

**Studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes.**

**Thesis**

**Submitted to**

Babasaheb Bhimrao Ambedkar University  
(A Central University)  
Lucknow



For the award of the degree of

**DOCTOR OF PHILOSOPHY  
IN  
HORTICULTURE**

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### **DECLARATION**

IViplaw Kumar, Enrollment No. 866/17, hereby declare that thesis entitled “**Studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes**” submitted the thesis for the fulfillment of the requirements for the award of the degree of **Doctor of Philosophy in Horticulture**, Department of Applied Plant Science (Horticulture), School for Biosciences and Biotechnology, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Rae Bareli Road, Lucknow (U.P.), India was carried out by me during the experimentation periods 2018-19 and 2019-20 are my own and original research work.

I do hereby undertake that the thesis is essentially free from any kinds of plagiarism.

Date: 14/02/2022

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## CERTIFICATE

This is to certify that the thesis entitled “Studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes” submitted for the degree of “Doctor of Philosophy” in the subject of Horticulture to the Babasaheb Bhimrao Ambedkar University, Lucknow is a bonafide research work carried out by Mr. Viplaw Kumar, Enrollment No. 866/17 under my supervision and guidance during the periods of 2018-19 and 2019-20 and that no part of this thesis has been submitted for any other degree or diploma to this or any other university.

The thesis submitted to Babasaheb Bhimrao Ambedkar University, Lucknow satisfies all the requirements as stipulated in the Doctor of Philosophy (Ph.D.) regulations-1999 as amended in 2008/2010/2013 and it is fit for submission and evaluation for the award of the degree of Doctor of Philosophy of the University.

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## LIST OF ABBREVIATIONS

S. No.	Abbreviation	Stands for
1.	%	Percentage
2.	&	And
3.	/	Per
4.	@	At the rate of
5.	<sup>0</sup> C	Degree Celsius
6.	ANOVA	Analysis of variance
7.	Df	Degree of freedom
8.	<i>et al.</i>	<i>etalli</i> (Co-authors/others)
9.	Fig.	Figure
10.	CRD	Completely Randomized Design
11.	i.e.	id est (that is)
12.	M.S.S.	Mean sum of squares
13.	Max.	Maximum
14.	Min.	Minimum
15.	Cm	Centimeter
16.	cm <sup>2</sup>	Centimeter square
17.	M	Meter

18.	Mg	Milligram
19.	g	Gram
20.	Kg	Kilogram
21.	No.	Number
22.	S	Significant
23.	NS	Non significant
24.	ml	Millilitre
25.	mm	Millimeter
26.	R.H.	Relative humidity
27.	S.Em $\pm$	Standard error of mean
28.	N	Normal solution
29.	$^{\circ}$ Brix	Degree Brix
30.	Fig	Figure
31.	SS	Sum of squares
32.	MS	Mean of squares
33.	MBL	Malihabad Local

## **Introduction**

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**Mango (*Mangifera indica* L.)** is one of the most important fruits in India and is considered the **national fruit**. It belongs to the family Anacardiaceae. The cultivation of mango in India is as old as 4,000 years reported by (de Candolle, 1883) on the basis of writings by subsequent botanists 6,000 year (Hill, 1952). Historical records and palaeo-botanical evidence provide ample proof about its origin in the Indo-Burma region (Mukherjee, 1958). It moved to China by the 7th Century, to East Africa around the 10th Century, AD to the Philippines at the beginning of the 15th Century. It spread from South and Southeast Asia over the tropical and subtropical areas of the world from the end of the 15th Century onwards. It reached Africa during the 16th Century, Brazil in the 1700s, Jamaica in 1782, Hawaii in 1809, Mexico early in the 19th Century and America during the second half of the 19th Century. Afterwards, it began popping up all over the world. The geographic spread of mango was essentially completed in the last half of the 19th Century with its introduction to such far-flung places as Florida, Hawaii, Fiji, Queensland, and Natal. Though, a tropical fruit, it is now cultivated under subtropical conditions in 89 countries of the world. The major mango growing countries are India, Pakistan, Bangladesh, Myanmar, Sri Lanka, Florida and Hawaii of USA, Australia, Brazil, Thailand, Philippines, Malaysia, Vietnam, Indonesia, Fiji Islands, Egypt, Israel, South Africa, Sudan, Somalia, Kenya, Uganda, Tanzania, Niger, Nigeria, Zaire, Madagascar Mauritius, Venezuela, Mexico, West Indies Islands, Cambodia, etc. Today, many of the popular varieties of mango grown around the world are derived from the mango produced in Florida (USA). The Portuguese are said to introduce vegetative propagation methods in India for the first time to clone superior mono-embryonic trees in the 15th Century. Mughal emperor Babar recognized the mango as the **choicest fruit of India** (Yadav and Singh, 2017). His descendants cultivated mango by evolving grafting techniques and growing technologies and making a huge collection of varieties. The most important mango cultivars of India (Alphonso, Dashehari, Langra, Chausa, etc.), are selections made at the time of Akbar (1542–1605 AD) and have been propagated by vegetative method for several hundred years and

got planted near **Darbhanga the Lakh Bagh**, an orchard of 1,00,000 mango trees. This big planting made at a time, when large orchards of fruit trees were almost unknown, eloquently proves the importance of the mango and the esteem in which it has long been held in India. Charles Marries, who visited the orchard 300 years later found some of those trees still in vigorous conditions. Relics of such orchards are still found in different parts of India. The origin of most of the improved cultivated varieties of India today can be traced to those early days. They have since been preserved under cultivation (for over 400 years) by the process of vegetative propagation.

Mango is most popular among the tropical fruits of the world and has been rightly described as '**King of Fruits**' owing to its delicious taste, captivating flavor and attractive aroma. Mango fruits are rich sources of Vitamin A and good sources of Vitamin C. They contain a good amount of minerals, particularly potassium. Ripe mango fruit is considered invigorating, refreshing and fattening. It is mainly used for both consumptions as ripe fruits and for processing into various products sliced, jam, jelly, squashes, syrups, nectars, baby food, mango leather, toffee, etc. Unripe fruits are also used for making chutney and pickles. Mango seed oil or mango butter is extracted from mango kernels resembling cocoa butter. The ash of burnt leaves is a household remedy for burns and scalds. The wood is used for furniture, floor and ceiling boards, window frames, packing boxes and splints, brush backs, plywood, shoe heel, and agricultural implements. According to Hindu mythology, mango is accepted as a holy tree and leaves and twigs are used in religious functions. Mango thrives well in a tropical and sub-tropical climate. It can be grown from sea level to an altitude of about 1400 meters. The favorable temperature is 18<sup>0</sup> C to 35<sup>0</sup> C, though it can tolerate temperatures high as 48<sup>0</sup> C. if trees are given regular irrigation. Mango is found growing well in areas receiving 250 mm to 2500 mm of annual rainfall. High humidity, rainfall, and frost during the flowering period are harmful.

Various studies have been carried out on the morphological diversity and horticultural attributes of Indian mangoes (Kumar *et al.* 1999, Singh and Bana, 1976). The development of mango hybrids that are efficient in nutrient utilization, provide better returns and are also able to endure adverse environmental conditions, form the major aims of modern fruit breeding (Khan, 2004). An ideal mango cultivar should have characters like a precocious, dwarf, regular and prolific in bearing, early

flowering and fruit set, attractive fruit colour and size, resistance to major diseases and other biotic-abiotic stresses (Litz,2009). The application of morphological characterization is the simplest of the formal, standardized and repeatable methods of evaluating crop genetic diversity. Some of the most important advantages of using morphological characterization are that published descriptor lists are readily obtainable for most major crop species, can be carried out in situ, is relatively low-cost and is easy to perform. Morphological characterization is the first step that should be done before more profound biochemical or molecular studies are carried out. However, the interpretation of genetic diversity on the basis of morphological and biochemical characters has several limitations. Morphological characters have complex inheritance patterns and are vulnerable to environmental conditions. Evaluation forms an important aspect for studying the constant performance of genotypes in a particular environment. The numerous varieties under cultivation provide an unusual diversity of aroma and taste besides morphological characters and nutritive values. Seedlings resulting from cross-pollination in this highly heterozygous crop have added to the variability of this crop in this region. The climate of Lucknow is quite suitable for quality mango production. A number of attempts have been made to find out, the suitable mango cultivars with good phenotypic and Physico-chemical attributes for this region. Further, confusion exists in the nomenclature of mangoes due to different local names for the same variety. The evaluation of genotypes is an important process in order to screen the potential cultivars from the collection for any specific region. Although a cultivar may express a unique behavior under a certain area, it may fail or sustain that peculiar character when grown under different locations. The genetic diversity within mango offers various opportunities to utilize these genomic resources and technologies to manipulate desirable traits. India has the richest germplasm collection and center for cultivating mangoes. Assessment of genetic variation within natural populations and among breeding lines is crucial for effective conservation and exploitation of genetic resources for crop improvement programs. Therefore, to identify superior parents, genetic characterization is a basic requirement for effective selection within the existing population or population arising out of hybridization. However, it is desirable to select suitable and genetically divergent parents, based on information about the genetic variability and genetic diversity present in the available genotypes. India is having the largest available genotypes wealth of mango with about 1,000 cultivars. Barring a few hybrids

resulting from the planned hybridization programs, almost all the known cultivars have been evolved from the selection as chance seedlings. The characteristic of each variety varies widely at different places and the ultimate fruit quality largely depends on the selection of a variety suitable for a particular region (**Iyer, 1987**). Keeping in view the above facts in mind, the present investigation entitled “Studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes.” with the following objectives:

**Objectives of the study:**

1. To make a survey of the orchards for collection of different genotypes of mango fruits from the Lucknow region and adjacent districts.
2. To study the morphological characters of different genotypes of mango fruits.
3. To estimate the biochemical composition of different genotypes of mango fruits.

## **Review of Literature**

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Mango (*Mangifera indica* L.) is one of the most popular fruits of the tropical and sub tropical regions. Mango is suffering from the intricate problem of erratic flowering behavior. The various factors affect the flowering and fruiting of mango. The literature pertaining to physical and biochemical characteristics of different genotypes of mango has been reviewed. A brief account of available information along with supporting evidence in mango fruit crop has been presented as under:

### **Fruit shape, size (length and breadth) and weight**

Shrivastava *et al.* (1987) while evaluating mango varieties in Madhya Pradesh observed that maximum weight per fruit was obtained in Vanraj (385.7 g) followed by Baneshan (350.0 g) Fazli (312.5 g) and Mallika (292.3 g). The varieties like Neelum and Alphonso produced fruits of lesser weight ranging from 121.81 to 168.0 g per fruit.

Pal *et al.* (1987) reported that mango cultivar Fazli registered fruit size of 15.47x 9.84 cm (length and breadth) and fruit weight (632.67 g) at the time of maturity.

Salvi and Gunjate (1988) had reported the length and breadth of Ratna fruits were 10.69 cm and 8.36 cm respectively.

Syamal and Mishra (1989) studied the Physico-chemical characteristics of some important mango varieties of Bihar and observed that the weight of fruit varied from (124.6 g to 506.2 g) in different varieties. The maximum fruit weight (506.2 g) was recorded in Fazli followed by Langra (310 g). Maximum length (14.24 cm) and diameter (9.70 cm) were recorded in Fazli followed by Langra (11.60 cm and 8.54 cm, respectively). The minimum length of 7.47 cm and the diameter of 5.20 cm were recorded in Mithua.

