other accessions and was tallest (0.92 m) followed by Acc. 4 (0.87m), Acc. 3 (0.83 m) and Acc. 5 (0.8 m), which were on par with Acc. 3 and Acc. 2 (0.77 m). CO 2 (0.66 m) and Arka Prabhath (0.65 m) were on par.

At 4MAP, plant height recorded in Pusa Nanha (0.79 m) was significantly dwarf from all other accessions followed by Acc 6 (1.05 m) and Arka Prabhath (1.09 m) and Red lady (1.09 m) which were on par. Acc.4 was significantly different from all other accessions and was tallest (1.623 m) followed by Acc. 3 (1.40 m), KAU Acc.1 (1.39 m) which was on par.

At 6 MAP also, Pusa Nanha (0.96 m), significantly dwarf from all other accessions followed by Acc 6. (1.24 m), Red lady (1.29 m) and Arka Prabhath

(1.37m). Acc. 4 (1.78 m) was the tallest which was on par with Acc. 3 (1.75 m) and followed by KAU Acc.1(1.73 m) which was also on par with Acc. 3(1.75 m).

At 8 MAP, plant height followed similar trend and Pusa Nanha (1.17 m) was the dwarf, and was significantly different from all other accessions followed by Acc. 6 (1.39 m) and Red lady (1.44 m) which was on par. KAU Acc.1(2.10 m) recorded the maximum plant height which was on par with Acc. 4 (2.09 m), followed by Acc. 3 (1.93 m) and Acc. 2 (1.87 m) which were on par.

At 10 MAP also Pusa Nanha (1.43 m) was dwarfest, significantly different from all other accessions followed by Red lady (1.72 m) and Acc. 6 (1.73 m) and which was on par. KAU Acc.1 (2.50 m) recorded the highest value followed by Acc. 4 (2.33 m) and Acc. 2 (2.29 m) which was on par.

At 12 MAP, Pusa Nanha recorded minimum height (1.70 m), significantly different from all other accessions followed by Acc. 6 (1.84 m) and Red lady (1.88 m) which was on par. KAU Acc.1 (2.69 m) recorded the highest value followed by Acc. 4 (2.59 m) and Acc. 3 (2.54 m) which were on par.

4.1.2 Collar girth

Collar girth of the plant at 2 MAP (Months After Planting), 4 MAP, 6 MAP, 8 MAP, 10 MAP, 12 MAP are presented in Table 2.

At 2 MAP, Acc.5 (12.47 cm) recorded the highest value which was on par with KAU Acc.1 (12.10 cm), followed by Acc.1 (11.17 cm), Acc.3 (10.50 cm) and Acc.4 (9.47 cm) was on par with Acc.2 (9.43 cm). The least value of collar girth was recorded in Pusa Nanha (6.93 cm) followed by Arka Prabhath (8.37 cm) which was on par with Acc.6 (8.43 cm) and Red lady (8.50 cm).

At 4 MAP, Acc.5 was significantly different from all other accessions and recorded the highest value of collar girth (24.47 cm) followed by Acc.1 (23.30 cm), KAU Acc.1 (22.67 cm), Acc. 3 (21.63 cm) which was on par with Acc.6 (21.53 cm).

Table1: Plant height of selected papaya accessions/ varieties (m)

Accessions/Varieties	2 MAP	4 MAP	6 MAP	8 MAP	10 MAP	12 MAP
Acc. 1	0.72	1.31	1.47	1.72	1.93	2.22
Acc. 2	0.77	1.33	1.59	1.87	2.29	2.40
Acc. 3	0.83	1.40	1.75	1.93	2.22	2.54
Acc. 4	0.87	1.62	1.78	2.09	2.33	2.59
Acc. 5	0.80	1.25	1.46	1.86	2.13	2.29
Acc. 6	0.54	1.05	1.24	1.39	1.73	1.84
KAU Acc.1	0.92	1.39	1.73	2.10	2.50	2.69
Pusa Nanha	0.43	0.79	0.96	1.17	1.43	1.70
Arka Prabhath	0.65	1.09	1.37	1.73	2.08	2.42
CO 8	0.60	1.21	1.55	1.84	2.06	2.31
Red lady	0.56	1.09	1.29	1.44	1.72	1.88
CO 2	0.66	1.17	1.42	1.60	1.81	2.17
CD(0.05)	0.03	0.04	0.04	0.06	0.04	0.09
S.Em.	0.01	0.02	0.01	0.01	0.01	0.02
C V (%)	3.17	2.37	1.73	1.73	1.40	2.11

The least value of collar girth was recorded in CO 8 (15.30 cm) followed by Arka Prabhath (16.30 cm), Pusa Nanha (17.70 cm), CO 2 (19.43 cm) and Red lady (19.63 cm) which was on par.

At 6 MAP, Acc.1 was significantly different from all other accessions and recorded the highest value of collar girth (33.53 cm) followed by Acc. 6 (32.77 cm), KAU Acc.1 (30.47 cm), Acc. 3 (28.53 cm) which was on par with Acc.5 (28.37 cm). The least value of collar girth was recorded in CO 8 (23.37 cm) which was on par with Pusa Nanha (23.37 cm), CO 2 (23.60 cm) and Red lady (23.70 cm).

At 8 MAP, CO 2 (45.73 cm) recorded the highest value of collar girth, which was on par with Acc.6 (44.53 cm), followed by CO 8 (42.47 cm), Acc.5 (40.90 cm), Pusa Nanha (37.57 cm) and KAU Acc.1 (35.87 cm) was on par with Acc.1 (35.57cm). The least value of collar girth was recorded in Acc.2 (28.57 cm) followed by Arka Prabhath (31.53 cm) which was on par with Red lady (31.57 cm).

At 10 MAP, Acc.6 was significantly different from all other accessions and recorded the highest value of collar girth (61.47 cm) followed by Acc. 4 (60.30 cm), CO 2 (56.47 cm), CO 8 (55.30 cm) and Acc.5 (53.47 cm). The least value of collar girth was recorded in Acc.2 (32.67 cm), significantly different from all other accessions, followed by Red lady (35.23 cm), Arka Prabhath (36.77 cm), Acc.1 (23.60 cm) and Acc.3 (39.53 cm).

At 12 MAP, Acc.4 was significantly different from all other accessions and recorded the highest value of collar girth (70.30 cm) followed by CO 2 (66.67 cm), Acc.6 (65.50 cm) which were on par. The least collar girth was recorded in Red lady (34.53 cm), significantly different from all other accessions, followed by Acc.2 (37.30 cm), Arka Prabhath (41.47 cm) and Acc.1 (41.57cm) which were on par.

Table 2: Collar girth of selected papaya accessions/ varieties (cm)

Accessions/Varieties	2 MAP	4 MAP	6 MAP	8 MAP	10 MAP	12 MAP
Acc. 1	11.17	23.30	33.53	35.57	38.53	41.57
Acc. 2	9.43	20.53	25.50	28.57	32.67	37.30
Acc. 3	10.50	21.63	28.53	33.47	39.53	45.20
Acc. 4	9.47	20.50	26.57	34.40	60.30	70.30
Acc. 5	12.47	24.47	28.37	40.90	53.47	58.57
Acc. 6	8.43	21.53	32.77	44.53	61.47	65.50
KAU Acc. 1	12.10	22.67	30.47	35.87	40.57	45.43
Pusa Nanha	6.93	17.70	23.37	37.57	50.30	54.47
Arka Prabhath	8.37	16.30	24.53	31.53	36.77	41.47
CO 8	9.33	15.30	23.37	42.47	55.30	60.33
Red lady	8.50	19.63	23.70	31.57	35.23	34.53
CO 2	9.37	19.43	23.60	45.73	56.47	66.67
CD (0.05)	0.44	0.42	0.76	1.49	0.75	1.23
S.Em.	0.01	0.01	0.25	0.50	0.25	0.42
C V (%)	2.65	1.20	1.64	2.37	0.95	1.40

4.1.3 Number of fully developed leaves

Data on the number of fully developed leaves of the plant at 2MAP (Months After Planting), 4MAP, 6MAP, 8MAP, 10MAP, 12MAP are shown in Table 3

At 2MAP, Acc 5 was significantly different from all other accessions and recorded the highest number of fully developed leaves of (16.47) followed by Acc. 1 (14.7), Red lady (14.37), KAU Acc.1 (13.50), which was on par with Acc. 2 (13.47). The lowest number of fully developed leaves was recorded in Acc.3 (10.73) which was significantly different from all other accessions, followed by Pusa Nanha (11.57) and Arka Prabhath (11.87) which were on par.

At 4 MAP, Acc.5 (18.60) recorded the highest number of fully developed leaves which was on par with KAU Acc. 1 (18.53), followed by Acc.1 (17.63) and Red lady (17.53) which were on par. The lowest number of fully developed leaves was recorded in CO 8 (13.33), which was on par with Acc.3 (13.60).

At 6 MAP, KAU Acc.1 was significantly different from all other accessions and recorded the highest number of fully developed leaves of (25.53) followed by Acc. 5 (22.50) and Arka Prabhath (21.53), Red lady (19.53). The lowest number of fully developed leaves was recorded in CO 8 (16.23) which was on par with Acc.6 (16.73), followed by Acc.6 (17.53) and Acc.3 (17.63) which were on par.

At 8 MAP, KAU Acc.1 recorded the highest number of fully developed leaves (27.10) which was on par with Arka Prabhath (26.77), followed by Acc.5 (25.53), Acc.1 (23.97) and Red lady (23.50) which were on par. The lowest number of fully developed leaves was recorded in CO 8 (19.10), which was on par with Acc.2 (20.30).

At 10 MAP KAU Acc. 1 was significantly different from all other accessions and recorded the highest number of fully developed leaves of (29.40) followed by Acc. 6 (26.27), which was on par with Acc.1 (25.47). The lowest number of fully

Table 3: Number of fully developed leaves of selected papaya accessions/ varieties

Accessions/Varieties	2 MAP	4 MAP	6 MAP	8 MAP	10 MAP	12 MAP
Acc. 1	14.70	17.63	18.77	23.97	25.47	27.77
Acc. 2	13.47	15.47	17.53	20.30	14.37	24.27
Acc. 3	10.73	13.60	17.63	20.43	20.33	21.60
Acc. 4	12.43	15.87	18.37	21.53	25.10	28.43
Acc. 5	16.47	18.60	22.50	25.53	23.23	26.43
Acc. 6	12.60	14.67	16.73	21.77	26.27	28.70
KAU Acc.1	13.50	18.53	25.53	27.10	29.40	30.73
Pusa Nanha	11.57	14.13	18.47	22.53	19.50	21.50
Arka Prabhath	11.87	16.43	21.53	26.77	24.00	25.87
CO 8	12.63	13.33	16.23	19.10	20.60	24.20
Red lady	14.37	17.53	19.53	23.50	23.97	24.73
CO 2	12.37	15.43	18.37	22.30	21.50	23.73
CD(0.05)	0.53	0.61	0.56	0.79	2.17	1.14
S.Em.	0.17	0.20	0.19	0.27	0.74	0.38
C V (%)	2.35	2.23	1.72	2.05	5.50	2.62

developed leaves was recorded in Pusa Nanha (19.50) which was on par with Acc.3 (20.33), CO 8 (20.60), Acc.2 (21.03) and CO 2 (21.50).

At 12MAP KAU Acc.1 was significantly different from all other accessions and recorded the highest number of fully developed leaves of (30.73) followed by Acc. 6 (28.7) which was on par with Acc.4 (28.43) and Acc.1 (27.77). The lowest number of fully developed leaves was recorded in Pusa Nanha (21.50) which is on par with Acc.3 (21.60).

4.1.4 Leaf area

Leaf area of the plant at 2 MAP (Months After Planting), 4 MAP, 6 MAP, 8 MAP, 10 MAP, 12 MAP are presented in the Table 4

At 2 MAP highest leaf area was recorded in KAU Acc. 1 (1462.26 cm²) followed by Acc. 6 (1378.84 cm²), CO 8 (1287.68 cm²), Acc.1 (1184.54 cm²) and Acc. 4 (1165.82 cm²) was on par with KAU Acc. 1. Lowest leaf area was recorded in Arka Prabath (614.25 cm²) which was on par with Acc. 3 (640.32 cm²) and Pusa Nanha (743.70 cm²).

At 4 MAP, maximum leaf area was recorded in Acc. 6 (2079.10 cm²) which was on par with KAU Acc. 1 (2075.17 cm²) followed by Acc.3 (1984.20 cm²). Lowest leaf area was recorded in Acc.4 (1629.66 cm²) which was on par with Acc. 1 (1638.24 cm²), Pusa Nanha (1641.91 cm²), Acc.2 (1707.54 cm²) and CO 8 (1718.14 cm²)

At 6 MAP, maximum leaf area was recorded in Acc. 2 (2663.57cm²), significantly different from all other accessions followed by Acc.5 (2514.66 cm²) Acc.3 (1984.20 cm²), KAU Acc. 1 (2075.17 cm²). Lowest leaf area was recorded in Acc.4 (1629.66 cm²) which was on par with Acc. 1 (1638.24 cm²), Pusa Nanha (1641.91 cm²), Acc.2 (1707.54 cm²) and CO 8 (1718.14 cm²).