Hoda and Yadav (1993) reported that maximum average fruit weight of (385.10 g) was recorded in Fazli, whereas minimum (142.6 g) in Neeluddin, the

length of the fruit was maximum in Alfazli (10.22 cm) followed by Neelgoa (6.37 cm) as compared to minimum breadth (4.55 cm) on Mahmood Bahar.

Gowda and Ramanjaneya (1994) reported the hybrid variety Arka Aruna has an average weight of (682 g) and the Alphonso variety with (216 g).

Kalra *et al.* (1994) found that the average fruit weight of different varieties varied from (188 g to 343 g). Whereas, maximum fruit weight (343 g) was noted in cultivar Langra Gorakhpur followed by Mallika (320 g) and minimum fruit weight (118 g) was noted in cultivar Gaurjeet.

Sharma and Josan (1995) reported that fruits of Mallika were maximum in weight (428 g) with large size. Fruits of Langra, Dashehari, Amrapali and Alphonso followed each other in descending order in average fruit weight and size.

Radha *et al.* (1996) reported that cultivar Fazli had the highest weight (545.0 g).

Rajput and Pandey (1998) evaluated the Physico-chemical properties of some mango cultivars. According to them, Mallika was superior to other cultivars in respect of fruit size. Langra and Sunderja also produced fruits of good size.

*Kumar* (1998) conducted a trial at Bihar Agriculture college regarding the Physico-chemical characteristics of mango varieties and found that the maximum size of the fruits (15.02 x 10.52 cm) was recorded in Fazli with maximum weight (545 g). Though the minimum length was recorded in Goa (5.71 cm) but its breadth (6.10 cm) was greater than length. Minimum breadth was recorded in Safeda Malihabadi (4.65 cm) with a minimum fruit weight of (75.0 g).

Rai *et al.* (2001) conducted an experiment on 17-years-old mango varieties at Central Horticultural Experimental Station, Chum, Ranchi and they observed highly significant differences for the characters, viz., average fruit weight, fruit length and fruit breath respectively.

Hoda *et al.* (2003) conducted research on the evaluation of mango cultivars for quality attributes and they reported that Fazli fruits were maximum in weight (450.98 g) followed by Mallika (416.78 g) and Baneshan (229.13g). While, minimum fruit weight (77.23 g) was recorded in Neelum.

Mannan *et al.* (2003) studied the Physico-chemical characteristics of some mango varieties in the Khulna region. There was significant variation among the mango varieties in relation to fruit size. The highest fruit length (15.53 cm), width (7.23 cm) and depth (6.16 cm) were found in Madrazi Tota followed by Sharmai Fazli (12.31 cm, 5.23 cm and 5.60 cm, respectively). Smaller fruit length (6.33 cm), width (5.30 cm) and depth (4.52 cm) were observed in Indian Lota. Regarding fruit weight, it was found maximum (564.0 g) in Madrazi Tota followed by Sharmai Fazli (427.0 g). The minimum weight was found in Neelambori (160.0 g).

Anila and Radha (2003) conducted research on the Physico-chemical analysis of mango varieties under Kerala conditions and concluded that Ratna had the superiority in terms of fruit measurements such as length, breadth, weight (10.90g, 8.50g and 398.01g, respectively). Next to Ratna (398.0 g), Neelum had the maximum fruit weight (267.3 g). The smaller fruits were produced by H-151. In terms of the length of fruits, all the varieties were more or less equal. In the case of fruit breadth, Ratna was followed by Prior, Neelum and the lower value was noticed in H-151 (5.6 cm).

Singh and Singh (2004) conducted the research on evaluation of mango hybrids and noted that Alfazli fruits were maximum in weight (249.07 g) and it was at par with Sundar Langra (244.11 g), while minimum fruit weight (196.00 g) was recorded in Arka Puneet.

Kumar and Singh (2005) reported that Mallika fruits were maximum in weight (480.00 g) followed by Banglora and Baneshan, while minimum fruit weight (150.00 g) was recorded in Alphonso.

Chanana *et al.* (2005) reported that maximum fruit weight (357.44 g) and size (length 13.09 cm and breadth 7.63 cm) was recorded in cultivar Mallika. While, Alphonso recorded minimum fruit weight (201.67 g/fruit) and size (length 9.33 cm and breadth 6.13 cm).

Chatterjee *et al.* (2005) observed the highest fruit weight in Alfazli but maximum fruit length was measured in Mallika and the highest fruit breadth was seen in Langra.

Pandey *et al.* (2006) conducted research on the identification of superior clones and elite seedlings of mango from Uttar Pradesh and reported that Langra clone V-3 possessed the heaviest (370 g) and largest (12.6 cm length, 7.5 cm diameter) fruits. Dashehari clone K-1 showed superiority over another identified clone with respect to the fruit characteristics by its large size (13.5cm length, 7.0 cm diameter, 300 g weight). Seedlings identified from different places exhibited a wide range of variability. The fruit weight varied from 205.8 g in Chausa seedlings to 299.0 g in Janisahab Karkan collected from Saharanpur. Among the elite seedlings, the maximum length (14.5 cm) and diameter (7.5 cm) of fruits were recorded in Janisahab Karkan.

Shafique *et al.* (2006) conducted an experiment regarding the physiological and chemical composition of different mango cultivars at various maturity levels and found that at mature and ripe stages, the minimum and maximum weights were found in Rani pasand and Fazli varieties, respectively (650.2 g and 150.6 g).

Kundu *et al.* (2009) reported higher fruit weight and fruit size in Durgabhog, Gopibhog, Ashu Gutti and Nababhog mango varieties.

Kanpure *et al.* (2009) reported that Mallika attained maximum fruit weight (302.67 g) over all the varieties. The hybrid Ratna and A.U. Rumani attained minimum fruit weight per fruit, while evaluating mango hybrids with reference to Kymore plateau of Madhya Pradesh.

Serry (2010) Evaluating some mango strains growing under Ismailia conditions concluded that different strains produced higher fruit weight ranging from 440-610 g/fruit. This means that the fruit is in the range of medium to bigger sized fruit. This parameter could be ensured in terms of fruit dimensions in both lengths (10.1-13.2 cm) and width (7.6-9.2 cm).

Majumder *et al.* (2011) studied the Physio-morphology, floral biology and fruit characteristics of mango and observed that the heaviest (365.33 g) and longest (11.50 cm) fruit was recorded in MI 16. The average breadth of different mango germplasm was found to vary from (10.96 to 5.37 cm). The thickest fruit (9.71 cm) was in MI16, whereas MI60 occupied a lower thickness (4.29 cm).

Iqbal *et al.* (2012) conducted research with the objective to evaluate the selected mango cultivars and observed that the highest fruit weight (455.90 g) was in Fazli, which was followed by (374.36 g) in Safed Chuasa. On the other hand, minimum fruit weight (129.57 g) was in Anwar Ritual.

Pleguezuelo *et al.* (2012) conducted an experiment on Physico-chemical quality parameters of mango fruits grown in a Mediterranean subtropical climate (SE Spain). The result revealed that the fruits from cultivar Osteen carried the highest average weight (697 g) and Australian cultivar Kensington had the lowest average weight (171 g), while other cultivars like Tommy Atkins, Palmer, Gleen, Valencia Pride and Irwin were considered as medium-sized weight group averaging (422 g). Maximum fruit length was noted in Osteen (126 mm) followed by Tommy Atkins (114 mm) and lower (80.4 mm) was recorded in Kensington.

Begum *et al.* (2012) conducted a trial on molecular analysis for genetic distinctiveness and relationship of indigenous landraces with a popular cultivar of mango in Andhra Pradesh and found that there was considerable variation in the fruit size (length, width and thickness) and weight. Fruit length varied from (8.00 cm to 14.80 cm). Fruit width ranged from (5.00 cm to 10.50 cm). Fruit weight ranged from (164.00 g to 552.00 g).

Bakshiet *al.* (2013) investigated various mango genotypes on the basis of physico-chemical characteristics under rainfed areas of Jammu. Out of all the fifteen mango genotypes studied, the fruit weight was maximum in Mallika (182.16 g) and lowest in Selection-4 (64.83 g). Maximum fruit length (10.52 cm) and fruit breadth (6.98 cm) were observed in Mallika. Whereas, it was minimum in Selection-1 (5.26 cm and 4.22 cm, respectively).

Okoth *et al.* (2013) evaluated physical attributes at three stages of ripeness (unripe, intermediate and fully ripe) of Apple, Ngowe and Kent mango varieties. The heaviest variety was Ngowe (625 g) at the unripe stage, while Apple had the lowest weight (363.46 g) at the ripe stage.

Mishra *et al.* (2014) evaluated the suitable cultivar for preparation of osmo dehydrated product (Candy) with four pulpy mango cultivars namely Amrapali, Mallika, Dashehari and Chausa. The entire mango cultivars were analyzed for

physico-chemical attributes. It was observed that cultivar Mallika was found best in terms of fruit weight (320.0 g), average fruit length (12.5 cm) and width (2.6 cm).

Naz *et al.* (2014) studied the physiologically fully mature fruits of eight mango cultivars for physical, chemical and sensorial attributes. Among the eight cultivars, Fazli produced the maximum green and ripe fruit weight, fruit length and breadth (453.0 g, 21.57 cm and 13.80 cm), respectively.

### **Fruit volume, specific gravity and firmness**

Shrivastava *et al.* (1987) studied the performance of Fifteen mango varieties collected from various parts of India at Fruit Research Station, Rewa. The results revealed that specific gravity was recorded to the tune of 1.02 to 1.06. Neelum had the highest specific gravity, i.e. 1.06. Varieties like Dashehari, S.B. Chuasa, Mallika, Fernandin, Baneshan and Mulgoa had 1.02, Langra, Fazli, Alphonso, Mankurad, Vanraj, Bangalora and Suvernarekha had 1.03, and Kesar had 1.04 values of specific gravity.

Pal *et al.* (1987) reported that mango cultivar Fazli maximum fruit volume (683.28 g) at the time of maturity.

Anila and Radha (2003) recorded maximum fruit volume in Hybrid Ratna (395.00 ml) with a specific gravity of 1.01 followed by Neelum (265.00 ml) volume and 1.01 specific gravity. Whereas, hybrid-151 possessed lower fruit volume (155.00 ml) and specific gravity (1.0). It was also noted that Alphonso fruit had maximum specific gravity i.e. 1.02.

Zaied *et al.* (2007) found that higher fruit volume (703.00 ml) was shown by Langra fruit followed by (453.33 ml) El Kobbaneia then Dabsha as compared with all other fruits. Meanwhile, the lower fruit volume (256.00 ml) was noted in Khade El Gamel and El Madam Fruits.

Ahmad *et al.* (2011) the experimental apple cultivars were grafted onto an M 9 root stock trained in a V system. All were planted in the winter of 2005 using drip irrigation. Starking highest fruit firmness (13.60 kg/cm<sup>2</sup>)

## Peel and pulp

Shrivastava *et al.* (1987) observed a higher percentage of pulp varying from 69.6 to 71.4 percent was noted in the varieties Mulgoa, Vanraj, Baneshan and Fazli. On the contrary, lower percentages of pulp i.e. from 46.9 to 56.6 percent were noted in the varieties S.B. Chausa, Neelum and Mankurad. Peel percentages were high in Neelum, Bangalora, Kesar, S.B. Chausa and Alphonso. The lower percentages of peel were observed in Langra, Dashehari and Suvernarekha.

Pal *et al.* (1987) observed that mango cultivar Fazli contains pulp percent of 82.83, peel (5.7 %) and pulp/stone ratio of 7.22 at the time of maturity.

Syamal and Mishra (1989) studied the Physico-chemical characteristics of mango varieties in Bihar. They observed maximum pulp weight (925.25 g) in Gulab Khas followed by Fazli (386.56 g) and Paharpur Sindhuria (208.69 g). On the other hand, Mithua, Zardaloo and Sopia contained minimum pulp weight (88.2, 97.22 and 122.38 g, respectively). Whereas, Variety Mithua had minimum peel weight (15.18 g) followed by Zardaloo (16.72 g) and Gulab Khas (18.83 g), similarly maximum peel weight was found in Fazli (58.27 g) followed by Sukul (45.76 g).

Gowda and Ramanjaneya (1994) recorded the least amount of pulp (58%) with the Alphonso variety.

Kalra *et al.* (1994) also reported maximum pulp percent in Mallika (77 %) and minimum in Asodia Deoband (57 %). Maximum peel percent was noted in Bareilly wala (25 %) and minimum in Mallika i.e. 12 %. Amin Khurd, Benazir, Langra Gorakhpur and Nisar Pasand all had 70 percent or above pulp content. Varieties like Anupam, Amin Buland Bagh, Nazuk Badan, Sohrab Sah and Saheb Pasand all had a pulp percentage ranged between of 65 to 67%.

Sharma and Josan (1995) observed that Mallika fruit was maximum (75.29) in pulp percent followed by Langra (72.91 %). Whereas, fruits of Dashehari, Amrapali and Alphonso followed each other in descending order in average pulp content with marginal differences.

Kumar(1998) studied the physico-chemical characteristic of eighty mango varieties under Bhagalpur, Bihar and reported that there was a great variation in pulp

content. Range of 56.7 percent pulp in variety Safeda Malihabad to 85.0 percent pulp in variety Puttu were recorded. Minimum skin percentage (8.9%) was recorded in variety Langra, while minimum stone percentage (4.4) was observed in variety Puttu. Three varieties, namely Dalma, Mandhappa and Puttu contained more than 80.0 percent pulp, while, pulp percent of 24 varieties were in a range of 70.0 to 79.9 % and thus total of 27 varieties may be considered as high pulp containers.

Sarkar *et al.* (2001) reported up to 78.1 percent pulp in mango cultivars.

Hoda *et al.* (2003) reported that Mallika registered maximum pulp content (68.00 %) followed by Dashehari (65.00 %) and Langra (64 %). while, minimum was found in Mulgoa (54 %). As regarding the peel, Neelum attained the highest (22.10 %) followed by Mulgoa and Vanraj. Whereas, minimum peel percent was recorded in Langra (17.13 %) and S. B. Chausa (17.50 %), respectively

Mannan *et al.* (2003) noted that the cultivar Sharmai Fazli fruit has the thickest peel, i.e., 2.89 mm followed by Madrazi Tota (2.63 mm) and Neelambori (2.06 mm), whereas thinnest peel was observed in hybrid Amrapali i.e. 1.84 mm in the study of physico-chemical characteristics of some mango varieties in Khulna region of Bangladesh.

Singh and Singh (2004) evaluated mango hybrids for flowering, fruiting and fruit quality attributes and reported that hybrid Arka Anmol was having maximum peel (23.0 %) followed by Arka Aruna (22.50 %) and Arka Puneet (21.50 %). On the other hand, the cultivars which contained a minimum percent of peel were Langra (18.70) and Bombai (18.90), respectively.

Gowda and Huddar (2004) noted the highest pulp percent in Sundar Langra (67.00 %), Langra (64.50 %) and Alfazli (63.50 %), while minimum pulp percent was noted in Bombai (57.00 %) and Arka Anmol (60.0 %). It was also noted that pulp was higher in Mallika mango as compared to Totapuri.

Kumar and Singh (2005) reported that the pulp percentage was found to be maximum in Mallika (69.00 %) followed by Langra (65.00 %). While, minimum pulp percentage was noted in Bangalora (57.00 %). With regard to peel percent, it was noted minimum in Langra (17.00 %) and maximum (21.00 %) in cultivar Bangalora.

Chatterjee *et al.* (2005) observed maximum pulp percentage (72.91) in Amrapali which was followed by Mallika (71.50 %) and minimum pulp percent was recorded in Ratna (61.79 %) followed by Mahmood Bahar (61.83 %).

Chanana *et al.* (2005) observed that the pulp content was maximum (71.66 %) in Langra followed by Mallika (70.75 %), while it was minimum (64.80 %) in Amrapali.

Kumar *et al.* (2006) studied variability in physico-chemical characteristics of mango genotypes in northern Kerala and observed that the cultivar Chhota Jehangir was having maximum peel weight (75.5 g) followed by Mulgoa (45.0 g) and Hybrid-56 (39.0 g), while, minimum peel weight was noted in cultivars Gomanga, Kalapady and Heralappaa (7, 9.2 and 11.5, respectively).

Kabir *et al.* (2007) recorded 20.95 to 55.06% non-edible portions from 12 mango germplasm.

Kundu *et al.* (2009) observed higher pulp weight in Durgabhog, Gopibhog, Ashu Guti and Nababhog mango varieties.

Serry (2010) concluded that the highest pulp percentage of 78.5% for strain 6, whereas the lowest pulp percentage of 64.5% for strain 7. In general, the strains that have a pulp percentage of more than 70% are desirable for fresh consumption and processing.

Jilani *et al.* (2010) noted maximum peel weight was exhibited by cultivar Fazli (84.99 g) followed by Alphonso (71.33 g) and Sanglakhi (65.28 g). Statistically, similar peel weight was recorded in Langra and Gulab Khas (56.72 and 54.72 g). The lowest peel weight was noted in Anwar Ratual (21.87 g). As regarding pulp weight, cultivar Fazli ranked first (329.63 g) followed by Suvarnarekha (326.20 g). Sanglakhi, Alphonso, Langra and Sinduri also showed good pulp weight. The cultivar Anwar Ratual had the lowest pulp weight due to smaller fruit size. Mango cultivar Suvarnarekha had the highest pulp percentage (92.40) followed by Fazli (79.49 %) and Langra (79.40 %). Other cultivars with a pulp percentage of 61.41 (Gulab-e-Khas) to 77.57 (Dashehari) were statistically at par.

Abourayya *et al.* (2011) observed cv. Keitt had the highest values of pulp percentage of weight followed by cv. Kent. Whereas, cv. Tommy Atkins had the lowest values of pulp percentage of weight. Meanwhile, cv. Tommy Atkins had the highest percentage of peel of weight followed by cv. Kent. While, cv. Keitt had the lowest percentage of peel of weight.

Majumder *et al.* (2011) observed that the percent edible portion (pulp %) varied significantly from 45.22 to 79.83 %. It was found maximum (79.83 %) in MI 09 and lowest (45.22 %) in MI39.

Nour *et al.* (2011) evaluated the physico-chemical characteristics of some Sudanese mango varieties (Abusamaka, Galb Altour and Magloba). It was observed that the highest level of extracted pulp was found in Malgoa (75.48%).

Pleguezuelo *et al.* (2012) reported that the highest pulp: seed ratio was found for cultivar Osteen (20.2), while the lowest ratio for cultivar Kensington (6.3) and Sensation (7.6). In addition, the cultivar Tommy Atkins and Irwin recorded acceptable ratios of 13.1 and 15.9, respectively. Maximum pulp weight (85.9 g) was found in cultivar Gleen followed by in Osteen and Palmer (85.5 and 85.4 g, respectively). While, minimum pulp weight was found in cultivar Sensation i.e. 77.6 g. As regarding the peel weight, it was found minimum in cultivar Gleen (6.30 %) followed by Valencia Pride (6.90 %) and it was reported that the highest peel percent were found in cultivars like Kensington (13.4 %), Sensation (12.0 %) and Tommy Atkins (11.2 %), respectively.

Begum *et al.* (2012) conducted an experiment and found that the percent peel varied from 8.80 to 30.50. The percent pulp varied from 48.30 to 74.40 and the percent stone varied from 8.90 to 22.30.

Singh *et al.* (2012) conducted a survey for evaluation of twenty-eight elite strains for table and sucking purposes on the basis of physical appearance and chemical attributes. Physico-chemical analysis of fruit samples revealed the variability found in the indigenous mango population in various qualitative and quantitative attributes.

Bakshi *et al.* (2013) reported the highest pulp weight (117.15 g) and pulp percentage in Mallika (71.48), while Dashehari showed maximum pulp: stone ratio (3.90). Maximum stone weight (35.60 g) was recorded in Mallika.

Okoth *et al.* (2013) recorded the highest and lowest pulp yield of Apple (75%) and Ngowe (70%), respectively.

Islam *et al.* (2013) conducted an experiment with two popular mango varieties in Bangladesh viz. Langra and Khirshapat at four different levels of Gibberellic acid GA<sub>3</sub> solution, namely, control, 100, 200 and 400 ppm. Data were obtained from various biochemical analyses in terms of physicochemical properties. The Khirshapat showed better performance in achieving higher quantity pulp.

Mishra *et al.* (2014) recorded higher pulp: stone ratio (4.70:1) in Mallika among four pulpy mango cultivars namely, Amrapali, Mallika, Dashehari and Chausa.

Modesto *et al.* (2016) studied the quality characteristics of some mango cultivars (Palmer, Par win, Tommy Atkins and Haden cultivars) and four replications for the physical analyses and six replications for the chemical analyses. The fruits of the Palmer cultivar presented better physical and chemical qualities.

## **Stone**

Shrivastava *et al.* (1987) evaluated the mango varieties in Madhya Pradesh. They reported that out of the 15 mango varieties the highest stone percentage was found in the variety S.B. Chausa, i.e. 29.9% followed by Suvernakha (24.0 %) and Mankurad (23.3 %), whereas minimum stone percent (12.4%) was found in cultivar Vanraj.

Pal *et al.* (1987) observed that mango cultivar Fazli attained a stone weight of (72.56 g) at the time of maturity, while studying the Physico-chemical characteristics of mango varieties of Bihar.

Shyamal and Mishra (1989) observed that maximum stone weight was found in Fazli (61.43 g) followed by Sukul (56.24 g). Whereas, minimum stone weight was found in cultivar Mithua (21.24 g) followed by Zardaloo (28.16 g).

Sharma *et al.* (1993) found maximum stone percentage in Alfazli followed by Sundar Langra.

Haque *et al.* (1993) also recorded ranged between (21.14 to 98.53 g) stone weight in mango fruits.

Kalra *et al.* (1994) reported that maximum stone percent was found in cultivar Asodia Deoband (21%) followed by Gaurjeet and Gulab Khas (20 %). Whereas minimum stone percent (11%) was found in cultivars Bangalora, Benazir and Mallika.

Anila and Radha (2003) conducted research on the physic-chemical analysis of mango varieties under Kerala conditions and concluded that the stone weight ranged from (22.55g to 47.76g) and was maximum in Ratna, but the percentage contribution to fruit weight by stone (12 %) was the minimum in this variety.

Mannan *et al.* (2003) reported that the higher stone length and breadth (13.66 cm and 4.75 cm) was found in the variety Fazli whereas, minimum stone length (5.43 cm), width (3.44 cm) and depth (1.29 cm) was observed in Indian Lota.

Chatterjee *et al.* (2005) observed that the stone percent was maximum (25.40 %) in Alfazli which was followed by Sundar Langra (24.55 %), whereas minimum (14.77 %) in Langra in a study of physico- chemical characteristics of mango hybrids.