Table 4: Leaf area of selected papaya accessions/ varieties (cm²)

Accessions/Varieties	2 MAP	4 MAP	6 MAP	8 MAP	10 MAP	12 MAP
Acc. 1	1184.54	1638.24	2046.55	2390.06	2874.95	3238.21
Acc. 2	1165.34	1707.54	2663.55	3192.06	3780.32	4064.45
Acc. 3	640.32	1984.20	2475.31	2787.37	2853.78	3590.11
Acc. 4	1165.82	1629.66	2123.68	2974.56	3564.24	4060.27
Acc. 5	1043.58	1847.92	2514.66	3225.40	3999.54	4257.89
Acc. 6	1378.87	2079.10	2303.61	2873.71	3359.09	4177.57
KAU Acc.1	1462.26	2075.17	2471.40	3134.99	3800.66	4035.91
Pusa Nanha	743.70	1641.91	1856.90	2042.98	2173.64	3282.20
Arka Prabhath	614.25	1726.72	2321.48	2665.43	3006.01	3621.24
CO 8	1287.68	1718.14	1740.75	1881.24	2357.89	3200.26
Red lady	1155.22	1851.13	1950.44	2224.75	2951.03	3427.52
CO 2	1044.72	1952.18	2447.93	2983.66	2928.55	2923.45
CD (0.05)	297.09	92.96	86.94	89.80	71.92	387.67
S.Em.	101.29	31.68	29.64	30.63	24.49	132.16
C V (%)	15.86	3.01	2.28	1.96	1.35	6.26

At 8 MAP, maximum leaf area was recorded in Acc.5 (3225.40 cm²) which was on par with Acc. 2 (3192.6 cm²) followed by KAU Acc. 1 (2471.40 cm²) and CO 2 (2983.66 cm²). Lowest leaf area was recorded in CO 8 (1881.24 cm²) followed by Pusa Nanha (2042.75 cm²) and Red lady (2224.75 cm²).

At 10 MAP, maximum leaf area was recorded in Acc. 5 (3999.54 cm²), significantly different from all other accessions followed by KAU Acc. 1 (3800.66 cm²) and Acc. 2 (3780.32 cm²), which were on par. Lowest leaf area was recorded in Pusa Nanha (2173.64 cm²), followed by CO 8 (2357.87 cm²) and Acc.3 (2853.78 cm²).

At 12 MAP, maximum leaf area was recorded in Acc.5 (4257.89 cm²) followed by Acc.6 (4177.57 cm²) Acc. 2 (4064.45cm²) Acc.4 (4060.27cm²) and KAU Acc. 1 (3800.66 cm²), which was on par with Acc.5. Lowest leaf area was recorded in CO 2 (2923.45 cm²) followed by CO 8 (3200.26 cm²), Acc.1 (3238.21 cm²) and Pusa Nanha (3282.20 cm²).

4.1.5 Leaf petiole length

Leaf petiole length at 2 MAP (Months After Planting), 4 MAP, 6 MAP, 8 MAP, 10 MAP, 12 MAP are as shown in Table 5.

At 2 MAP Acc.1 was significantly different from all other accessions and recorded the highest petiole length of (35.63 cm) followed by Acc. 4 (34.27 cm), KAU Acc. 1 (32.37 cm), Acc. 3 (31.30 cm), Acc.2 (28.50 cm), Acc.6 (26.73 cm) and Acc.5 (24.77 cm). The lowest petiole length was recorded in Pusa Nanha (20.57 cm) followed by CO 2 (21.93 cm) which was on par with Arka Prabhath (22.47 cm) and Red lady (22.57 cm) which are on par.

At 4 MAP Acc.1 was significantly different from all other accessions and recorded the highest petiole length of (44.50 cm) followed by CO 2 (40.50 cm) which was on par with Acc. 4 (39.70 cm), KAU Acc. 1 (38.50 cm) Acc. 3 (38.47 cm), Pusa

Nanha (37.23 cm) and CO 8 (37.20 cm) .The lowest petiole length was recorded in Acc.2 (32.37 cm) which was on par with Acc.6 (32.70 cm), Acc.5 (33.70 cm), Red lady (34.10 cm) and Arka Prabath (35.50 cm).

At 6 MAP, Acc. 3 (57.23 cm) recorded the highest number of fully developed leaves which was on par with KAU Acc. 1 (55.27 cm), The lowest number of fully developed leaves was recorded in CO 8 (39.07 cm) which was significantly different from all other accessions, followed by Pusa Nanha (45.47 cm) and Acc.2 (45.47 cm) which were on par

At 8 MAP, Acc.4 was significantly different from all other accessions and recorded the maximum petiole length of (72.47 cm) followed by Acc. 7 (67.83 cm), Acc. 1 (62.33 cm). The least petiole length was recorded in CO 8 (52.50 cm) which was on par with Pusa Nanha (52.70 cm).

At 10MAP, Acc.4 was significantly different from all other accessions and recorded the highest petiole length of (90.60 cm) followed by KAU Acc. 1 (88.83 cm), Acc.1 (74.67 cm), CO 2 (71.53 cm) and Red lady (71.03 cm), which were on par. The least petiole length was recorded in Arka Prabhath (56.70 cm) which was significantly different from all other accessions, followed by Acc.5 (57.93 cm), CO 8 (62.57 cm), Pusa Nanha (65.83 cm) and Acc.6 (67.70 cm).

At 12MAP, Acc. 4 was significantly different from all other accessions and recorded the highest petiole length of (102.70 cm) followed by KAU Acc. 1 (99.00 cm), Acc.1 (85.80 cm), Acc.6 (83.60 cm), CO 2 (82.43 cm) and Red lady (81.80 cm) , which were on par. The least petiole length was recorded in Arka Prabhat (65.83 cm) which was significantly different from all other accessions, followed by Acc.5 (69.07 cm), Pusa Nanha (73.20 cm), CO 8 (74.33 cm), which were on par.

Table 5: Leaf petiole length of selected papaya accessions/ varieties (cm)

Accessions/Varieties	2 MAP	4 MAP	6 MAP	8 MAP	10 MAP	12 MAP
Acc. 1	35.63	44.50	51.90	62.33	74.67	85.80
Acc. 2	28.50	32.37	45.47	56.37	68.70	78.33
Acc. 3	31.30	38.47	57.23	61.30	68.53	79.43
Acc. 4	34.27	39.70	52.63	72.47	90.60	102.70
Acc. 5	24.77	33.70	49.77	54.63	57.93	69.07
Acc. 6	26.73	32.70	48.60	57.87	67.70	83.60
KAU Acc.1	32.37	38.50	55.27	67.83	88.83	99.00
Pusa Nanha	20.57	37.23	45.43	52.70	65.83	73.20
Arka Prabhath	22.47	35.50	54.53	56.23	56.70	65.83
CO 8	23.87	37.20	39.07	52.50	62.57	74.33
Red lady	22.57	34.10	52.10	60.77	71.03	81.80
CO 2	21.93	40.50	52.93	61.13	71.53	82.43
CD(0.05)	0.69	3.71	2.06	0.88	1.17	1.72
S.Em.	0.23	1.26	0.70	0.30	0.40	0.59
C V (%)	6.52	5.90	2.41	0.87	0.98	1.25

4.1.6 Number of lobes per leaf

No. of lobes per leaf at 2MAP (Months After Planting), 4 MAP, 6 MAP, 8MAP, 10 MAP, 12 MAP are presented in the Table 6. Lobe characters were found to be non -significant among the treatments.

Table 6: Number of lobes per leaf of selected papaya accessions/ varieties

Accessions/Varieties	2 MAP	4 MAP	6 MAP	8 MAP	10 MAP	12 MAP
Acc. 1	5.00	7.00	9.00	9.00	9.00	9.00
Acc. 2	5.00	7.00	9.00	9.00	9.00	9.00
Acc. 3	5.00	7.00	9.00	9.00	9.00	9.00
Acc. 4	5.00	7.00	9.00	9.00	9.00	9.00
Acc. 5	5.00	7.00	9.00	9.00	9.00	9.00
Acc. 6	5.00	7.00	9.00	9.00	9.00	9.00
KAU Acc.1	5.00	7.00	9.00	9.00	9.00	9.00
Pusa Nanha	5.00	7.00	9.00	9.00	9.00	9.00
Arka Prabhath	5.00	7.00	9.00	9.00	9.00	9.00
CO 8	5.00	7.00	9.00	9.00	9.00	9.00
Red lady	5.00	7.00	9.00	9.00	9.00	9.00
CO 2	5.00	7.00	9.00	9.00	9.00	9.00
CD(0.05)	NS	NS	NS	NS	NS	NS
S.Em.	-	-	-	-	-	-
C V (%)	-	-	-	-	-	-

4.2 FLOWERING AND FRUITING CHARACTERS

The data on flowering and fruiting characters of papaya genotypes are presented in Tables 7 and 8.

4.2.1 Days to first flowering

The least number of days for first flowering was recorded in Acc. 2 (108.33) which was on par with CO 8 (112.00) followed by KAU Acc. 1 (113.67) which was on par with Acc.4 (117.00).

The maximum number of days for first flowering was recorded by Acc.3 (135.00), significantly different from all other accessions followed by Arka Prabhath (129.00), CO 2 (127.33) and Acc.5 (126.00) which were on par with each other.

4.2.2 Height of first flowering (cm)

The least height at which first flowering, was recorded by Pusa Nanha (70.70 cm), significantly different from all other accessions followed by Acc.6 (91.17cm), Arka Prabhath (99.73 cm) and Red lady (100.50 cm) which were on par. Maximum height at which first flowering was recorded by Acc.4 (140.80 cm), significantly different from all other accessions followed by Acc.3 (133.73 cm), Acc.2 (128.53 cm) and Acc.1 (124.53 cm) which were on par.

4.2.3 Sex expression

The data on sex expression are given Table 7. The 50 percent of accessions were dioecious and 50 percent were gynodioecious in nature. Among the treatments, Acc. 1, 2, 4, 6, Arka Prabhat and Red lady are gynodioecious and Acc 1, Acc 5, KAU Acc 1, Pusa Nanha, CO 8 and CO2 were dioecious.

4.2.4 Height of fruiting

The least height at which fruiting occurred was recorded by Pusa Nanha (98.70 cm), significantly different from all other accessions followed by Acc.6 (115.20 cm), Arka Prabhath (122.37 cm), KAU Acc. 1 (127.17 cm) and Red lady (100.50 cm). Maximum fruiting height was recorded by Acc.4 (166.80 cm), significantly different from all other accessions followed by Acc.3 (158.23 cm), Acc.2 (152.73 cm) and Acc.1 (148.53 cm).

4.2.5 Fruit length (cm)

Maximum fruit length of 27.57 cm was recorded in Acc.5 which was significantly different from all other accessions, followed by CO 2 (26.00 cm), Pusa Nanha (24.73 cm). Lowest fruit length was recorded KAU Acc.1 (14.63 cm) which was on par with Acc.2 (15.33 cm) and Acc.3 (15.63 cm).

4.2.6 Fruit width (cm)

Maximum fruit width of 17.90 cm was recorded in Pusa Nanha which was significantly different from all other accessions, followed by Red lady (15.90 cm) and CO 8 (14.57 cm). Lowest fruit length was recorded Acc.2 (12.17 cm) which was on par with KAU Acc.1 (12.47 cm), Acc.3 (12.53 cm) and Arka Prabhath (12.96 cm).

4.2.7 Weight of fruit (g)

Maximum fruit weight of 1866.67g was recorded in Pusa Nanha which was on par with Acc.5 (1766.67 g) followed by Acc.4 (1346.67 g). Least fruit weight was recorded Acc.3 (813.33 g) followed by KAU Acc.1 (1003.33 g) Acc.2 (1040.00 g), which were on par.

Table 7: Flowering and fruiting characters of papaya accessions/ varieties

Accessions/Varieties	Days to first flowering	Height of first flowering (cm)	Sex expression	Height of fruiting (cm)	Fruit length (cm)	Fruit width (cm)	Weight of fruit (g)
Acc. 1	123.33	124.53	Gynodioecious	148.53	21.166	13.30	1293.33
Acc. 2	108.33	128.53	Gynodioecious	152.73	15.33	12.17	1040.00
Acc. 3	135.00	133.73	Dioecious	158.23	15.63	12.53	813.33
Acc. 4	117.00	140.80	Gynodioecious	166.80	24.27	13.73	1346.67
Acc. 5	126.00	116.83	Dioecious	138.27	27.57	14.57	1766.67
Acc. 6	121.33	91.17	Gynodioecious	115.20	16.30	11.80	1160.00
KAU Acc.1	113.67	109.00	Dioecious	127.17	14.63	12.47	1003.33
Pusa Nanha	121.67	70.70	Dioecious	98.70	24.73	17.90	1866.67
Arka Prabhath	129.00	99.73	Gynodioecious	122.37	20.90	12.97	1183.33
CO 8	112.00	117.77	Dioecious	139.60	23.97	14.57	1323.33
Red lady	117.33	100.50	Gynodioecious	134.47	17.37	15.90	1270.00
CO 2	127.33	116.17	Dioecious	139.47	26.00	13.43	1223.33
CD(0.05)	4.44	4.78	NA	3.48	1.13	0.77	118.25
S.Em.	1.51	1.62	-	1.18	0.38	0.26	40.31
C V (%)	2.16	2.50	-	1.49	3.21	3.28	5.48



Plate 4a. Papaya accessions/varieties in fruiting stage

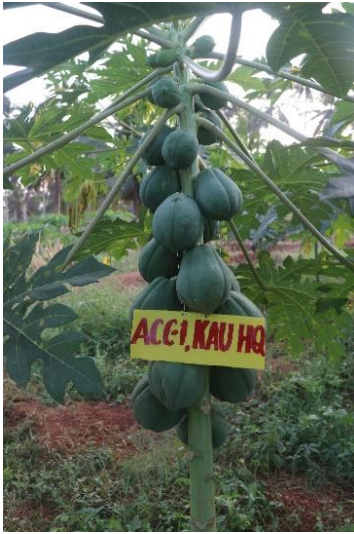


Plate 4b. Papaya accessions/varieties in fruiting stage

4.2.8 Volume of fruit (ml)

Highest fruit volume of 1754.33 ml was recorded in Pusa Nanha which was significantly different from all other accessions followed by Acc.5 (1686.00 ml), CO 8 (1263.33 ml), Red lady (1203.33 ml). Least fruit volume was recorded Acc.3 (733.33 ml) followed by Acc.6 (936.67 ml) which was on par with Acc.2 (940.00 ml) and KAU Acc. 1 (945.33 ml).

4.2.9 Shape of fruit

With respect to fruit shape, the fruits showed wide variation. Acron, high round, oblong ellipsoid, lengthened cylindrical, elongate, elliptic, globular, oblong, oval shapes were observed, based on IBPGR Descriptors for papaya.

4.2.10 Flesh thickness (cm)

Maximum flesh thickness of 3.37cm was recorded in Acc.5 which was on par with Pusa Nanha (3.36 cm) followed by Acc.4 (2.90 cm). Lowest flesh thickness was recorded by Acc.2 (1.86 cm) which was on par with Acc.3 (1.87 cm), KAU Acc. 1 (2.03 cm), CO 2 (2.07 cm) and Arka Prabhath (2.11 cm).

4.2.11 Peel thickness (cm)

Peel thickness was found to be non-significant among treatments.

4.2.12 Fruit cavity index

Lowest fruit cavity index was recorded by Pusa Nanha (17.43), which was on par with Red lady (18.23). Highest fruit cavity index was recorded by KAU Acc. 1 (24.44) followed by CO 2 (22.65) and Acc.4 (22.42).

4.2.13 Number of seeds

Maximum number of seeds per fruit was recorded in Acc.2 (958.51), significantly different from all other accessions, followed by CO 2 (753.09) and KAU

Acc. 1 (745.73) which were on par. Least number of seed per fruit was recorded by Red lady (40.50) followed by Acc.4 (251.78) and Arka Prabhath (297.92), which were on par.

4.2.14 **Weight of 100 seeds (dry)**

The seed weight for 100 seeds was maximum in Acc.5 (1.93 g) which was on par with CO 2 (1.84 g), followed by Acc. 3 (1.73 g). Lowest seed weight for 100 seeds was recorded by CO 8 (1.14 g), which was on par with Red lady (1.19 g) followed by Acc.2 (1.37 g).

4.3 YIELD CHARACTERS

The data on yield characters are presented in Table 9.

4.3.1 **Number of fruits per plant**

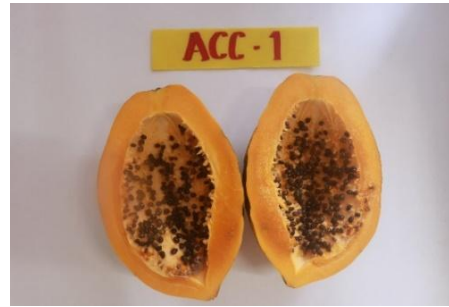
KAU Acc. 1 recorded the maximum number of fruits (20.67) followed by Acc.6 (20.27) and Acc.4 (19.40) which were on par with KAU Acc.1. Lowest number of fruits was recorded by Arka Prabhath (7.17) which was on par with Acc.3 (7.47).

4.3.2 **Yield per plant (Kg)**

The maximum plant yield was recorded in Acc.5 (26.93 kg), significantly different from all other accessions, followed by Acc.4 (26.23 kg), Acc.6 (23.50 kg), Pusa Nanha (22.47 kg). Lowest plant yield was recorded by Acc.3 (6.70 kg) followed by Arka Prabhath (8.63 kg) and CO 2 (15.37 kg).

Table 8: Flowering and fruiting characters of papaya accessions/ varieties (continued)

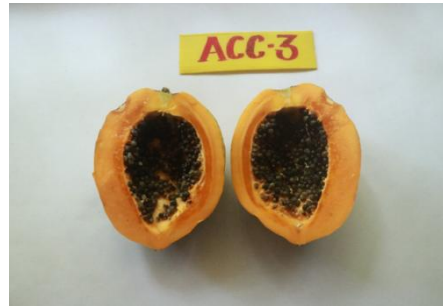
Accessions/Varieties	Volume of fruit (ml)	Shape of fruit	Flesh thickness (cm)	Peel thickness (cm)	Fruit cavity index	No: of seeds	Weight of 100 seeds (dry) (g)
Acc. 1	1195.00	Acron	2.63	0.20	22.21	400.90	1.61
Acc. 2	940.00	High round	1.87	0.20	22.09	958.51	1.37
Acc. 3	733.33	Oblong ellipsoid	1.87	0.13	21.64	570.49	1.73
Acc. 4	1173.33	Lengthened cylindrical	2.90	0.13	22.42	251.78	1.64
Acc. 5	1686.00	Elongate	3.37	0.20	19.47	573.60	1.93
Acc. 6	936.67	Elliptic	2.40	0.13	20.27	380.58	1.57
KAU Acc.1	945.33	High round	2.03	0.17	24.44	745.73	1.49
Pusa Nanha	1754.33	Globular	3.37	0.17	17.43	670.02	1.57
Arka Prabhath	1074.33	Lengthened cylindrical	2.11	0.10	21.08	297.92	1.45
CO 8	1263.33	Elongate	2.23	0.17	20.87	658.22	1.14
Red lady	1203.33	Oblong	2.73	0.17	18.23	40.50	1.19
CO 2	1170.00	Oval	2.07	0.20	22.65	753.09	1.84
CD(0.05)	38.22	NA	0.35	NS	1.55	53.97	0.11
S.Em.	13.03	-	0.12	0.03	0.64	18.39	0.03
C V (%)	1.92	-	8.50	40.67	5.39	6.06	4.36



T₁ – Acc 1



T₂ – Acc 2



T₃ – Acc 3

Plate 5a. Fruit characters of different accessions/varieties



T₄ – Acc 4



T₅ – Acc 5



T₆ – Acc 6

Plate 5b. Fruit characters of different accessions/varieties



T₇ – KAU Acc 1



T₈ – Pusa Nanha



T₉ – Arka Prabhat

Plate 5c. Fruit characters of different accessions/varieties



T₁₀ – CO 8



T₁₁ – Red Lady



T₁₂ – CO 2

Plate 5d. Fruit characters of different accessions/varieties

Table 9: Yield characters of selected papaya accessions/ varieties

Accessions/Varieties	Number of fruits per plant	Yield per plant (Kg)
Acc. 1	15.16	18.27
Acc. 2	17.52	17.97
Acc. 3	7.47	6.70
Acc. 4	19.40	26.23
Acc. 5	14.91	26.93
Acc. 6	20.27	23.50
KAU Acc.1	20.68	20.80
Pusa Nanha	12.88	22.47
Arka Prabhath	7.18	8.63
CO 8	16.17	21.23
Red lady	14.12	21.46
CO 2	12.49	15.37
CD(0.05)	2.33	0.59
S.Em.	0.86	0.20
C V (%)	10.55	1.83

4.4 QUALITY PARAMETERS

4.4.1 Organoleptic Test

4.4.1.1 Organoleptic test for papaya fruit

Data on organoleptic test for papaya fruit are presented in Table 10

The highest score for taste was obtained in Acc. 6 with a value of 8.45, followed by Red lady (8.13), Acc. 2 (8.06). The least score was obtained in Acc. 1 with a value of 4.96.

The highest score for flavour was obtained in CO8 with a value of 8.06, followed by Red lady (8.04), Acc. 6 (7.95). The least score was obtained in Acc. 3 with a value of 4.65.

The highest score for colour was obtained in CO8 with a value of 8.57, followed by Arka Prabhath (8.54), Red lady (8.45). The least score was obtained in Acc. 3 with a value of 4.57.

The highest score for overall acceptance was obtained in Acc. 6 with a value of 8.52, followed by Red lady (8.43), Acc. 2 (8.19). The least score was obtained in Acc. 1 with a value of 4.86.

4.4.1.2 Organoleptic test for papaya jam

Data on organoleptic test for papaya fruit are presented in Table 11

The highest score for taste was obtained in Red lady with a value of 8.25, followed by Acc. 6 (8.17), Arka Prabhath (7.84). The least score was obtained in Acc. 5 with a value of 4.35.

The highest score for flavour was obtained in Red lady with a value of 8.01, followed by Acc. 6 (7.88), CO8 (7.39). The least score was obtained in Acc. 1 with a value of 4.67.

The highest score for colour was obtained in CO8 with a value of 8.64, followed by Arka Prabhath (8.56), Red lady (8.34). The least score was obtained in KAU Acc. 1 with a value of 5.34.

The highest score for overall acceptance was obtained in Red lady with a value of 8.41, followed by Acc. 6 (8.30), Arka Prabhath (8.10). The least score was obtained in Acc. 3 with a value of 5.16.

4.4.1.3 Organoleptic test for papaya tutti frutti

Data on organoleptic test for papaya fruit are presented in Table 12

All the treatments recorded same score for taste, flavour, colour, overall acceptance respectively as 6.75, 5.31, 8.62 and 7.11.

Table 10: Organoleptic test of papaya fruit

Accessions/Varieties	Papaya Fruit			
	Taste	Flavour	Colour	Overall acceptance
Acc. 1	4.96	5.23	4.98	4.86
Acc. 2	8.06	7.85	7.94	8.19
Acc. 3	5.96	4.65	4.57	5.09
Acc. 4	6.79	6.91	6.01	6.83
Acc. 5	6.59	5.99	7.06	6.83
Acc. 6	8.45	7.95	8.31	8.52
KAU Acc.1	7.16	7.34	7.28	7.24
Pusa Nanha	5.86	6.59	6.42	6.37
Arka Prabhath	7.53	6.91	8.56	7.65
CO 8	7.86	8.06	8.57	8.09
Red lady	8.13	8.04	8.45	8.43
CO 2	6.89	7.51	7.08	7.06



Plate 6a. Ripened papaya accessions/varieties for organoleptic test



Plate 6b. Ripened papaya accessions/varieties for organoleptic test

Table 11: Organoleptic test of papaya jam

Accessions/Varieties	Papaya Jam			
	Taste	Flavour	Colour	Overall acceptance
Acc. 1	6.54	4.67	6.24	6.25
Acc. 2	7.12	6.95	6.84	7.31
Acc. 3	5.32	5.98	5.74	5.16
Acc. 4	5.57	5.32	7.52	5.46
Acc. 5	4.35	5.81	6.13	5.76
Acc. 6	8.17	7.88	8.14	8.30
KAU Acc.1	7.64	6.91	5.34	7.68
Pusa Nanha	6.35	6.28	6.97	6.58
Arka Prabhath	7.84	7.38	8.56	8.11
CO 8	7.21	7.39	8.64	7.67
Red lady	8.25	8.01	8.34	8.41
CO 2	6.35	6.78	7.13	6.83



Plate 7a. Papaya jam for organoleptic test



Plate 7b. Papaya jam for organoleptic test

Table 12: Organoleptic test of papaya tutti frutti

Accessions/Varieties	Papaya Tutti Frutti			
	Taste	Flavour	Colour	Overall acceptance
Acc. 1	6.75	5.31	8.62	7.11
Acc. 2	6.75	5.31	8.62	7.11
Acc. 3	6.75	5.31	8.62	7.11
Acc. 4	6.75	5.31	8.62	7.11
Acc. 5	6.75	5.31	8.62	7.11
Acc. 6	6.75	5.31	8.62	7.11
KAU Acc.1	6.75	5.31	8.62	7.11
Pusa Nanha	6.75	5.31	8.62	7.11
Arka Prabhath	6.75	5.31	8.62	7.11
CO 8	6.75	5.31	8.62	7.11
Red lady	6.75	5.31	8.62	7.11
CO 2	6.75	5.31	8.62	7.11



Plate 8. Papaya tutti frutti for organoleptic test

4.4.2 Shelf life (days)

The data on shelf life is presented in Table 13. The maximum shelf life was recorded by Acc.6 (8.70) which was on par with Acc.2 (8.53) and Arka Prabhath (8.23). The lowest shelf life was recorded by Acc.1 (4.63) which was on par with Acc.3 (4.70) and Acc.4 (4.93).

Table 13: Shelf life of papaya accessions/ varieties

Accessions/Varieties	Shelf life (days)
Acc. 1	4.63
Acc. 2	8.53
Acc. 3	4.70
Acc. 4	4.93
Acc. 5	6.30
Acc. 6	8.70
KAU Acc.1	6.67
Pusa Nanha	6.20
Arka Prabhath	8.23
CO 8	7.37
Red lady	7.17
CO 2	5.90
CD (0.05)	0.73
S.Em.	0.24
C V (%)	6.51

4.5 BIOCHEMICAL PARAMETERS OF FRUIT

The data on biochemical parameters of fruit are presented in Table 14.