Pandey *et al.* (2006) noted that the smaller stone was found in Clone V-1 of Langra which is only 18.3 g followed by Clone V-3 (22.4 g), whereas larger stone was found in Chausa seedling (39.0 g) followed by cultivar Janisahab Karkan (36.3 g) and Dashehari clone K-1 (31.0 g) in an experiment on the identification of superior clones and elite seedlings of mango from Uttar Pradesh.

Kumar *et al.* (2006) studied variability in physico-chemical characteristics of mango genotypes in northern Kerala. The result showed that the smaller stone was found in Ratnagiri Alphonso (19.9 g) followed by Kallu Neelum (20.0 g).

Jilani *et al.* (2010) reported that Fazli and Alphonso excelled in stone weight (48.67g and 47.07 g) with a non-significant difference. Minimum stone weight (22.99 g) was recorded in Dashehari followed by Anwar Ratna (30.98 g).

Abourayya *et al.* (2011) reported that Tommy Atkins had the highest percentage of the seed of weight followed by Kent. While, Keitt had the lowest percentage of the seed of weight, cv. Keitt had the highest seed length, followed by cv. Tommy Atkins while, cv. Kent had the lowest values in the two seasons.

Majumder *et al.* (2011) studied the physio-morphology, floral biology and fruit characteristics of mango and found that MI39 produced the heaviest stone (111.61 g) followed by MI82 (96.11 g) and MI98 (92.07 g). The lightest was observed in MI54 (21.33g). MI16 had the longest stone (12.93 cm.) but MI58 produced the smallest stone (5.34 cm). The widest stone (5.84 cm) was noted in MI 16 and the thinnest stone (1.42 cm) was found in MI01.

Pleguezuelo *et al.* (2012) observed in a study of the physico-chemical characteristics of some mango varieties in Khulna Region of Bangladesh that the seed weight of the fruits of cultivar Osteen proved the lowest (4.2 %) among all the cultivars. On the other hand, the percentage of seed contribution to the total fruit weight for cultivar Tommy Atkins and Irwin were acceptable (6.9 and 5.7%, respectively). cultivar Kensington and Sensation showed the highest percentages of seed to total fruit weight (11.8 and 10.4 %), respectively.

### **Total soluble solids (T.S.S), acidity, and sugars (reducing sugar, non-reducing sugar, total sugars)**

Kalra *et al.* (1981) reported that Chausa (25.5 °Brix) had the higher T.S.S contents followed by Mallika (21.5 °Brix), while the maximum reducing sugar was estimated in Kolanka Goa (6.5 %) among the mango cultivars screened.

Prasad (1984) reported that the maximum reducing sugar content was found 9.97 and 10.10 percent in Alphonso. Non reducing sugar was found maximum 7.44 and 7.47 percent in Unnabi Gola, whereas, the minimum 3.78 and 3.23 percent in Alphonso variety during 1980-81 and 1981-82, respectively. The total soluble solids content was found to be in the range from 15.44 and 15.48 percent (Bhadauran) to 20.55 and 20.66 percent (Mulgoa) during both the years of investigations. The maximum acidity content (0.589 and 0.585 percent) was found in Olour followed by 0.558 and 0.561 percent in Unnabi and Gola, respectively.

Pal *et al.* (1987) observed that 9.53 percent TSS, 0.758 percent acidity and 4.85 and 7.14 percent reducing and non-reducing sugars were obtained at the ripening stage. The fruit quality observed by physical and chemical analysis revealed that the maximum T.S.S (20.9%) was observed in Mallika variety followed by Dashehari (20.2%) and Langra (19.3 %), respectively. T.S.S. namely S. B. Chausa, Alphonso and Mankurad were also higher. The varieties having big-sized fruits, like Vanraj, Mulgoa, Fazli, Baneshan and Bangalora showed lower T.S.S. Similar trends were also observed in the values recorded for total sugars of mango.

Shrivastava *et al.* (1987) reported that Mallika, Dashehari, Langra Mankurad and S.B. Chausa varieties produced the fruits of higher total sugars content.

Salvi and Gunjate (1988) have also reported the T.S.S of Ratna fruits as (23 °Brix), Neelum (17.50 °Brix) and Alphonso (19 °Brix) were recorded.

Syamal and Mishra (1989) found maximum T.S.S (21.79) percent in Langra, which was followed by Bombai (19.52 %). Acidity was recorded minimum in Langra (0.185 %) followed by Mithua (0.286 %), Fazli (0.325 %) and Himsagar (0.326 %). Reducing and non-reducing sugars were recorded to be higher in Langra.

Kulkarni and Haribabu (1991) observed reducing sugar percent varied from 3.26 in Sukul to 5.28 in Langra and non-reducing content varied from 6.28% in Sipia to 11.48% in Langra. Maximum acidity percent was found in Neeleshan and minimum in Amrapali.

Khader and Pal (1992) observed T.S.S in a range of 15.1 to 17.0 °Brix, titrable acidity ranged between 0.14 to 0.22 % and reducing sugar from 2.9 to 3.8 % in mango fruits. In another study of mango varieties for processing, the highest T.S.S (25.2 °Brix) content was observed in Saheb Pasand. However, Amin Kurad, Gaurjeet, Nisar Pasand and Shorab Sah had T.S.S more than 20 °Brix. Acidity was observed to be higher in Benazir Sandila followed by Asodia Deoband (0.58 %). However, lower acidity (0.15) was observed in the fruits of Gulab Khas followed by Anupam (0.19 %).

Bhuyan and Guha(1995) found 16.22 to 24.14 °Brix T.S.S in fourteen mango germplasms under the climatic conditions of Rajasthan.

Sharma and Josan (1995) found that T.S.S was maximum (20.7 %) in Dashehari and minimum (15.2 %) in Alphonso with a significant difference. Acidity was minimum in Dashehari (0.253%) and maximum in Alphonso (0.473%).

Chaudhari *et al.* (1997) observed 2.6 to 7.1 % reducing sugar, 6.20 to 11.50 % non-reducing sugar and 0.14 to 0.59 % acidity in nineteen South Indian mango varieties.

Sardar *et al.* (1998) reported that the total soluble solids (T.S.S) content was found maximum in Langra (21.65<sup>0</sup>Brix) followed by Gopal bhogh (20.6<sup>0</sup>Brix), while Sadawala had the lower (14.3<sup>0</sup>Brix).

Kumar (1998) observed varieties like Anannas, Bharatbhog, Husnarah and Kalapady had shown higher value of T.S.S (26.0<sup>0</sup>Brix). While, Kurukkane, Pahutan, Puttu and Taimurlang had lower T.S.S in the range of 15.0 to 16.0<sup>0</sup>Brix. Though high acidity was recorded in Cluster (0.7148 %), whereas it was minimum in Husnarah and Lucknow Safeda (0.0603 %) But a moderate value of acidity was recorded in varieties like Langra, Bombai, etc. which was found to be about 0.2412 percent.

Mannan *et al.* (2003) reported that total soluble solids (T.S.S) were found to be maximum in Indian Lota (18.02 %) followed by Sharmai Fazli (17.07 %) and it was minimum in Neelambori (17.07 %). The maximum acidity (0.3224 %) was found in Indian Lota followed by Neelambori (0.3015 %) and the minimum acidity (0.2279 %) was found in Sharmai Fazli. Results of the qualitative analysis of the fruits indicated the superiority of Ratna in terms of T.S.S and sugar contents (24<sup>0</sup>Brix and 20.66 %), respectively. In the case of T.S.S, H-151 was almost equal with Ratna, followed by Neelum and Alphonso. The minimum value for TSS (10<sup>0</sup>Brix) was recorded in Muvandan.

Anila and Radha (2003) reported the total and reducing sugar were found to be high in H-151 and Alphonso next to Ratna. Alphonso and Neelum fruits recorded higher acidity values. Whereas, all other varieties were at par with respect to this parameter.

Hoda *et al.* (2003) noted in a study of mango cultivars for quality attributes among the twenty mango cultivars. Dashehari had the maximum percentage of total

soluble solids (21.90 %) and total sugars content (16.08%) followed by Mallika, Langra and Himsagar.

Gowda and Huddar (2004) noted acidity per cent. It was maximum in Mallika (0.33 %) and minimum acidity percent was noted in Alphonso (0.17 %). The total soluble solids were higher in Mallika mango as compared to Totapuri.

Singh and Singh (2004) evaluated mango hybrids for flowering, fruiting and fruit quality attributes. Results showed that the T.S.S. content was found maximum (20.93 %) in Sundar Langra followed by Langra (20.80 %) and Bombai (20.35 %). Arka Anmol recorded the minimum T.S.S. content. Check variety Bombai showed maximum acidity (0.33 %) followed by Langra, while it was found least in Alfazli. Similarly, Sundar Langra had maximum total sugar content (17.59 %) followed by Langra (17.36 %). There was a very marginal difference in sugars content of Arka Anmol, Arka Aruna, Arka Puneet and Alfazli.

Kumar and Singh (2005) evaluated mango genotypes for flowering, fruiting and fruit quality attributes. The results showed that total soluble solids were found maximum (22.90 %) in Mallika followed by Langra, Kesar and Alphonso. Dadamian recorded minimum T.S.S content. Titratable acidity was found to be minimum in Kesar (0.20 %) being at par with Mallika (0.23 %). Bagbahar had maximum titratable acidity (0.89 %) followed by Banglora. However, total sugars were found maximum in Mallika followed by Langra, Bagbahar and Alphonso.

Chanana *et al.* (2005) reported that the highest total soluble solids (20.04 %) were recorded in the fruits of Dashehari which were closely followed by those of Langra, Amrapali and Mallika. Whereas, it was the minimum (17.50 %) in Alphonso. The acid content was lower in Dashehari followed by Langra and maximum in Alphonso. Reducing sugar was the maximum (3.95 %) in Langra, while minimum in Mallika (3.00 %).

Chatterjee *et al.* (2005) observed maximum T.S.S in Amrapali i.e. 25.00 percent and minimum in Neelgoa (18.43 %). Maximum acidity was registered in Neeleshan (0.265 %) and minimum in Prabha Shankar (0.170 %). Reducing sugar was recorded maximum in Sundar Langra i.e. 6.77 percent and minimum (4.15 %) in Mahmood Bahar. Amrapali with non-reducing sugar (13.99 %) was found superior to

all hybrids and check. Maximum total sugars content was recorded in Amrapali i.e. 19.86 percent and Mahmood Bahar showed a minimum (13.93 %) total sugars content.

Uddin *et al.* (2006) conducted an experiment to study the biochemical characterization of different mango germplasm grown in the climatic conditions of Mymensingh. The results revealed that the total soluble solids content of 22 mango germplasms were measured at the ripe stage and it was observed that the variation in T.S.S among different germplasms was highly significant. Chausa contained the higher T.S.S (26.27 %) followed by Langra (25.20 %). The lower total soluble solids (19.73) were recorded in Tommy Atkin. Maximum reducing sugars (7.37 %) was found in Amrapali the lowest content of reducing sugar (2.82 %) was observed in Mixed Special followed by Sindhu (2.88 %). On the other hand, the non-reducing sugar content of the fruit pulp of mango varied from 9.89 to 15.10 %. Amrapali had the higher percentage of non-reducing sugar (15.10 %). Total sugars were observed highest in cultivar Amrapali (20.34 %) and the lower percentage of sugar was recorded from Sinduri (12.71 %).