4.5.1 Crude fibre

The highest fibre content was observed in Acc.6 (1.27%) followed by CO 8 (1.19%) and Acc.2 (1.11%), which were on par with Acc.6. The lowest fibre content was observed in KAU Acc. 1 (0.70%), which was on par with Arka Prabhath (0.74%) CO 2 (0.76%), Acc.5 (0.85%) and Acc.1 (0.86%).

4.5.2 Titrable acidity

The maximum titrable acidity content was observed in CO 2 (0.24%) which was on par with Acc.2 (0.20%) followed by Acc.1 (0.18%) and Pusa Nanha (0.17%). The lowest acidity content was observed in Acc.5 (0.14%) which was on par with Acc.4 (0.15%), Arka Prabhath (0.15%) Acc.3 (0.15%), Red lady (0.16%), Acc.6 (0.16%), CO 8 (0.16%) and KAU Acc. 1 (0.16%).

4.5.3 Total soluble solids

TSS of the fruit showed significant variation among treatments. The highest TSS of 14.71 °B was recorded by Acc.6, which was on par with Acc. 2 (13.67 °B) followed by Red lady (13.20 °B) and CO 8 (12.04°brix), which were on par . The least TSS was recorded by Acc. 1 (8.97 °B) which was on par with Pusa Nanha (9.64 °B) and CO 2 (9.85 °B).

4.5.4 Reducing, Non reducing and Total sugars

Analysis of data on sugars showed significant difference among the treatments. The highest per cent of reducing sugar was recorded by Red lady (9.46 %) which was on par with CO 8 (9.45 %), Acc. 2 (9.39 %), KAU Acc. 1 (9.32%), Acc. 6 (9.32 %) and Arka Prabhath (9.13 %). Pusa Nanha recorded the lowest per cent of reducing sugar of 7.59 per cent, which was on par with Acc.4 (7.70 %).

The highest per cent of total sugar was recorded by Red lady (10.12 %) which was on par with Acc.6 (10.10%), CO 8 (9.95%), Arka Prabhath (9.75%) and KAU Acc. 1 (9.71%). Acc.4 recorded the lowest per cent of total sugar of 8.05 per cent, which was on par with Pusa Nanha (8.15 %).

With respect to non- reducing sugar, there was no significant difference among the treatments.

4.5.5 Carotenoid content

The highest carotenoid content was observed in CO 8 (3.18 mg/ 100g) which was on par with Arka Prabhath (3.14 mg/ 100g) followed by Acc. 6 (2.87 mg/ 100g) and Red lady (2.50 mg/ 100g). Lowest carotenoid content was observed in Acc.3 (1.58 mg/ 100g) which was on par with Acc. 1 (1.61 mg/ 100g) and Acc. 4 (1.80 mg/ 100g).

4.5.6 Lycopene content

The highest lycopene content was observed in CO 8 (1.72 mg/ 100g) which were on par with Red lady (1.62 mg/ 100g) followed by Arka Prabhath (1.36mg/ 100g) and Acc. 6 (1.12 mg/ 100g) which were on par. Lowest lycopene content was observed in Acc.1 (0.15 mg/ 100g) which was on par with Acc. 4 (0.28 mg/ 100g).

4.5.7 Ascorbic acid content

The highest ascorbic acid content was observed in Acc.4 (93.37 mg/ 100g) followed by KAU Acc. 1 (85.47 mg/ 100g) which was on par with Arka Prabhath (83.93 mg/ 100g) and Acc. 2 (82.97 mg/ 100g). Lowest ascorbic acid content was observed in Pusa Nanha (44.03mg/ 100g) which was on par with Acc.3 (45.47mg/ 100g).

Table 14: Biochemical parameters of papaya accessions/ varieties

Accessions/Varieties	Fibre content (%)	Acidity (%)	Total Soluble Solids (⁰ B)	Reducing sugar (%)	Total sugars (%)	Non reducing sugar (%)	Carotenoid content (mg/ 100g)	Lycopene content (mg/100g)	Ascorbic acid (mg/100g)
Acc. 1	0.86	0.18	8.97	8.55	8.87	0.32	1.61	0.15	57.60
Acc. 2	1.11	0.20	13.66	9.39	9.69	0.30	2.14	0.94	82.97
Acc. 3	0.92	0.15	10.45	8.24	8.75	0.51	1.58	0.51	45.47
Acc. 4	1.04	0.15	11.26	7.69	8.05	0.35	1.80	0.29	93.37
Acc. 5	0.85	0.14	11.11	8.43	8.89	0.46	2.21	0.74	67.97
Acc. 6	1.27	0.16	14.71	9.32	10.10	0.78	2.87	1.12	61.43
KAU Acc.1	0.70	0.16	11.96	9.32	9.71	0.39	1.91	0.46	85.47
Pusa Nanha	0.95	0.17	9.64	7.59	8.15	0.56	2.47	0.36	44.03
Arka Prabhath	0.74	0.15	11.32	9.13	9.75	0.62	3.14	1.36	83.93
CO 8	1.19	0.16	12.04	9.45	9.95	0.50	3.18	1.72	65.80
Red lady	1.04	0.16	13.20	9.46	10.12	0.66	2.50	1.62	56.37
CO 2	0.76	0.24	9.85	8.52	9.02	0.50	1.86	0.35	60.33
CD(0.05)	0.19	0.03	1.32	0.48	0.42	NS	0.27	0.14	6.51
S.Em.	0.06	0.01	0.44	0.16	0.14	-	0.09	0.05	2.21
C V (%)	11.71	13.57	6.72	3.26	2.72	-	6.97	11.72	5.72

DISCUSSION

5. DISCUSSION

Papaya (*carica papaya* L.) is considered as one of the important and nutritious fruit. It is easily cultivable, has a short pre-bearing period, gives quick returns and adapts itself to diverse soil and climatic conditions. Practically very little attempt has been made for short listing papaya varieties/types suitable for commercial cultivation North Kerala region. In this context, the present investigation on evaluation of selected papaya cultivars/types/varieties was proposed with an objective of identifying variety/ types suitable for Northern zone of Kerala. The results of the study are briefly discussed below.

5.1 GROWTH CHARACTERS

In this study, the growth characters were assessed based on plant height, collar girth, number of fully developed leaves, leaf area, length of petiole and number of lobes per leaf. All the treatments were significantly different at all stages of growth with respect to all the growth characters considered as presented in Tables 1 to 5.

5.1.1 Plant height

The present study revealed, among the different accessions/varieties tested Pusa Nanha recorded the least plant height compared to other genotypes/accessions at 2, 4, 6, 8, 10 and 12 month after planting with 0.43 m, 0.79 m, 0.96 m, 1.17 m, 1.43 m and 1.70 m respectively (fig. 1). KAU Acc. 1 (2.69 m), Acc.3 (2.54 m), Acc.4 (2.59 m), Red lady (1.88 m) and CO 2 (2.17 m) were comparatively taller. Though short stature of the papaya plant is most desirable as it allows easy harvesting, the variation in height of the plant was reported. The result of the present investigation was also in accordance with the findings of Ram (1983) that Pusa Nanha record and average height of 106cm and Bose and Mitra (1985) that average height of CO 2 was 220 cm. Das *et al.* (2014) reported a height of 139.47 cm for Pusa Nanha. According to Kumar *et al.* (2015) papaya plant height varied from 120 cm to 185.33 cm with varietal difference.

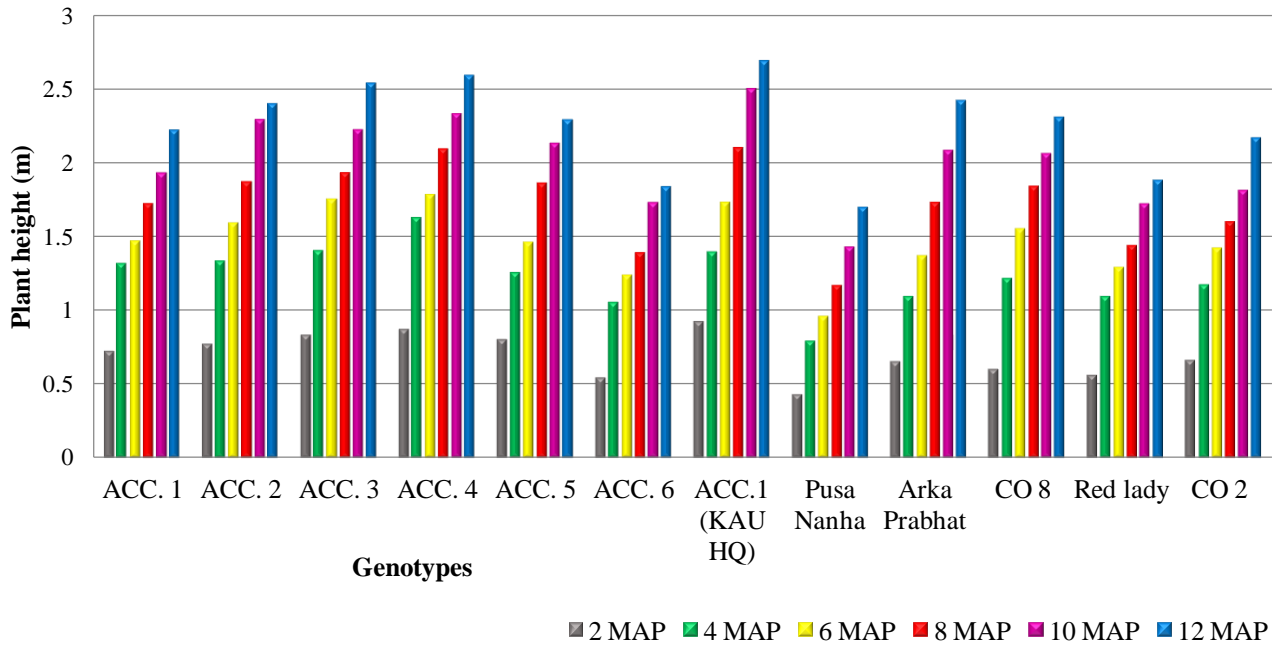


Fig. 1: Plant height of selected papaya accessions/ varieties

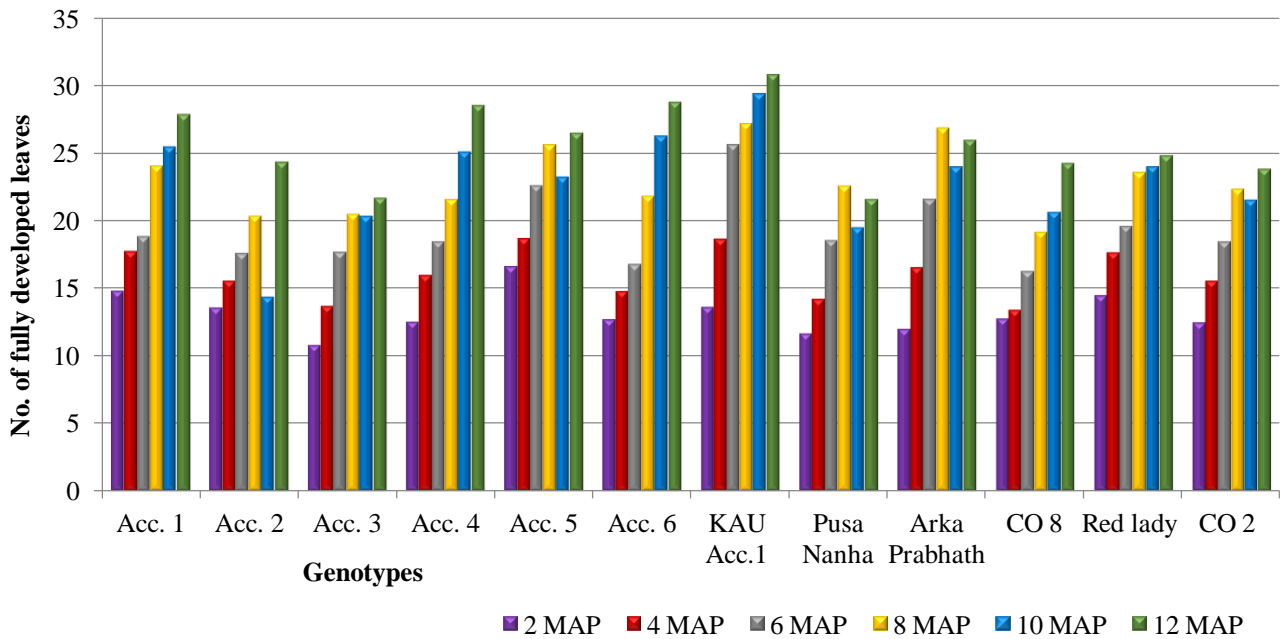


Fig. 2: Number of fully developed leaves of selected papaya accessions/ varieties

Other than the earlier reports, KAU Acc.1 (2.69 m), Acc.3 (2.54 m), Acc.4 (2.59 m) recorded high plant height which might be due to the agro- climatic conditions prevailing in northern region. The chance for such varietal variation in height was earlier reported by Gandhi (1957).

5.1.2 Collar girth

The result of the study, by the end of observation period revealed that, Acc. 4 recorded the highest collar girth (70.30 cm) and the least collar girth was recorded by Red lady (34.53 cm). This result contradicts the findings of Tulasigeri *et al.* (2017) that Red lady recorded a collar girth of 41.39 cm.

5.1.3 Number of fully developed leaves

Present study showed the result on number of fully developed leaves as at the initial months after planting Acc. 5 (16.47 and 18.60 respectively at 2 and 4 MAP) recorded more number of leaves and by six month after planting to end of the observation period KAU Acc. 1(25.53, 27.1, 29.40 and 30.73 at 6, 8, 10 and 12 MAP) recorded the highest number of leaves. Though the earlier reports are scanty the result corroborated the findings of Dwivedi *et al.* (1999) in which the number of leaves at the stage of flowering and fruit production are positively co- related. Similarly Anh *et al.*(2011) also reported that number of leaves varied from 17.6 to 21.8 with varietal difference in papaya.

5.1.4 Leaf area

The present study showed though KAU Acc .1 recorded the maximum leaf area at earlier stages of growth, Acc. 5 followed by Acc. 6 recorded the maximum leaf area with further growth towards the flowering and fruiting stage of the plant. This result was in accordance with the findings of Reshma (2016) that increase leaf area differed among the accession at different stages of growth. Leaf area had a positive co- relation with yield as it enhances the photosynthetic ability. So, this might be the reason why Acc.5 had maximum yield.

5.1.5 Petiole length

In the present study, Acc.1 recorded the longest length of petiole at initial stages of growth and Acc.4 recorded the longest petiole length with further growth towards the flowering and fruiting stage of the plant. But different accessions had different trend with advancement of growth of the plant. This result is in accordance with the findings of Ram (2005) that a positive co- relation of number of fruits with petiole length. Acc. 4 with maximum petiole length recorded and number of fruits also more in the present investigation.

5.2 FLOWERING AND FRUITING CHARACTERS

Significant differences were observed with respect to flowering and fruiting characters of papaya. Among different accessions and varieties

5.2.1 Days to first flowering

Days of first flowering vary between accessions. In the present study, among the different accessions/ varieties, the shortest period of first flowering was recorded in Acc. 2 (108.33 days) which is on par with CO 8 (112.00 days) followed by KAU Acc. 1 (113.67 days) which was on par with Acc.4 (117.00 days). Maximum number of days for first flowering was recorded by Acc.3 (135.00 days), significantly different from all other accessions followed by Arka Prabhath (129.00 days) which was on par with CO 2 (127.33 days) and Acc.5 (126.00 days). This variation might be due to the genetic variation among the accession/ varieties and climatic condition of the region. Variation in the time for first flowering observed among the accessions/ varieties support the earlier findings of Subramanyam and Iyer (1981) that a time range of 115.40 to 146.93 days for first flowering with different varieties was observed in papaya. Singh and kumar (2010) reported a varietal difference in differential days for first flowering. The findings of Tulasigeri *et al.* (2017) also supported the results of the present investigation that a variation in the days of first flowering with different genotypes from 72.64 days to 103.80days.

5.2.2 Height at which first flowering occurs

Lower the height at which first flowering occurs, easier will be the harvesting of papaya (Ghanta *et al.*, 1992). This earlier finding was in line with the results of the present study that the lowest height at which first flowering occurred was recorded by Pusa Nanha (70.70 cm) which significantly differed from all other accessions followed by Acc.6 (91.17cm), Arka Prabhath (99.73 cm) and Red lady (100.50 cm) which were on par. Maximum height at which first flowering occurred was recorded by Acc.4 (140.80 cm) followed by Acc. 3 (133.73 cm), Acc.2 (128.53 cm) and Acc. 1 (124.53 cm) which were on par. These results are in close conformation with the findings of Reshma (2016) that height of first flowering among the different accession varied from 61.00 cm to 152.27 cm.

5.2.3 Height at which fruiting occurs

Height of the plant and height at which fruiting occurs are positively related. The results of this investigation showed the lowest fruiting height was recorded by Pusa Nanha (98.70 cm) corresponding to its lowest height followed by Acc.6 (115.20cm), Arka Prabhath (122.37 cm), KAU Acc. 1 (127.17 cm) and Red lady (100.50 cm). Maximum fruiting height was recorded by Acc.4 (166.80 cm) followed by Acc. 3 (158.23 cm), Acc. 2 (152.73 cm) and Acc. 1 (148.53 cm). Ram (1982) and Dash *et al.* (1998) reported varietal difference in the height of first flowering and fruiting which supports the findings of the present study.

5.2.3 Fruit length

The results of present study revealed maximum fruit length of 27.57 cm in Acc.5 which followed by CO 2 (26.00 cm), Pusa Nanha (24.73 cm) and lowest fruit length in Acc. 1 (KAU HQ) (14.63 cm) which was on par with Acc.2 (15.33 cm) and Acc.3 (15.63 cm). This result was supported by the findings of Lakshmi (2000) that fruit length ranged between 14.89 cm to 27.14 cm and Singh (2010) that the papaya fruit length ranged between 16.00 cm to 35.00 cm.

5.2.4 Weight of fruits

Results of present investigation showed highest fruit weight of 1866.67 g in Pusa Nanha which was on par with Acc.5 (1766.67 g). Lowest fruit weight was recorded in Acc. 3 (813.33 g) followed by KAU Acc. 1 (1003.33 g) and Acc. 2 (1040.00 g) which were on par. This result is in accordance with the findings of Lakshmi (2000) that Pusa Nanha recorded the highest fruit weight with the tested genotypes of papaya. The experiment by Singh and kumar (2010) revealed a fruit weight range of 0.48 to 2.20 kg. Anh *et al.* (2011) reported that the fruit weight ranged between 0.61 kg per fruit to 1.64 kg per fruit. All these reports were in same line with the results of this experiment. Rao *et al.* (1958) reported the weight of average papaya fruit to be from 1 to 1.5 kg

5.2.5 Volume of fruits

Highest fruit volume of 1754.33 ml was recorded in Pusa Nanha which was significantly different from all other accessions, followed by Acc.5 (1686.00 ml), CO 8 (1263.33 ml), Red lady (1203.33 ml). Lowest fruit volume was recorded Acc.3 (733.33 ml) followed by Acc.6 (936.67 ml) which was on par with Acc.2 (940.00 ml) and KAU Acc. 1 (945.33 ml). This result is in line with the findings of Lakshmi (2000) that Pusa Nanha had the highest fruit volume and average fruit volume range between 213.61 cc to 1537.33 cc.

5.2.6 Shape of fruit

In the present experiment a wide range of variation in shape of papaya was observed such as acron, high round, oblong ellipsoid, lengthened cylindrical, elongate, elliptic, globular, oblong and oval. This observation was in accordance with Reshma (2016) that wide variation in fruit shape of papaya was observed during their survey.

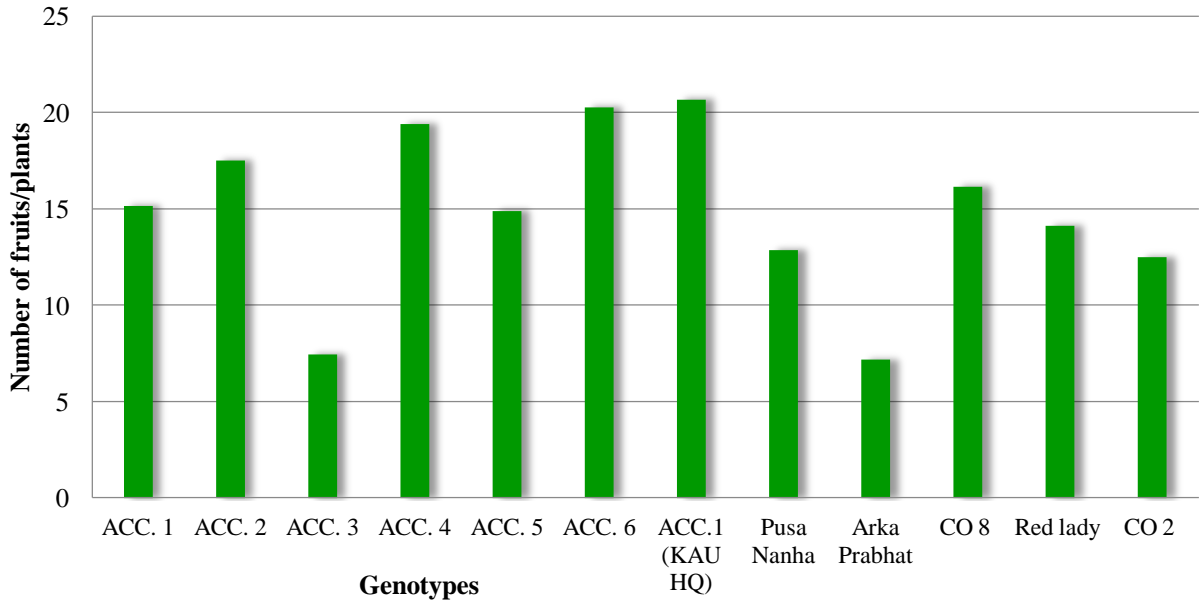


Fig. 3: Fruits per plant of selected papaya accessions/ varieties

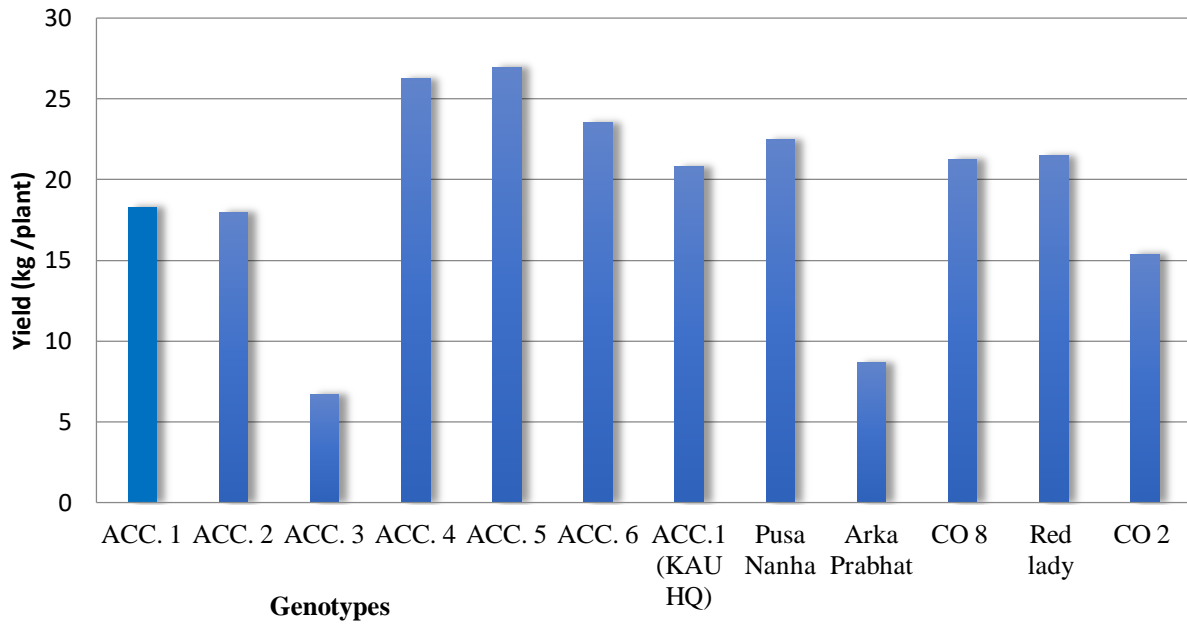


Fig. 4: Yield (kg) of selected papaya accessions/ varieties

5.2.7 Flesh Thickness

Flesh thickness mainly determines the edible portion of the fruits. In this study, the highest flesh thickness of 3.37 cm was recorded in Acc.5 which was on par with Pusa Nanha (3.36 cm) followed by Acc.4 (2.90 cm) and the least flesh thickness was recorded by Acc.2 (1.86 cm) which was on par with Acc.3 (1.87 cm), KAU Acc.1 (2.03 cm), CO 2 (2.07 cm) and Arka Prabhath (2.11 cm). Meena *et al.* (2012) also reported maximum flesh thickness in PusaNanha.

5.3 YIELD CHARACTERS

With regard to the yield attributes also significant differences were noticed among the accessions/varieties. Highest number of fruits was recorded in KAU Acc.1 (20.67) followed by Acc.6 (20.27) and Acc.4 (19.40) which were on par with Acc.1 (KAU HQ). The highest plant yield was recorded in Acc.5 (26.93 kg) , significantly different from all other accessions, followed by Acc.4 (26.23 kg), Acc.6 (23.50 kg) and Pusa Nanha (22.47 kg). In this investigation fruit weight and number of fruits had positive co- relation with the yield per plant. This result is in line with the findings of Lakshmi (2000) and Chalak *et al.* (2016).

5.4 QUALITY PARAMETERS

5.4.1 Organoleptic test

Sensory evaluation was done in ripened papaya fruit, prepared jam and tutti frutti. The organoleptic characters are taste, flavour, color and overall acceptance.

Among the 12 papaya accessions/varieties evaluated the highest taste was obtained in Acc.6 (8.45) followed by Red lady (8.13), Acc. 2 (8.06). The highest score for flavour was obtained in CO8 (8.06) followed by Red lady (8.04), Acc. 6 (7.95). The highest score for colour was obtained in CO8 (8.57) followed by Arka Prabhath (8.54) and Red lady (8.45).The highest score for overall acceptance was obtained in Acc. 6 (8.52) followed by Red lady (8.43), Acc. 2 (8.19).