Shafique *et al.* (2006) studied the physiological and biochemical composition of different mango cultivars at various maturity levels. The results revealed that all the varieties at ripe stages had higher sugar content as compared to immature and mature stages. The maximum sugar/ acid ratio was noted in Khirsapat (162.52 %) followed by Gopal bhog (150.0 %). The higher (48.5 %) acidity was found in cultivar Khir shapat followed by Fazli (43.55 %).

Kumar *et al.* (2006) found that the T.S.S of the three north Kerala mango genotypes ranged between 12.7 and 25.20<sup>0</sup>Brix. Heralappa (25.20<sup>0</sup>Brix) and Kalapady (24.70<sup>0</sup>Brix) were the two top genotypes in this respect. Fruits of Ratnagiri Alphonso showed higher acidity (0.92%) and lower T.S.S (17.2<sup>0</sup>Brix) than the popular variety Alphonso, T.S.S of Alphonso was 21.80<sup>0</sup>Brix.

Pandey *et al.* (2006) reported that Langra clone V-3 possessed T.S.S (18.0 %) and acidity (0.26 %). Dashehari clone K-12 showed good T.S.S. (17.5 %) and low acidity (0.16 %). T.S.S varied from 10.0 in Janisahab Karkan to 18.50 % in Naudah. The lower acidity was measured in Abdullah Great (0.06 %) and the highest in

Janipasand Karkan (0.35 %). The elite seedling Nada possessed good T.S.S (18.5 %) and medium acidity (0.31 %).

Kabir *et al.* (2007) found T.S.S to be in the range of 16.25 and 27.65 °Brix, while studying 12 mango germplasm under Mymensingh conditions.

Rajwana *et al.* (2010) observed higher acidity (1.90 %) in Anwar Ratual followed by Faiz Kareem (1.43 %) and Chausa (0.60 %). The comparable values found in this study ranged between 1.90 and 0.27. The higher value of total sugars was observed in Anwar Ratual (26.45 %) which was statistically at par with Chausa (25.88%). Non reducing sugar remained higher than reducing sugar which were found maximum in cultivar Chausa (23.61 %) and lower (18.07%) in Faiz Kareem. Higher T.S.S. was noted in cultivar Chausa i.e. 26.72°Brix followed by Anwar Ratual (26.47 °Brix).

Serry(2010) reported that acidity ranged from 0.3 to 1.0 % and total sugars ranged from 12 to 14 % while, evaluating different strains of mango.

Jilani *et al.* (2010) found maximum sugar content in fruit of Langra, Maida, Gulab-e- Khas and Anwar Ratual (20%) followed by Dashehari and Suvarnarekha. Alphonso had minimum sugar content (15 %).

Majumder *et al.* (2011) observed that the variation in T.S.S among the germplasm was highly significant. MI28 contained the higher T.S.S (28.26 %) and MI20 contained the lower T.S.S (16.90 %).

Nour *et al.* (2011) reported that Mulgoba variety had higher soluble solids and total sugars (17 °Brix and 11.93%) compared to the lowest soluble solids and total sugars of the variety Busamaka (11°Brix and 10.18%). However, the highest level of the reducing sugar (3.45%) was estimated in Abusamaka variety compared to the lowest value of Gulb Altour variety (2.96%).

Pleguezuelo *et al.* (2012) studied the physico-chemical characteristics of mango fruits grown in a Mediterranean subtropical climate (South Spain) and reported that the higher acidity is being reported for cultivar Valencia Pride, with an average acidity of 0.22. The lower acidities were found for cultivars Kent and Lippins, with 0.04 and 0.06 %, respectively. In relation to the Total Soluble Solids

(T.S.S), the cultivar Lippins showed the higher value among all the cultivars, values ranging from 19.5% for cultivar Osteen to 15.7 % for cultivar Gleen.

Fiyas *et al.* (2012) reported that freshly extracted mango pulp from Sindura and Mallikacultivars contained a significant amount of total soluble solids (19.4<sup>0</sup>Brix and 21.8 <sup>0</sup>Brix),total sugars (11.5 and 11.8 %), reducing sugar (2.7 and 3.5 %) and acidity (0.27 and 0.48 %) respectively.

Islam *et al.* (2013) conducted an experiment with two popular mango varieties in Bangladesh Langra and Khirshapat. Data were obtained from various biochemical analyses in terms of physico-chemical properties. TSS after the 6th day of storage produced more quantities of sugars (total, reducing and non-reducing). The results explored that some physico-chemical properties of TSS and sugars (total, reducing and non - reducing) increased rapidly.

Bakshiet *al.* (2013) found the highest total soluble solids and acidity in Dashehari (20.25 <sup>0</sup>B) and Mallika (0.36 %), respectively. Dashehari showed maximum total sugars (16.63 %) and reduced sugar (5.02 %).

Okoth *et al.* (2013) evaluated the chemical and nutritive quality attributes of Apple, Ngowe and Kent at three stages of ripeness. Total titratable acidity (TTA) decreased with ripeness, whereas total soluble solids (TSS) and TSS/TTA increased with increasing ripeness. The Apple varieties showed superior quality attributes in terms of low TTA of 0.04%, higher TSS of 19.50 <sup>0</sup>Brix at the ripe stage. The Kent varieties scored lowest in TSS (6.50 <sup>0</sup>Brix) at all stages

Naz *et al.* (2014) recorded higher total sugars contents in the pulp of Langra, Samar Behist Chausa and Anwar Ratual (20.67%, 20.43% and 20.33%), respectively. Whereas, 19.83% TSS was recorded in Langra.

Mishra *et al.* (2014) recorded the highest total sugars (18.5%) in Mallika among four pulpy mango cultivars namely, Amrapali, Mallika, Dashehari and Chausa.

Abdelrahmana and Dawoud (2015) evaluated six mango genotypes viz., Wad-Sirare, Sanosyiah, Badr, Bit-Baday, Shabbala and Al-Shareef and Abu-Samaka in terms of some physico-chemical properties. Significant differences were noted among

genotypes in terms of total titratable acidity. Significantly, greater TSS was associated with Sanosyia and Wad-Sirare than the other genotypes.

### **Ascorbic acid and total carotenoids content (expressed as $\beta$ - carotene mg/100g)**

Akinyele and Keshinro (1980) reported that ascorbic acid content makes the mango fruit an excellent source of vitamin C, its content varying from 32 to 200 mg per 100g of edible pulp.

Kalra *et al.* (1981) found Langra fruits were richest in Vitamin C (43.56 mg/100 g).

Syamal and Mishra (1989) studied ten mango varieties for their chemical constituents. ascorbic acid content was noted maximum in the variety Langra (136.25 mg/100 g) followed by Bombai (58.75 mg/100 g) and lower vitamin C was noted in cultivar Mithua (11.84 mg/100 g).

Khader and Pal (1992) observed ascorbic acid content in mango fruits in a range of 17.3 to 45.7 mg/100 g pulp and total carotenoids content in a range of 0.25 to 6.55 mg/100 g.

Shafqat *et al.* (1992) found the maximum vitamin C contents (180.2 mg/100 g) in cultivars Ghulab-e-Khas and Sanglakhi, respectively.

Kalra *et al.* (1994) also observed, while screening north Indian non-commercial mango varieties for processing that vitamin C content was higher in Nisar Pasand (41.6 mg/100g) followed by 30.2 mg/100 g in Gulab Khas, while, in most other cultivars, it was below 20 mg/ 100 g. Nazuk Badan had the lowest total carotenoids of 0.38 mg/100 g followed by Bangalora. On the other hand, Nisar Pasand exhibited a higher content (2.08 mg/100g) of total carotenoids. However, Benazir, Gulab Khas, Gaurjeet, Mallika and Saheb Pasand all had bright pulp colour having carotenoid content of more than 1.0 mg/100g.

Hoda *et al.* (2003) evaluated twenty mango cultivars at Bihar and recorded maximum ascorbic acid content in Dashehari (69 mg/100g) and minimum in

Mankurad. In terms of total carotenoid content, Mallika was on the top (4.95 mg/100 g), whereas, minimum content was observed in Alphonso (2.33 mg/100 g).

Anila and Radha (2003) observed maximum ascorbic content in cultivars H-151 (53.00 mg/100 g) and Ratna (31.30 mg/100 g). Whereas, lower ascorbic acid was found in cultivars Prior and Muvandan (1.23 mg/100g and 1.50 mg/100g), respectively in a study of physico-chemical characteristics of mango under Kerala conditions.

Singh and Singh (2004) noted maximum ascorbic acid in cultivar Sundar Langra (123.50 mg/100g) followed by Langra (115 mg/100g), Bombai (112 mg/100g) and Alfazli (107.32 mg/100g). In terms of total carotenoid content, it was also found maximum in cultivar Sundar Langra (2.98 mg/100g) followed by cultivar Langra (2.91 mg/100g) and Bombai (2.88 mg/100g) respectively.

Kumar and Singh (2005) evaluated mango genotypes for fruit quality attributes. Estimated results showed that Vit-C content was found maximum in cultivar Alphonso i.e. (91.53 mg/100g) followed by Langra (61.00 mg/100g). Whereas, minimum vitamin-C content was obtained in cultivar Dadamian i.e. only (12.40 mg/100g). As regarding the total carotenoid content, it was found maximum in cultivar Mallika (2.98 mg/100g) which was closely followed by Bombai (2.69 mg/100g) and Langra (2.63 mg/100 g).

Shafique *et al.* (2006) observed maximum ascorbic content in Khirsapat fruit(48.5 mg/100g) followed by Fazli (43.5 mg/100g) and Surjapuri (40.8 mg/100g), whereas, Ranipasand contained lower ascorbic acid content (35.0 mg/100g).

Kumar *et al.* (2006) observed variability of ascorbic acid from 9.2 to 164.4 mg. Higher ascorbic acid was found in Heralappa (164.4 mg) followed by Karpuram (139.1 mg), Gomanga (136.9 mg) and Chinnarasam (134.7 mg). While, it was noted lower in Kalluneelum (9.2 mg) followed by Alampur Baneshan (13.3 mg) and Hybrid-56 (21.2 mg).

Uddin *et al.* (2006) observed a highly significant difference among different germplasm in respect of ascorbic acid content. The ascorbic acid content of the fruits of different mango germplasm ranged from 5.32 to 52.14 mg/100 g. Sindhu had the

maximum content of ascorbic acid (52.14 mg/100 g), while the minimum ascorbic acid (5.32 mg/100 g) was recorded in Alphonso.

Pandey *et al.* (2006) reported that Dashehari clone K-1 possessed maximum Vit-C (12.3 mg/100g pulp) followed by Langra clone V-3 (11.2 mg/100g pulp) and Langra clone Y-1 (10.4 mg/100g pulp). Whereas, it was found lower in Abdullah Great (5.7 mg/100g pulp) and 6.8 mg/100g pulp in Dashehari clone K-2 during identification of superior clones and elite seedlings of mango from Uttar Pradesh.

Ribeiro *et al.* (2007) reported that total carotenoid content was found to be 1.91 mg/ 100g in Haden and 2.63mg/100g in Palmer. The total ascorbic acid was reported to be 9.79 mg/100g in Tommy Atkins 77.71 mg/100g.

Zaied *et al.* (2007) evaluated some mango species and noted the maximum vitamin-C content (27.04 mg/100ml juice) in cultivar Dabsha, followed by El-Madam (25.09 mg/100 ml juice) and Khade El-Gamel (22.30 mg/100 ml juice) and lower Vitamin-C content was observed in cultivars Mabrouka and Langra (3.04mg/100 ml juice and 7.04mg/100 ml juice), respectively.

Saleh *et al.* (2009) noted higher Vitamin-C content in El-Madam fruits (27.25 mg/100 mljuice) followed by Ganofia fruits (26.30 mg/100 ml juice) and the lowest amount of Vitamin-C was found in variety Gemela (14.60 mg/100 ml juice) and Zaghloul (16.47 mg/100 ml juice).

Kundu *et al.* (2009)reported satisfactory ascorbic acid content in the varieties Nababhog, Mithua, Durlavbhog, Gopibhog, Gour and Subodh Gutti.

Rajwana *et al.* (2010) estimated maximum vitamin-C content in cultivar Faiz Kareem in a range between 24.33 to 108.0 mg/100 g. Whereas, cultivar Anwar Ratual possessed vitamin-C content in a range of 12 to 82.92 mg/ 100 g and Chausa possessed 17.57 to 65.52 mg/100 g pulp during different stages of ripening. With respect to the total carotenoid content, it was noted in a range between 17.71 to 69.99 pg/100g. Cultivar Chausa reached higher up to 69.99 followed by Anwar Ratual which excelled up to 42.72 mg/100g and Faiz Kareem reached up to 29.24 mg/100g during different stages of ripening in a study of mango hybrids for shelf life and fruit quality.

Serry (2010) reported that vitamin C ranged from 38.7 to 62.7mg/100 ml juice.

Jilani *et al.* (2010) reported the maximum ascorbic acid in the fruit of Gulab-e-Khas (179 mg/100 g), which was closely followed by Sanglakhi (178 mg/100g) and Langra (176 mg/100 g). Whereas, the minimum content of vitamin-C was found in the fruit of Anwar Retual (131 mg/100 g).

Fiyas *et al.* (2012) reported that freshly mango pulp from Sindura and Mallika cultivars contained a significant amount of total carotenoids (7154 and 4801 µg/100 g). The amount of bio accessible beta-carotene was higher in the Mallika(0.89 mg/100 g), followed by Badami (0.79 mg/100 g).

Okoth *et al.* (2013) evaluated the quality attributes of Apple, Ngowe and Kent at three stages of ripeness. Vitamin C decreased with ripeness. Whereas 1-carotene increased with increasing ripeness. The Apple varieties registered the highest vitamin C content of 109.35mg/100g (FW) at the unripe stage. The Kent varieties scored lowest vitamin C content at all stages. Kent variety from Kitui zone also had the lowest content in 1- carotene at their unripe stage.

Mishra *et al.* (2014) recorded the highest beta-carotene (5.3 mg/100g) in Mallika among four pulpy mango cultivars namely, Amrapali, Mallika, Dashehari and Chausa.

## **Organoleptic evaluation**

Bakshiet *al.* (2013) found in organoleptic rating that Dashehari was rated best in terms of color, flavor and taste over all the genotypes.

Okoth *et al.* (2013) evaluated sensory quality at the fully ripe stage of apple, Ngowe and Kent mango varieties and reported the most and least preferred skin fruit colour of Kent and Ngowe varieties with a mean score of  $6.54 \pm 1.5$  and  $5.61 \pm 1.7$ , respectively. The most preferred flesh colour, flavor, taste, texture and overall acceptability were reported in apple variety followed by Ngowe and lastly Kent.

Naz *et al.* (2014) studied on the eight mango cultivars for sensorial attributes. Among the eight cultivars, the sensory attributes varied significantly according to cultivars. Out of eight cultivars, Langra obtained higher scores, while Anwar Ratual

was found to be highly satisfactory followed by Samar Behist Chausa for flavor and taste. Both of these cultivars were equally acceptable for overall acceptability. However, none of the cultivars was rejected by the panelists regarding the sensory evaluation.

Mishra *et al.* (2014) reported Mallika fetched the highest score in the organoleptic test (9.00).

## Materials and Methods

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The present investigation entitled “**Studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes.**” was carried out at the orchards of local farmers’ in the vicinity of Malihabad and Unnao region. For recording observations on various parameters (Physico- biochemical aspects) works were done in laboratory of Horticulture, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow (U.P), India during both the year (2018-2019 and 2019-2020), respectively.

### 3.1 Location of experimental site:

The field experimental was carried out in the orchards of the farmers’ exactly located at malihabad region of Lucknow. It is situated at the latitude of 26.92<sup>0</sup> N and 80.30<sup>0</sup> E with an altitude of 128.87 m from the mean sea level.

### 3.2 Soil characters:

The soil texture of the experimental site was sandy clay loam which is well-drained and well aerated. The soil texture was quite loose suited from the development of the plant root system.

**Table.3.1: Soil characteristics of mango orchards before the inception of the experiment.**

S.NO.	Soil property	Value	Method of Analysis
1.	Soil reaction (ph)1:2.5 soil: water ratio	8.00	Glass electrode ph meter (Jackson,1973)
2.	Available nitrogen (kg/ha)	171.5	Estimated by alkaline permanganate method as described by (Jackson,1973)
3.	Available phosphorus (kg/ha)	12.50	Olsen s method (Olsen S <i>et al</i> ,1954)
4.	Available potassium (kg/ha)	180.9	Flame photometer (Jackson,1973)

### 3.3: Climate and meteorological conditions:

Lucknow is meteorologically characterized as semi and sub-tropical climate. The climate of this region is sub-tropical with maximum temperature ranging from 30<sup>0</sup>-45<sup>0</sup> in summer, the minimum temperature varying from 6<sup>0</sup> to 12<sup>0</sup>c in winter and relative humidity (50-77%) in different seasons of the year. Frost can be expected from the last week of December to the end of February. The annual rainfall ranged from 700 mm to 1000 mm, most of which is received from June to September with some scattered shower in winter brought by the north-east monsoon. The weather parameters which prevailed during the course of the investigation were recorded at the meteorological observation of the IISR, Lucknow.

**Observations on the weather on a weekly recorded during the experimental period of the crop (2018-19 and 2019-20)**

**Table No. 3.2: Meteorological parameters during 2018-19.**

Standard meteorological Week	Period 2018-2019	Temperature (°C)		Relative humidity (%)	Annual Rainfall (mm)
		Max.	Min.		
44	Nov, 01-07	32.0	14.3	67.0	0.0
45	Nov, 08-14	28.5	11.0	64.0	0.0
46	Nov, 15-21	29.1	12.7	63.0	0.0
47	Nov, 22-28	28.1	10.3	64.5	0.0
48	Nov, 29-Dec, 05	26.9	9.8	70.5	0.0
49	Dec, 06-12	25.1	6.7	69.5	0.0
50	Dec, 13-19	23.9	7.0	69.5	0.0
51	Dec, 20-26	23.5	3.4	64.5	0.0
52	Dec, 27-Jan, 02	21.8	2.5	62.0	0.0
1	Jan, 03-09	22.7	4.9	71.0	0.0
2	Jan, 10-16	22.6	5.8	65.0	0.0
3	Jan, 17-23	22.9	4.5	68.0	0.0

4	Jan, 24-30	21.8	10.3	77.5	0.0
5	Jan, 31- Feb, 06	22.3	7.0	69.5	0.0
6	Feb, 07-13	22.5	9.5	77.5	0.0
7	Feb, 14-20	23.6	10.4	73.5	0.0
8	Feb, 21-27	26.4	11.3	67.5	0.0
9	Feb, 28- Mar, 06	23.6	9.5	71.0	0.0
10	Mar, 07-13	27.5	10.9	63.0	0.0
11	Mar, 14-20	30.5	13.1	54.0	0.0
12	Mar, 21-27	32.1	15.0	49.0	0.0
13	Mar, 28- April, 03	34.7	17.0	51.1	0.0
14	April, 04-10	35.6	18.3	54.5	0.0
15	April, 11-17	30.5	13.1	54.0	4.1
16	April,18- 25	32.1	15.0	49.0	5.5
17	April, 26- May,02	34.7	17.0	51.0	3.9
18	May, 3- 9	35.6	18.3	54.5	3.0
19	May,10-16	21.4	48.0	3.2	0.0
20	May,17-23	18.7	49.5	4.7	0.0
21	May,24-30	23.9	39.0	3.1	0.0
22	May,31-June, 06	22.8	38.0	3.9	0.0
23	June,07- 13	25.3	26.0	6.7	0.0
24	June, 14- 20	23.2	37.5	5.1	0.0
25	June,21- 27	24.7	35.5	5.6	0.8
26	June,28-July 04	24.2	44.0	3.7	0.0
27	July,05- 11	25.4	50.5	2.4	2.0
28	July,12- 18	26.6	49.0	5.7	0.0
29	July,19- 25	25.7	61.0	4.6	0.6

**Table No. 3.3: Meteorological parameters during 2019-20.**

Standard meteorological Week	Period 2019-2020	Temperature (°C)		Relative humidity (%)	Annual Rainfall (mm)
		Max.	Min.		
44	Nov, 01-07	30.0	15.2	75.0	0.0
45	Nov, 08-14	29.5	14.9	67.5	0.0
46	Nov, 15-21	29.4	13.0	64.0	0.0
47	Nov, 22-28	27.7	11.9	69.0	0.0
48	Nov, 29-Dec, 05	26.5	12.5	76.0	0.0
49	Dec, 06-12	24.9	8.2	70.0	0.0
50	Dec, 13-19	22.2	10.4	79.5	0.0
51	Dec, 20-26	17.9	7.9	80.0	0.0
52	Dec, 27-Jan, 02	15.2	5.7	79.0	0.0
1	Jan, 03-09	20.4	8.3	75.3	0.0
2	Jan, 10-16	17.7	7.1	84.5	4.6
3	Jan, 17-23	17.7	10.2	93.1	12.2
4	Jan, 24-30	20.8	6.6	71.3	67.8
5	Jan, 31- Feb, 06	22.3	7.2	71.2	0.0
6	Feb, 07-13	22.9	5.3	65.2	0.0
7	Feb, 14-20	25.6	9.5	62.1	0.0
8	Feb, 21-27	26.5	12.1	75.5	9.2
9	Feb, 28- Mar, 05	26.7	12.7	73.6	0.2
10	Mar, 06-12	26.3	13.2	72.1	24.8
11	Mar, 13-19	27.0	14.0	73.6	18.0
12	Mar, 20-26	31.2	16.5	62.3	0.0
13	Mar, 27- April, 02	31.8	18.1	55.1	4.8
14	April, 03-09	35.2	17.6	44.3	0.0
19	May, 10-16	36.8	21.1	54.7	2.6

20	May, 17-23	33.9	20.8	65.9	2.1
21	May, 24-30	33.8	20.8	66.5	2.3
22	May, 31-June, 06	34.5	21.5	63.6	2.2
23	June, 07- 13	39.8	23.4	41.3	3.5
24	June, 14- 20	41.5	24.7	48.7	2.6
25	June, 21- 27	35.3	24.0	68.6	3.1
26	June, 28-July 04	33.7	24.2	71.3	2.2
27	July, 05- 11	37.0	26.4	73.3	2.0
28	July, 12- 18	33.6	26.3	80.6	2.0
29	July, 19- 25	33.6	25.3	83.6	2.7

**Source: ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow, (UP).**

### **3.4: Experimental materials:**

The experiment was conducted using thirty distinct mango genotypes for two consecutive years (2018-2019 and 2019-2020). The trees were 22 to 24 years old and maintained at Farmers' orchards of malihabad and Unnao region. These genotypes were maintained following uniform cultural practices to ensure yield of quality fruits. Three representative, healthy and uniform fruit of each genotype were selected for study. Standard method and procedures were followed for recording various physical and biochemical attributes.