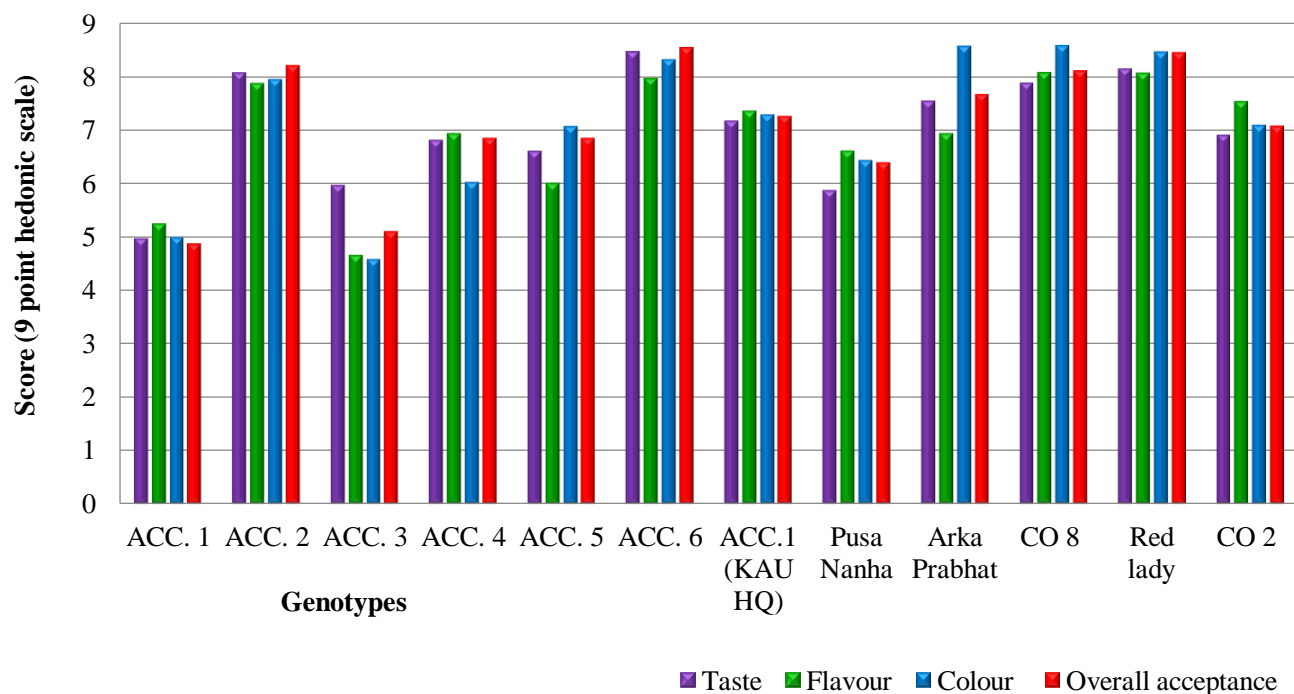


Fig. 5: Organoleptic test of papaya fruit

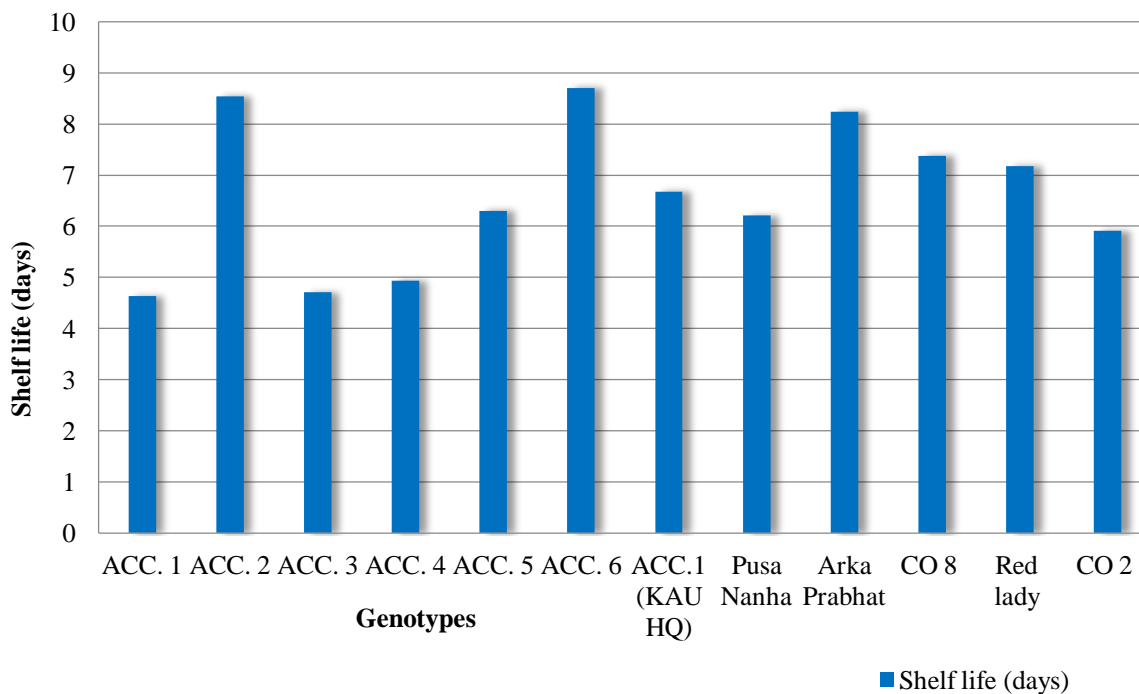


Fig. 6: Shelf life of papaya genotypes

From the papaya fruit sensory evaluation, Acc.6 was found to be promising type with respect to taste and overall acceptance.

In the case of papaya jam, the highest score for taste was obtained in Red lady (8.25) followed by Acc. 6 (8.17), Arka Prabhath (7.84). The highest score for flavour was obtained in Red lady (8.01) followed by Acc. 6 (7.88), CO8 (7.39). The highest score for colour was obtained in CO8 (8.64) followed by Arka Prabhath (8.56) and Red lady (8.34). The highest score for overall acceptance was obtained in Red lady (8.41) followed by Acc. 6 (8.30), Arka Prabhath(8.10). From the papaya jam sensory evaluation, Red lady was found to be promising type with respect to taste, flavor and overall acceptance.

5.4.2 Shelf life (days)

Highest shelf life was recorded by Acc.6 (8.70) which was on par with Acc.2 (8.53) and Arka Prabhath (8.23 days). The lowest shelf life was recorded by Acc.1 (4.63) which was on par with Acc.3 (4.70 days) and Acc.4 (4.93 days). The results of the present study are in accordance with the findings of Nirujogi and Dinesh (2012), who reported that the shelf life of hybrid Arka Prabhath ranged from 5.92 to 10.02 days. Similar result was also reported by Tulasigeri (2017) that Arka Prabhath had longest shelf life (8.11 days). The results of the present study are in line with these findings though Acc. 6 was on par with Arka Prabhath, which recorded the highest value of shelf life (8.23 days).

5.5 BIOCHEMICAL PARAMETERS OF FRUIT

5.5.1 Titrable Acidity

The results of the study showed highest titrable acidity content in Acc.2 (0.23) which was on par with Acc.4 (0.20), followed by Acc.6 (0.17) and Pusa Nanha (0.17). The lowest acidity content was observed in Acc.1 (0.13) which was on par with CO2 (0.13), Arka Prabhath (0.14) Acc.3 (0.15), Acc.5 (0.15) and KAU Acc. 1

(0.15). Contrary to the findings of Lakshmi (2000) that CO 2 recorded highest acidity, in this study Acc. 2 recorded the highest acidity value.

5.5.2 Total soluble solids

TSS of the fruit showed significant variation among treatments. In this study the highest TSS of 14.71 °B was recorded by Acc.6, which was on par with Acc. 2 (13.67 °B) followed by Red lady (13.20 °B) and CO 8 (12.04 °B) which were on par. The lowest TSS was recorded by Acc. 1 (8.97 °brix) which was on par with Pusa Nanha (9.64 °B) and CO 2 (9.85 °B). Lakshmi (2000) reported Pusa Nanha had lowest TSS value among the tested genotypes and in general the TSS value range between 11.6 percent to 14.76 percent. Similar findings of the range of TSS value between 6 percent to 13 percent were reported by Mehta and Tomar (1980) and Ram (1981).

5.5.3 Reducing, Non reducing and Total sugars

The highest per cent of reducing sugar was recorded by Red lady (9.46 %) which was on par with CO 8 (9.45 %), Acc. 2 (9.39 %), KAU Acc. 1 (9.32%), Acc. 6 (9.32 %) and Arka Prabhat (9.13 %). The highest per cent of total sugar was recorded by Red lady (10.12 %) which was on par with Acc.6 (10.10%), CO 8 (9.95%) Arka Prabhat (9.75%) and KAU Acc. 1 (9.71%). Auxilia and Sathiamoorthy (1996) reported the reducing, non reducing sugar and total sugar content ranged from 5.50 per cent to 11.79 per cent, 0.18 per cent to 1.38 per cent and 7.86 per cent to 12.75 per cent respectively

5.5.4 Carotenoid content

The carotenoid content in the papaya varieties evaluated in the present study, ranged from 1.58 mg/100g to 3.18 mg/100g. Highest carotenoid content was observed in CO 8 (3.18 mg/ 100g) followed by Arka Prabhat (3.14 mg/100g) Acc. 6 (2.87 mg/100g), Red lady (2.50 mg/100g). A range of 1.64 mg per 100 g to 2.47 mg

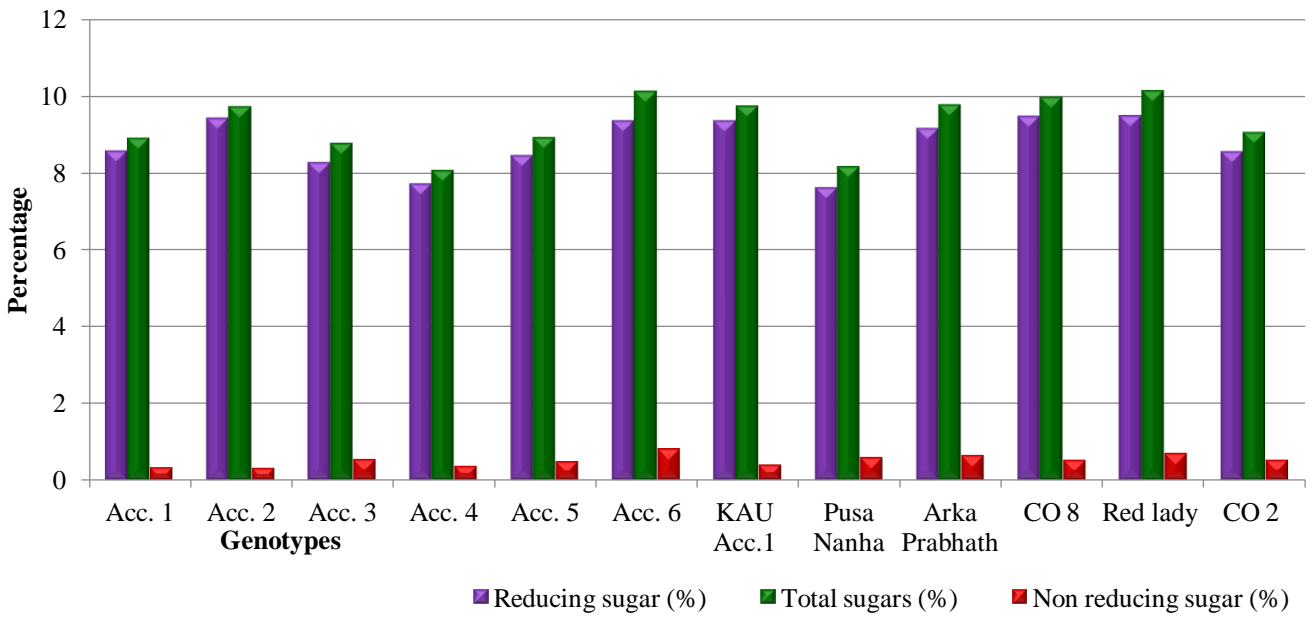


Fig. 7: Reducing sugar (%) of papaya accessions/ varieties

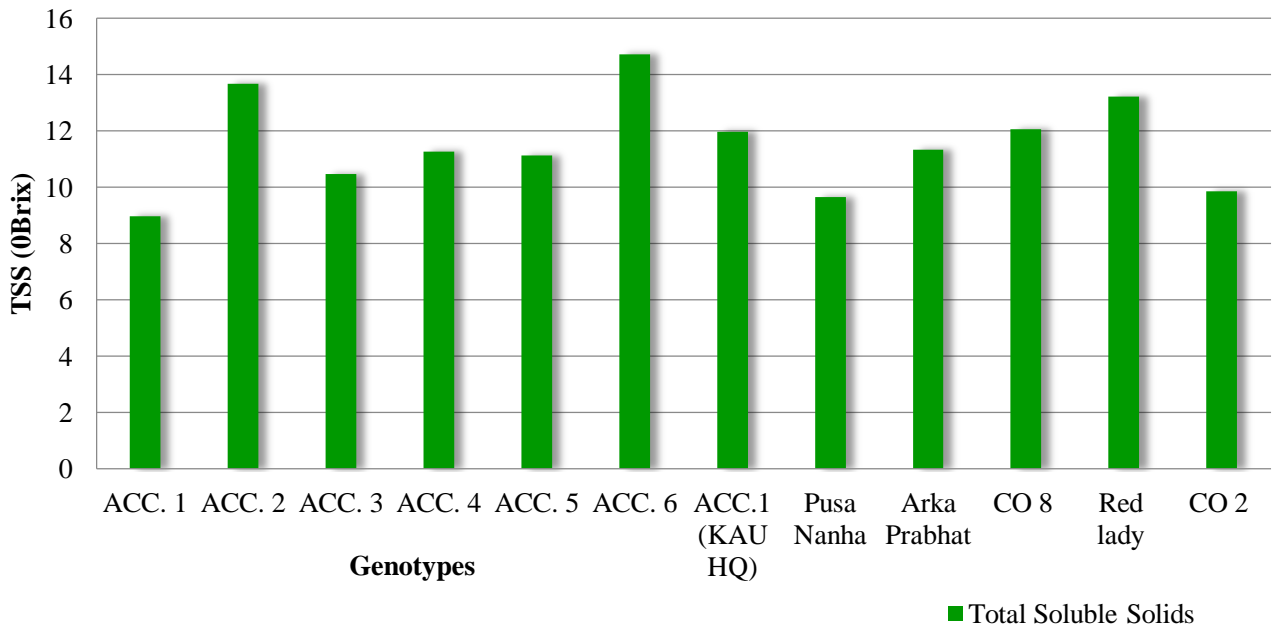


Fig. 8: TSS (°Brix) of papaya accessions/ varieties

per 100g carotenoid content in different varieties of papaya was recorded by Lakshmi (2000). A range of 3.35 mg per 100 g to 7.6mg per 100g carotenoid content in different varieties of papaya was recorded by Auxcilia and Sathiamoorthy (1996). Similar variation in carotenoid content was observed in the present study.