# 1. A general view of mango orchards.



### Location of orchards:

Owner of the orchard	Location of experimental materials	Experimental materials
Sunder Lal	Lucknow (Malihabad)	Dashehari, Zardalu, Rangila, Jauhari, Khasam-Khas, Shahtuki, MBL-2, MBL-3
Shyam Sunder	Lucknow (Malihabad)	Lucknow Safeda, Tukumi, Fazli, Neelum, MBL-6, MBL-7, MBL-8
Anand Gupta	Lucknow (Malihabad)	Amrapali, Nayab, Green Sweet Langra, Hushnara, Taimurya, Desi-Amin, MBL-4, MBL-5
Sudheer Kumar	Unnao (Safipur)	Ramkela, Chausa, Makhan, Bombay Green, Desi-Sipia, Sultan

### 3.5: Experimental design:

The experiment was laid out in Completely Randomized Design (CRD). Three fruits of each genotype were randomly selected and collected from 30 genotypes for physical and biochemical studies.

Design : Completely Randomized Design (CRD)

Treatments : Thirty

Replication : Three

Unit of fruits : One

### 3.6: Treatments details:

The experiment consisted of thirty treatments which are as follows with their symbols:

<b>S.NO.</b>	<b>Treatments/Genotypes</b>	<b>Symbol</b>
1.	<b>Amrapali</b>	<b>T<sub>1</sub></b>
2.	<b>Nayab</b>	<b>T<sub>2</sub></b>
3.	<b>Bombay Green</b>	<b>T<sub>3</sub></b>
4.	<b>Makhan</b>	<b>T<sub>4</sub></b>
5.	<b>Green Sweet</b>	<b>T<sub>5</sub></b>
6.	<b>Langra</b>	<b>T<sub>6</sub></b>
7.	<b>Hushnara</b>	<b>T<sub>7</sub></b>
8.	<b>Desi-Sipia</b>	<b>T<sub>8</sub></b>
9.	<b>Sultan</b>	<b>T<sub>9</sub></b>
10.	<b>Dashehari</b>	<b>T<sub>10</sub></b>
11.	<b>Zardalu</b>	<b>T<sub>11</sub></b>
12.	<b>Taimuriaya</b>	<b>T<sub>12</sub></b>
13.	<b>Desi – Amin</b>	<b>T<sub>13</sub></b>
14.	<b>Chausa</b>	<b>T<sub>14</sub></b>
15.	<b>Lucknow Safeda</b>	<b>T<sub>15</sub></b>
16.	<b>Tukumi</b>	<b>T<sub>16</sub></b>
17.	<b>Fazli</b>	<b>T<sub>17</sub></b>
18.	<b>Ramkela</b>	<b>T<sub>18</sub></b>
19.	<b>Neelum</b>	<b>T<sub>19</sub></b>
20.	<b>Shahtuki</b>	<b>T<sub>20</sub></b>
21.	<b>Khasam-Khas</b>	<b>T<sub>21</sub></b>
22.	<b>Jauhari</b>	<b>T<sub>22</sub></b>
23.	<b>Rangila</b>	<b>T<sub>23</sub></b>
24.	<b>MBL-2 (Malihabad Local)</b>	<b>T<sub>24</sub></b>
25.	<b>MBL-3</b>	<b>T<sub>25</sub></b>
26.	<b>MBL-4</b>	<b>T<sub>26</sub></b>
27.	<b>MBL-5</b>	<b>T<sub>27</sub></b>
28.	<b>MBL-6</b>	<b>T<sub>28</sub></b>
29.	<b>MBL-7</b>	<b>T<sub>29</sub></b>
30.	<b>MBL-8</b>	<b>T<sub>30</sub></b>

### **3.7: Observations were recorded:**

#### **3.7.1: Morphological characters:**

##### **Fruit characters:**

##### **3.7.1.1: Fruit colour (skin/rind) and shape:**

The fruits of the different genotypes having attractive, natural fully developed colour, freshness and naturally shape were given higher marks.

##### **3.7.1.2: Fruit weight (g):**

Each fruit was weighed with the help of electric balance separately and the sum was averaged for computing the mean fresh fruit weight in gram.

##### **3.7.1.3: Fruit length and breadth (cm):**

The length and width of three fruits from each genotype were measured with the help of Vernier Callipers and expressed in centimeter

##### **3.7.1.4: Volume of fruit (ml):**

The data on the fruit volume was recorded by water displacement method. Average fruit volume was expressed in terms of ml.

##### **3.7.1.5: Specific gravity:**

The specific gravity was determined by fruit weight dividing by fruit volume using following formula:

$$\text{Specific gravity} = \frac{\text{Weight of fruit}}{\text{Volume of fruit}}$$

##### **3.7.1.6: Fruit firmness:**

The fruit firmness of three fruits from each genotype were measured with the help of Penetrometer and expressed in kg/cm<sup>2</sup>.

## **Peel characters:**

### **3.7.1.6: Thickness of the peel (mm):**

It was measured with the help of Vernier Callipers after removing it from fruit and expressed in (mm)

### **3.7.1.8: Peel weight (g):**

It was calculated by taking the weight of peel on an electronic weighing balance after removing it from fruit and expressed in gram (g).

### **3.7.1.8: Peel percentage:**

The skin of fruit obtained after peeling was weighed on an electronic balance and the percentage was calculated with the following formula.

$$\text{Peel(\%)} = \frac{\text{Weight of peel}}{\text{Weight of fruit}} \times 100$$

## **Stone characters:**

### **3.7.1.9: Stone shape, body and marking:**

The stone of the different genotypes having natural fully developed, shape and different marking on the surface were given higher marks.

### **3.7.1.10: Stone length (cm):**

After separating the pulp and peel of the fruits, the stone of these fruits was used to measure the length with the help of a Vernier Callipers and average value of length of stone was worked out.

### **3.7.11: Stone breadth (cm):**

After separating the pulp and peel of the fruits, the stone of these fruits was used to measure the breadth with the help of a Verniers Callipers and an average value of the length of stone was worked out.

### **3.7.12: Stone thickness (cm):**

After separating the pulp and peel of the fruits, the stone of these fruits was used to measure the stone thickness with the help of a Verniers Callipers and average value of the length of stone was worked out.

### **3.7.13: Stone weight (g):**

Each fruit stone was weighed with the help of electric balance separately and the sum was averaged for computing the mean fruit stone weight.

### **3.7.2: Bio-chemical parameters:**

#### **3.7.2.1: Total soluble solids (TSS °Brix):**

The total soluble solids of the crushed fruit sample and extracted juice were determined by using a digital hand refract meter () of (0-32°Brix) range. The value was corrected at 20 °C and expressed as percent TSS of mango fruits (Ranganna, 2010).

#### **3.7.2.2: Acidity (%):**

Known quantity of the fruit pulp (5g) was mixed with small amount of distilled water and filtered through muslin cloth. Then requisite volume was made up to 100 ml. Five ml aliquot was taken for titration against 0.1 N sodium hydroxide (Noah) solution using 1-2 drops phenolphthalein as indicator. The results were calculated using following formula and expressed as per cent acid per 100 g fruit (Ranganna, 2010).

$$\text{Acidity} = \frac{\text{Titrate value} \times \text{normality of alkali} \times 64 \times \text{volume made up}}{\text{Aliquot taken} \times \text{volume of sample} \times 1000} \times 100$$

#### **3.7.2.3: Ascorbic acid (mg/100gm pulp):**

For determining the ascorbic acid, 5 gm fruit sample was crushed in pestle and mortar with 3 per cent metaphosphoric acid and filtered through muslin cloth in 50 ml volumetric flask. Then volume was made up of 50 ml with 3% HPO<sub>3</sub> (metaphosphoric acid) solution. Then 5 ml aliquot was titrated against 2, 6-dichloro-phenol-indophenol

dye solution (Ranganna, 2010). The end point was marked by appearance of light pink colour, which persisted at least for 15 seconds. The ascorbic acid content was expressed mg/100g solid and calculated with help of following formula:

$$\text{Dye factor} = \frac{5}{\text{Titrate volume of standard ascorbic acid}}$$

$$\text{Ascorbic acid} = \frac{\text{Titrate value} \times 100 \text{ factor} \times \text{volume made up} \times 100}{\text{Aliquot of extract taken for estimation} \times \text{volume of sample taken for estimation}}$$

### 3.7.2.4 Total invert sugar (%):

Out of 100 ml sample prepared for reducing sugar analysis, 5 ml aliquot was taken and mixed with 3 drops HCl and kept for overnight. Next day 2-3 drops phenolphthalein indicator was added and neutralized with 30 per cent sodium hydroxide solution there after adding 5 ml of each Fehling's solution 'A' and 'B' to the neutralized aliquot the mixture was titrated against 1.0% glucose (Dextrose) in boiling stage using methylene blue as indicator. The appearance of light brick colour was marked as the end point. The result was calculated and expressed as per cent total invert sugars.

$$\text{Total invert sugars} = \frac{\text{Blank titrate value} - \text{aliquot value} \times \text{volume made up}}{\text{Aliquot taken for estimation} \times \text{weight of sample}} \times 100$$

### 3.7.2.5 Reducing sugar (%):

5gram fruits sample was taken and crushed with small amount of distilled water. Then requisite volume were made up 100 ml with distilled water. 5 ml aliquot was taken into separate conical flask and 5 ml of each Fehling's solution, A, and B were mixed with aliquot. There after mixture was heated and titrated against 1 per cent glucose (Dextrose) to the end point of brick colour appearance. A blank sample was also titrated against 1 % glucose (Dextrose). The calculation for reducing sugar was done and result expressed as per cent of reducing sugar.

$$\text{Reducing sugar} = \frac{\text{Blank titrate value} - \text{aliquot value} \times \text{volume made up}}{\text{Aliquot taken for estimation} \times \text{weight of sample}} \times 100$$

### **3.7.2.6: Non-reducing sugar (%):**

Non-reducing sugar was calculated by deducting the quantity of reducing sugar from total invert sugars and multiplied by factors 0.95. The results were expressed as per cent of non-reducing sugar.

$$\text{Non-reducing sugar (\%)} = [\text{Total invert sugars (\%)} - \text{reducing sugar (\%)}] \times 0.9$$

### **3.7.2.7: Total sugars (%):**

Sum of reducing sugar and non-reducing sugar expressed in as total sugar.

$$\text{Total sugar} = \text{reducing sugar} + \text{non reducing sugar}$$

### **3.7.2.8: Total carotenoids content (mg/100g):**

One gram of sample was weighed and ground with acetone using acid and alkali-washed sand in a pestle and mortar. The extract was decanted into a conical flash. The extraction was continued till the residue was colorless. The acetone extract was transferred to a separating funnel containing 10-15 ml of petroleum ether and mixed gently. About 25 ml of 5% sodium sulphate solution was added. It was shaken and kept for sometimes and yellow colour pigment was transferred into the petroleum ether later. The layer was collected in a volumetric flask and acetone layer was separated containing 5% sodium sulphate. 15 ml petroleum ether was added to the acetone layer containing  $\text{Na}_2\text{SO}_4$  until the colour got transferred into the petroleum ether. The colour intensity was measured at 452 nm in a spectrophotometer. The total carotenoids content was calculated using the following formula:

### **3.7.3: Organoleptic evaluation:**

To assess the consumers acceptability organoleptic studies were conducted by score card system with a panel of five judges. The observations were conducted when the 75 percent fruits ripened. The sample were selected randomly and evaluated for their sensory characteristics such as and general appearance using a semi- trained panel consisting of 5 judges. The judges were requested to record their degree of liking and disliking on a sensory score card using 9- point hedonic scale ranging from 1 to 9, which represents from like extremely to dislike extremely.