5.5.5 Ascorbic acid content

The highest ascorbic acid content was observed in Acc.4 (93.37 mg/100g) followed by KAU Acc. 1 (85.47 mg/100g) which was on par with Arka Prabhath (83.93 mg/100g) Acc. 2 (82.97 mg/100g). Lowest ascorbic acid content was observed in Pusa Nanha (44.03mg/100g) which was on par with Acc.3 (45.47mg/100g). These results are in line with the earlier findings that generally ascorbic acid content of papaya varieties varied between 27.65 per cent to 65.57 per cent (Auxcilia and Sathyamoorthy, 1996) and 62.01 per cent to 131.25 per cent (Lakshmi, 2000).

SUMMARY

6. SUMMARY

The present study entitled “Evaluation of promising accessions of papaya (*Carica papaya* L.) for cultivation in North Kerala.” was conducted at the Department of Pomology and Floriculture, College of Agriculture, Padannakkad, Kasaragod and Regional Agricultural Research Station, Pilicode during the period from 2017 to 2019 with the objective to evaluate selected papaya types and released varieties/hybrids to identify best papaya genotypes for yield and quality for cultivation in North Kerala. The results of the present study are summarized below:

- In the field evaluation, Pusa Nanha recorded the minimum plant height throughout the observation period. Acc.6 and Red lady were comparatively short in stature. Maximum collar girth was recorded in Acc.4 towards the end of the observation period.
- KAU Acc. 1 showed a continuous increase in the number of fully developed leaves from two months of planting (13.5) to the end of the observation period (30.73) recording the highest value. Though Acc. 5 showed low leaf area at the beginning, with the further growth of the plant to flowering and fruiting, it showed maximum leaf area, which positively influenced the yield. A similar trend was also showed by Acc. 6 with respect to leaf area and number of fruits and yield. Highest petiole length was recorded in Acc.4 (102.70 cm).
- Acc.2 (108.33) and CO 8 (112.00) flowered earlier compared to other accessions/ varieties studied in this investigation. The minimum height at which first flowering and fruiting occurred was recorded by Pusa Nanha followed by Acc. 6.
- Maximum fruit length of 27.57 cm was recorded in Acc.5 whereas maximum fruit width (17.90 cm), fruit weight (1866.67 g) and fruit volume (1754.33 ml) were recorded in Pusa Nanha.
- With respect to fruit shape, genotypes showed wide variation viz., Acron, high round, oblong ellipsoid, lengthened cylindrical, elongate, elliptic, globular, oblong and oval shapes.

- Flesh thickness was maximum in Acc. 5 (3.37 cm) and lowest fruit cavity index was recorded by Pusa Nanha (17.43), which was on par with Red lady (18.23).
- The number of seed per fruit was highest in Acc.2 and seed weight for 100 seeds was maximum in Acc.5 (1.93 g).
- Highest number of fruits was recorded in KAU Acc. 1 (20.67) and Acc.6 (20.27) and plant yield was maximum in Acc.5 (26.93kg), Acc.4 (26.23 kg) and Acc.6 (23.50 kg).
- Among the 12 papaya genotypes evaluated, Acc.6 and Red lady were better in taste and overall acceptance. For jam preparation, Red lady was found to be the best followed by Acc.6. In the case of papaya Tutti Frutti, all the papaya accessions/varieties recorded same score for taste, flavour, colour, overall acceptance.
- Acc.6 (8.70) showed maximum shelf life compared to other papaya accessions/ varieties.
- The study showed the highest fibre content in Acc.6 (1.27%), per cent of reducing sugar in Red lady (9.46 %), per cent of total sugar in Red lady (10.12 %) on par with Acc.6 (10.10 %), carotenoid in CO 8 (3.18 mg / 100 g) on par with Arka Prabhath (3.14 mg/100 g) followed by Acc. 6 (2.87 mg / 100 g) and Red lady (2.50 mg/100 g), lycopene content in CO 8 (1.72 mg / 100 g) which were on par with Red lady (1.62 mg/ 100g) followed by Arka Prabhath (1.36 mg/100g) and Acc. 6 (1.12 mg/100 g) which were on par, ascorbic acid content in Acc.4 (93.37 mg/100 g) followed by KAU Acc.1 (85.47 mg/100 g).

The present study could identify the suitability of Acc. 6 (local genotype collected from Kasaragod) for better yield with consumer preference for cultivation in North Kerala. This accession showed remarkable overall acceptance with respect to short stature (1.84 m), number of fruits (20.27), yield (23.50 Kg), organoleptic test (Score-8.52) and good shelf life (8.70 days).

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**EVALUATION OF PROMISING ACCESSIONS OF
PAPAYA (*Carica papaya* L.) FOR CULTIVATION IN
NORTH KERALA**

**By
AKHIL P
(2017-12-023)**

**Abstract of the Thesis
Submitted in partial fulfillment of the
requirements for the degree of**

MASTER OF SCIENCE IN HORTICULTURE

**Faculty of Agriculture
Kerala Agricultural University**



**DEPARTMENT OF FRUIT SCIENCE
COLLEGE OF AGRICULTURE
PADANNAKKAD, KASARGOD 671 314
KERALA, INDIA**

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ABSTRACT

Papaya (*Carica papaya* L.), is an important fruit crop cultivated in the tropical and subtropical regions due to its versatile uses, high palatability, nutritional and health benefits. Even though India is a major producer of papaya in the world, in Kerala, it is yet to assume the status of a commercial fruit crop. Lack of availability of varieties/types adapted to climatic conditions in Kerala and dependency on private breeders for seeds are the challenges for its commercial cultivation. However, there is a growing interest among farmer's in Kerala to take up its cultivation in an orchard scale recently due to its ease of growing and economic potential. In this context, the present investigation on evaluation of selected papaya cultivars/types/varieties is proposed with an objective to find out genotypes suitable for cultivation in Northern zone of Kerala.

The study entitled "Evaluation of promising accessions of papaya (*Carica papaya* L.) for cultivation in North Kerala" was conducted at the Department of Pomology and Floriculture, College of Agriculture, Padannakkad, Kasaragod and Regional Agricultural Research Station, Pilicode during the period from 2017 to 2019.

The experiment was laid out in RBD with 12 treatments and 3 replication. The treatments included six promising papaya genotypes selected from the Kasaragod district, one accession already found to be promising from the KAU main campus, Vellanikkara., four released varieties namely Pusa Nanha, Arka Prabhath, CO-8, CO-2 and Red lady (F1 hybrid) from private breeder company.

Among the accessions/varieties, Pusa Nanha (1.70 m), Acc. 6 (1.84 m) and Red lady (1.88 m) were shorter in terms of plant height. Flowering and fruiting occurred at the lowest height in Pusa Nanha followed by Acc. 6, which is a positive character for easy harvesting of fruits.

Maximum fruit weight was recorded in PusaNanha(1866.67g), Acc.5 (1766.67g), Acc. 4 (1346.67 g). Highest number of fruits was recorded in KAU Acc. 1 (20.67), Acc.6 (20.27) and Acc.4 (19.40). Fruit yield per plant was highest in Acc.5 (26.93kg), Acc.4 (26.23kg) and Acc.6 (23.50kg), PusaNanha (22.47kg). Shelf life of fruits at ambient conditions was maximum in Acc.6(8.70) which was on par with Acc.2 (8.53) and Arka Prabhath (8.23).

Among the 12 papaya accessions/varieties evaluated for organoleptic analysis, the most preferred taste and overall acceptance was recorded by Acc.6 followed by Red lady. When value added to papaya jam, best taste, flavour and overall acceptance was recorded in Red lady followed by Acc. 6.

Biochemical analysis revealed that the highest fibre content was observed in Acc.6 (1.27%) followed by CO 8 (1.19) and Acc.2 (1.11%) which were on par with Acc.6. The maximum per cent of reducing sugar was recorded by Red lady (9.46 %) which was on par with CO 8 (9.45 %), Acc. 2 (9.39 %), KAU Acc. 1 (9.32%), Acc. 6 (9.32 %) and Arka Prabhath (9.13 %). Total sugar content was maximum in Red lady (10.12 %) which was on par with Acc.6 (10.10%), CO 8 (9.95%), Arka Prabhath (9.75%) and KAU Acc. 1 (9.71%). The highest carotenoid content was observed in CO 8 (3.18 mg/ 100g) which was on par with Arka Prabhath (3.14 mg/ 100g) followed by Acc. 6 (2.87 mg/100g) and Red lady (2.50 mg/100g). The lycopene content was maximum in CO 8 (1.72 mg/ 100g) which was on par with Red lady(1.62 mg/ 100g) followed by Arka Prabhath (1.36mg/ 100g), and Acc. 6 (1.12 mg/ 100g) which were on par. Highest ascorbic acid content was observed in Acc.4 (93.37 mg/ 100g).

In this study, six accessions, five varieties and one promising accession reported earlier from the main campus, Vellanikkara, KAU were evaluated and the study revealed that Acc. 6 (local genotype collected from Kasaragod) as the most promising compared to all other genotypes for higher yield with consumer

preference for cultivation in North Kerala. This accession was found to be better with respect to short stature (1.84 m), number of fruits (20.27), yield (23.50 kg) , Organoleptic test (Score-8.52) and good shelf life (8.70 days) and nutritional qualities such as high fibre content, carotenoid content and lycopene content.

സംക്ഷിപ്തം

ഉഷ്ണമേഖല, മിതോഷ്ണ മേഖല പ്രദേശങ്ങളിൽ വൈവിധ്യമായ ഉപയോഗത്തിന്റേയും മികച്ച സ്വാദ്, ഉയർന്ന പോഷക മൂല്യങ്ങൾ, ആരോഗ്യ സംരക്ഷണം എന്നിവയുടെയെല്ലാം അടിസ്ഥാനത്തിൽ കൃഷി ചെയ്യപ്പെടുന്ന ഒരു പ്രധാന വിളയാണ് പപ്പായ. ദേശീയ തലത്തിൽ മികച്ച വിളയായി കൃഷി ചെയ്യപ്പെടുമ്പോഴും ഒരു വാണിജ്യവിള എന്ന നിലയിൽ കേരളത്തിൽ ഇന്നും പപ്പായ കൃഷി സാധാരണമല്ല. കാലാവസ്ഥയ്ക്ക് അനുയോജിച്ച ഇനങ്ങളുടെ ലഭ്യതക്കുറവും നടീൽ വസ്തുക്കൾക്കായി സ്വകാര്യ സ്ഥാപനങ്ങളെ ആശ്രയിക്കേണ്ടി വരുന്നതും കേരളത്തിൽ പപ്പായ കൃഷി വേണ്ട രീതിയിൽ പ്രാധാന്യം ലഭിക്കാത്തതിന്റെ ഘടകങ്ങളാണ്. ഈ അവസരത്തിലാണ് “ഉത്തര കേരളത്തിലെ തിരഞ്ഞെടുത്ത പപ്പായ ഇനങ്ങളുടെ വിലയിരുത്തൽ” ലക്ഷ്യം വെച്ചുകൊണ്ടുള്ള ഈ പഠനം നിർദ്ദേശിക്കപ്പെട്ടിട്ടുള്ളത്.

“ഉത്തരകേരളത്തിലെ തിരഞ്ഞെടുക്കപ്പെട്ട പപ്പായ ഇനങ്ങളുടെ വിലയിരുത്തൽ” എന്ന ഈ പഠനം 2017 മുതൽ 2019 വരെയുള്ള കാലഘട്ടത്തിൽ കേരള കാർഷിക സർവ്വകലാശാലയുടെ കീഴിലുള്ള പടന്നക്കാട് കാർഷിക കോളേജിലെ ഫല-പുഷ്പ വർഗ്ഗ വിള വകുപ്പിലും പിലിക്കോട് പ്രാദേശിക ഗവേഷണ കേന്ദ്രത്തിലും ആണ് നടത്തി വന്നത്.

12 ട്രീറ്റ്‌മെന്റുകളും 3 റപ്ലിക്കേഷനുകളും ഉപയോഗിച്ചുകൊണ്ട് റാണ്ടമെസ്ഡ് ബ്ലോക്ക് ഡിസൈനിലാണ് പഠനം നടത്തിയത്. കാസറഗോഡ് ജില്ലയിലെ വിവിധ പ്രദേശങ്ങളിൽ നിന്നും ശേഖരിച്ച മികച്ച 6 നാടൻ തരങ്ങളും, കേരള കാർഷിക സർവ്വകലാശാലയിൽ നിന്നും മികച്ചതായി വിലയിരുത്തപ്പെട്ട ഒരു ഇനവും കേരളത്തിന് പുറത്തെ ഇനങ്ങളായ പൂസ നൻഹ, അർക്ക പ്രഭാത്, സി.ഒ-2, സി.ഒ-8 എന്നീ നാലിനങ്ങളും, സ്വകാര്യ കമ്പനിയിൽ നിന്നുള്ള റെഡ് ലേഡി (എഫ്1) എന്ന ഇനവും ഉൾപ്പെടെ 12 ഇനങ്ങളിലായാണ് വിലയിരുത്തൽ പഠനം നടന്നത്.

മേൽപ്പറഞ്ഞ ഇനങ്ങളിൽ പൂസ നൻഹ (1.70 മീറ്റർ), Acc. 6 (1.84 മീറ്റർ), റെഡ് ലേഡി (1.88 മീറ്റർ) എന്നിവയായിരുന്ന ഉയരം കുറഞ്ഞ ഇനങ്ങളായി കാണപ്പെട്ടത്. പൂസ നൻഹ എന്ന ഇനം ഏറ്റവും ചെറിയ ഉയരത്തിൽ തന്നെ പുഷ്പിക്കുന്നതായും, കായ് പിടിക്കുന്നതായും കാണപ്പെട്ടപ്പോൾ രണ്ടാമതായി Acc. 6 സ്ഥാനം പിടിക്കുകയുണ്ടായി. മേൽപ്പറഞ്ഞ ഗുണങ്ങൾ എളുപ്പത്തിൽ കായ്കൾ വിളവെടുക്കുന്നതിന് സഹായകരമാണ്.

പൂസ നൻഹ (1866.67ഗ്രാം) എന്ന ഇനം ഏറ്റവും ഭാരമുള്ള കായ്കൾ രേഖപ്പെടുത്തിയപ്പോൾ രണ്ടാമതും മൂന്നാമതുമായി Acc. 5 (1766.67 ഗ്രാം) ഉം Acc. 4 (1346.67 ഗ്രാം) ഉം

രേഖപ്പെടുത്തപ്പെട്ടു. കായ്ഫലങ്ങളുടെ എണ്ണത്തിൽ ഏറ്റവും മികച്ച ഇനമായി കെ.എ.യു. Acc. 1 (20.67) ഉം പിന്നാലെ Acc. 6 (20.27), Acc. 4 (19.40) ഉം രേഖപ്പെടുത്തി. എന്നാൽ ഏറ്റവും മികച്ച വിളവ് ലഭിക്കുന്നത് Acc. 5 (26.93 കിലോ) എന്ന ഇനത്തിനാണ്. അതിനു പിറകിലായി മികച്ച വിളവ് ലഭിച്ചത് Acc. 4 (26.23 കിലോ), Acc. 6 (23.50 കിലോ), പൂസ നൻഹ (22.47 കിലോ) എന്നീ ഇനങ്ങൾക്കുമാണ്. അനുയോജ്യമായ സാഹചര്യങ്ങൾ ലഭ്യമാവുമ്പോൾ ഏറ്റവും കാലം കേടു കൂടാതെ ഇരിക്കുന്നത് Acc. 6 (8.70 ദിവസം) എന്ന ഇനവും അതിനോടൊപ്പം Acc. 2 (8.53 ദിവസം), അർക്ക പ്രഭാത് (8.23 ദിവസം) എന്നീ ഇനങ്ങളുമാണ്.

12 ഇനങ്ങളുടെ ഗുണകണങ്ങൾ ഒർഗാനോ ലെപ്റ്റിക് വിലയിരുത്തൽ നടത്തിയപ്പോൾ Acc.6 ഇനത്തിനാണ് ഏറ്റവും സ്വീകാര്യത ലഭിച്ചത്. രണ്ടാമതായി റെഡ് ലേഡി ഇനവും മികച്ച സ്വീകാര്യത രേഖപ്പെടുത്തി. മുല്യവർദ്ധന പരിഗണിക്കുമ്പോൾ പപ്പായ ജാം, മികച്ച സ്വാദ്, ഗുണം എന്നിവയുടെ അടിസ്ഥാനത്തിൽ റെഡ് ലേഡി ഏറ്റവും മികച്ചതായി രേഖപ്പെടുത്തിയപ്പോൾ തൊട്ടു പിന്നിലായി Acc. 6 രേഖപ്പെടുത്തി.

ജൈവ രാസ വിലയിരുത്തലുകൾ നടത്തിയപ്പോൾ മികച്ച നാര് അടങ്ങിയ ഇനമായി Acc.6 (1.27 %) ഉം ക്രമത്തിൽ സി.ഒ-8 (1.19 %), Acc. 2 (1.11 %) എന്നിവയും രേഖപ്പെടുത്തി. റെഡ്യൂസിംഗ് ഷുഗർ കണക്കാക്കുമ്പോൾ ഉള്ള ക്രമം റെഡ് ലേഡി (9.46 %), സി.ഒ-8 (9.45%), Acc.2 (9.39 %), കെ.എ.യു. Acc.1 (9.32 %), Acc.6 (9.32 %), അർക്ക പ്രഭാത് (9.13%) എന്നിങ്ങനെയാണ്. ആകെ ഷുഗറിന്റെ അളവ് പരിശോധിക്കുമ്പോൾ ഏറ്റവും കൂടുതലായി കണ്ടെത്തിയത് റെഡ് ലേഡി (10.12 %) എന്ന ഇനത്തിലാണ്. അതിനു പിന്നിലായി Acc.6 (10.10 %), സി.ഒ-8 (9.95 %), അർക്ക പ്രഭാത് (9.75 %), കെ.എ.യു. Acc.1 (9.71 %) എന്നീ ഇനങ്ങളും വിലയിരുത്തപ്പെട്ടു. കരോട്ടിനോയിഡ് ഘടകം പരിശോധിക്കുമ്പോൾ സി.ഒ-8 (3.18 മി.ഗ്രാം/100ഗ്രാം) ഏറ്റവും ഉയർന്ന അളവ് രേഖപ്പെടുത്തുകയും അതിനു കീഴിലായി അർക്ക പ്രഭാത് (3.14 മി.ഗ്രാം/100ഗ്രാം), Acc.6 (2.87 മി.ഗ്രാം/100ഗ്രാം), റെഡ് ലേഡി (2.50 മി.ഗ്രാം/100ഗ്രാം) എന്നീ ഇനങ്ങളും രേഖപ്പെടുത്തുകയും ചെയ്തു. ഏറ്റവും കൂടുതൽ ലൈകോപീൻ ഘടകം രേഖപ്പെടുത്തിയത് സി.ഒ - 8 (1.72 മി.ഗ്രാം/100ഗ്രാം) എന്ന ഇനമാണ്. പിന്നാലെയായി റെഡ് ലേഡി (1.62 മി.ഗ്രാം/100ഗ്രാം) എന്ന ഇനവും അതിനു താഴെയായി അർക്ക പ്രഭാത് (1.36 മി.ഗ്രാം/100ഗ്രാം), Acc.6 (1.12 മി.ഗ്രാം/100ഗ്രാം) എന്നീ ഇനങ്ങളും

രേഖപ്പെടുത്തുകയുണ്ടായി. അസ്കോർബിക് ആസിഡ് ഏറ്റവും കൂടുതൽ അടങ്ങിയിട്ടുള്ള ഇനമായി Acc.4 (93.37 മി.ഗ്രാം/100ഗ്രാം) വിലയിരുത്തപ്പെടുകയും ചെയ്തു.

പഠനത്തിന്റെ ഫലമായി കണ്ടെത്തിയിട്ടുള്ള നിരീക്ഷണങ്ങൾ അടിസ്ഥാനപ്പെടുത്തി മേൽപറഞ്ഞ 12 തരം പപ്പായ ഇനങ്ങളിൽ മികച്ച വിളവും ഉപഭോക്താക്കളിലെ സ്വീകാര്യതയും കണക്കിലെടുത്തുകൊണ്ട്, ഉത്തരകേരളത്തിൽ കൃഷിക്ക് ഏറ്റവും അനുയോജ്യമായ ഇനം എന്ന നിലയിൽ Acc. 6 (കാസറഗോഡ് ജില്ലയിൽ നിന്നും ശേഖരിച്ച ഇനം) മറ്റുള്ള ഇനങ്ങളേക്കാളും താരതമ്യേന മികച്ചതായി കാണപ്പെട്ടു. ചെടിയുടെ ഉയരം കുറഞ്ഞ പ്രകൃതം (1.84 മീ.), കായ്കളുടെ എണ്ണം (2.27 കായ്കൾ), വിളവ് (23.50 കി.ഗ്രാം), ഓർഗാനോലെപ്റ്റിക് സ്വീകാര്യത (8.52), സൂക്ഷിപ്പ് കാലം (8.70 ദിവസം) തുടങ്ങിയ ഗുണങ്ങളും നാർ, കരോട്ടിനോയിഡ്, ലൈകോപീൻ തുടങ്ങിയ പോഷക ഘടകങ്ങളും മറ്റുള്ള ഇനങ്ങളേക്കാൾ മികച്ചതായി രേഖപ്പെടുത്തുകയുണ്ടായി.

APPENDICES

APPENDIX I

Weather data during the experimental period June 2018 to August 2019

Month/year	Temperature (°C)		Relative humidity (%)		Monthly rainfall (mm)	Sunshine
	Maximum	Minimum	Maximum	Minimum		
Jun 2018	29.55	24.11	94.07	83.80	30.84	1.81
Jul 2018	30.00	24.49	94.45	81.06	28.01	1.96
Aug 2018	29.34	23.95	94.87	80.94	22.34	2.78
Sep 2018	30.57	24.22	89.20	69.03	0.60	8.02
Oct 2018	31.01	24.37	90.81	68.10	5.01	7.15
Nov 2018	31.83	23.85	90.10	61.63	1.83	7.64
Dec 2018	31.39	22.05	91.61	64.35	0.58	7.06
Jan 2019	31.16	18.65	91.39	55.61	0.00	9.44
Feb 2019	32.07	21.36	90.04	55.21	0.00	9.22
Mar 2019	32.37	23.22	88.23	60.61	0.00	8.37
Apr 2019	33.56	25.35	81.07	61.73	1.39	8.14
May 2019	33.35	26.13	86.10	66.48	1.36	9.01
Jun 2019	31.38	25.17	91.90	74.13	23.27	5.46
Jul 2019	29.31	24.05	93.81	81.26	36.43	2.70
Aug 2019	30.22	26.30	92.50	76.18	32.27	2.46

APPENDIX II

Chemical properties of soil

Parameter	Results
pH	4.89
OC	1.17
N (kg ha ⁻¹)	125.5
P (kg ha ⁻¹)	32.32
K (kg ha ⁻¹)	295.57
Ca (ppm)	276.50
Mg (ppm)	114.50
Fe (ppm)	23.50
Mn (ppm)	7.50
Zn (ppm)	5.00
Cu (ppm)	6.00
B (ppm)	0.56

APPENDIX III

Sensory score card for organoleptic evaluation of papaya

Name:

You are requested to assess the product in terms of general acceptability on a 9 point hedonic scale

Score system: Like extremely **9**, Like very much **8**, Like moderately **7**, Like slightly **6**, Neither like nor dislike **5**, Dislike slightly **4**, Dislike moderately **3**, Dislike very much **2**, Dislike extremely **1**

Characteristics	Sample code									
	1	2	3	4	5	6	7	8	9	
Taste										
Flavor										
Color										
Overall acceptance										

Comments if any:

Signature

APPENDIX IV

Details of farmers holding the promising Papaya types

Papaya type	Name of farmer	Address	Panchayat/ Municipality
Acc.1	Sri. Raju Ebrahim	Vallamkattu house, Chayoth P.O Kayyur	Parappa
Acc.2	Smt. Pathmavathi	Palathara house, Vengad P.O Cheruvatur,Nileshwar	Nileshwar
Acc.3	Sri. Rajan	L V Temple Kanhangad P.O Kanhangad	Kanhangad
Acc.4	Sri. K Kamaraj	Arikkara house Ravaneswaram P.O Ravaneswaram	Ajanur
Acc.5	Smt. Anitha	Aryattu house Kundamkuzhy P.O Muliyar	Karadka
Acc.6	Smt. K K Kausalya	Madathil house Kodakkad P.O Pilicode	Nileshwar