The sample with score below 5.0 for any sensory attribute were rejected.

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

### 3.8: Statistical analysis:

Data recorded on various respect to parameters with three replications were subjected to statistical analysis (**Panse and Sukhatme, 1985**).

#### Analysis of variance:

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments					
Error					
Total					

The standard error (SE<sub>m±</sub>) for the difference of treatment means were computed as follows.

$$S.E.m_{\pm} = \sqrt{\frac{MSE}{r}}$$

Where,

MSE = Mean sum of squares due to error

r = Number of replications

The calculation of C.D. at 0.5% at table values will be carried out with help of following formula: -

$$CD = SE_{m\pm} \times \sqrt{2} \times \text{Table value at 5\%}$$

Where,

CD = Critical Difference

SE<sub>m±</sub> = Standard Error of Mean

## Experimental Findings

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The present investigation entitled “**Studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes**” was carried out in the orchards of malihabad regions of farmers’ in Lucknow. The Physico and biochemical works was done in laboratory of Horticulture, Department of Horticulture, School of Agriculture Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.), India during both the year (2018-19 and 2019-20), respectively. The observations on morphological and biochemical characteristics of different genotypes of mango fruit were analysed statistically and presented in this chapter under following headings. Each character of mango was described in light of data presented in tables and graphically illustrated.

### 4.1: Morphological characters:

#### Fruit characters:

##### 4.1.1: Fruit colour:

The data with respect to fruit colour under different genotypes are given in Table 4.1.

**Table 4.1: Fruit colour of different mango genotypes.**

Treatments	Genotypes	Fruit colour
T-1	Amrapali	Deep orange- yellow
T-2	Nayab	Greenish red
T-3	Bombay Green	Apple green
T-4	Makhan	Row sienna
T-5	Green Sweet	Greenish

<b>T-6</b>	<b>Langra</b>	Lime green
<b>T-7</b>	<b>Hushnara</b>	Blood red
<b>T-8</b>	<b>Desi-Sipia</b>	Lemon green with amber yellow on exposed surface
<b>T-9</b>	<b>Sultan</b>	Lemon yellow
<b>T-10</b>	<b>Dashehari</b>	Canary yellow, on keeping change to raw sienna
<b>T-11</b>	<b>Zardalu</b>	Succinum to crem yellow
<b>T-12</b>	<b>Taimurya</b>	Lemon yellow
<b>T-13</b>	<b>Desi – Amin</b>	Greenish
<b>T-14</b>	<b>Chausa</b>	Golden-yellow colour
<b>T-15</b>	<b>Lucknow Safeda</b>	Raw sienna
<b>T-16</b>	<b>Tukumi</b>	Greenish to light yellow
<b>T-17</b>	<b>Fazli</b>	Green colour
<b>T-18</b>	<b>Ramkela</b>	Lime green with lemon yellow extending downward
<b>T-19</b>	<b>Neelum</b>	Sea green
<b>T-20</b>	<b>Shahtuki</b>	Yellow cadmium
<b>T-21</b>	<b>Khasam-Khas</b>	Yellow, turning brown later on
<b>T-22</b>	<b>Jauhari</b>	Raw sienna
<b>T-23</b>	<b>Rangila</b>	Canary yellow
<b>T-24</b>	<b>MBL-2</b>	Greenish yellow
<b>T-25</b>	<b>MBL-3</b>	Yellowish
<b>T-26</b>	<b>MBL-4</b>	Greenish
<b>T-27</b>	<b>MBL-5</b>	Sea green
<b>T-28</b>	<b>MBL-6</b>	Leman green
<b>T-29</b>	<b>MBL-7</b>	Light green turning yellow
<b>T-30</b>	<b>MBL-8</b>	Lime green

## 2. A general view of different genotypes of mango fruits.



#### 4.1.2: Fruit shape:

The data with respect to fruit shape under different genotypes are given in Table 4.2.

**Table 4.2: Fruit shape of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Fruit shape</b>
T-1	Amrapali	Ovate oblique
T-2	Nayab	Oblong
T-3	Bombay Green	Oval
T-4	Makhan	Almost oval
T-5	Green Sweet	Almost oblong
T-6	Langra	Oblong
T-7	Hushnara	Oblong
T-8	Desi-Sipia	Almost oval
T-9	Sultan	Roundish
T-10	Dashehari	Oblong to elliptical
T-11	Zardalu	Oblongish oval
T-12	Taimurya	Ovalis oblong
T-13	Desi – Amin	Medium elliptic
T-14	Chausa	Medium oblong
T-15	Lucknow Safeda	Reniform
T-16	Tukumi	Oblong slightly oblique at the apical end
T-17	Fazli	Ovalis long
T-18	Ramkela	Roundish
T-19	Neelum	Oblong with raised beak
T-20	Shahtuki	Almost oblique
T-21	Khasam-Khas	Irregular
T-22	Jauhari	Uniform
T-23	Rangila	Reniform
T-24	MBL-2	Oblong to elliptical
T-25	MBL-3	Oblique long
T-26	MBL-4	Roundish
T-27	MBL-5	Ovalis long
T-28	MBL-6	Ovalis
T-29	MBL-7	Oblong
T-30	MBL-8	Oblique long

**3. A general view of fruit length (cm) and fruit breadth (cm) of mango is being measured in laboratory.**



### 4.1.3: Length of fruit (cm):

The data concerning to length of fruit under different genotypes for both the year are presented in Table 4.3 and shown graphically in Fig. 4.1 respectively.

During 2018-19, significant difference in fruit length was observed in Fazli which fruits had maximum length (12.33 cm) followed by Chausa (10.80 cm) and Langra (10.77 cm). The minimum fruit length (5.98 cm) was observed in genotype MBL-6.

Further during 2019-20, significant difference in fruit length was observed Fazli was at the top having the length (13.15 cm) followed by Chausa (11.17 cm) and Langra (10.83 cm). While, minimum fruit length (5.25 cm) was observed in genotype MBL-6.

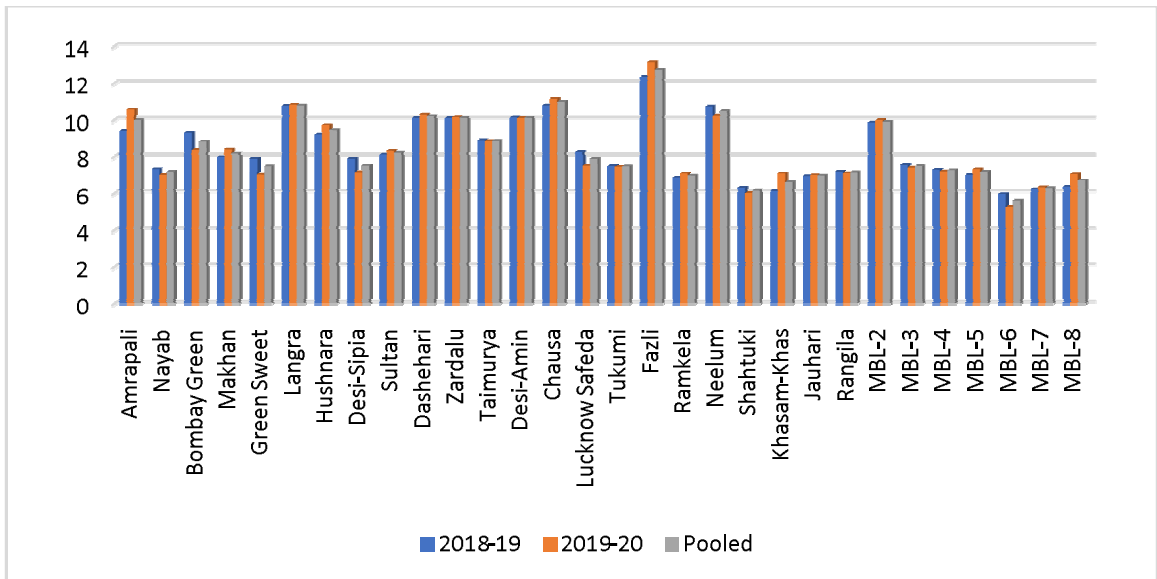
After critical analysis of pooled data, it was found that significant differences occurred among the genotypes under trial. It clearly indicates that maximum fruit length (12.74 cm) was found in Fazli followed by Chausa (10.98 cm) and Langra (10.80 cm). The lowest fruit length (5.61 cm) was observed in genotype MBL-6.

**Table 4.3. Fruit length (cm) of different mango genotypes.**

		<b>Fruit length (cm)</b>		
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	9.41	10.57	9.99
<b>T-2</b>	<b>Nayab</b>	7.33	7.03	7.18
<b>T-3</b>	<b>Bombay Green</b>	9.30	8.36	8.83
<b>T-4</b>	<b>Makhan</b>	7.99	8.40	8.19
<b>T-5</b>	<b>Green Sweet</b>	7.90	7.04	7.47
<b>T-6</b>	<b>Langra</b>	10.77	10.83	10.80
<b>T-7</b>	<b>Hushnara</b>	9.20	9.73	9.46
<b>T-8</b>	<b>Desi-Sipia</b>	7.89	7.15	7.52
<b>T-9</b>	<b>Sultan</b>	8.12	8.32	8.22
<b>T-10</b>	<b>Dashehari</b>	10.13	10.31	10.22

<b>T-11</b>	<b>Zardalu</b>	10.11	10.16	10.13
<b>T-12</b>	<b>Taimurya</b>	8.89	8.86	8.87
<b>T-13</b>	<b>Desi – Amin</b>	10.15	10.11	10.13
<b>T-14</b>	<b>Chausa</b>	10.80	11.17	10.98
<b>T-15</b>	<b>Lucknow Safeda</b>	8.25	7.52	7.88
<b>T-16</b>	<b>Tukumi</b>	7.50	7.45	7.47
<b>T-17</b>	<b>Fazli</b>	12.33	13.15	12.74
<b>T-18</b>	<b>Ramkela</b>	6.86	7.09	6.97
<b>T-19</b>	<b>Neelum</b>	10.73	10.24	10.48
<b>T-20</b>	<b>Shahtuki</b>	6.33	6.02	6.17
<b>T-21</b>	<b>Khasam-Khas</b>	6.16	7.09	6.62
<b>T-22</b>	<b>Jauhari</b>	6.95	6.99	6.97
<b>T-23</b>	<b>Rangila</b>	7.19	7.11	7.15
<b>T-24</b>	<b>MBL-2</b>	9.86	9.99	9.92
<b>T-25</b>	<b>MBL-3</b>	7.55	7.42	7.48
<b>T-26</b>	<b>MBL-4</b>	7.31	7.21	7.26
<b>T-27</b>	<b>MBL-5</b>	7.02	7.33	7.17
<b>T-28</b>	<b>MBL-6</b>	5.98	5.25	5.61
<b>T-29</b>	<b>MBL-7</b>	6.24	6.35	6.29
<b>T-30</b>	<b>MBL-8</b>	6.37	7.06	6.71
<b>SEm±</b>		0.274	0.223	0.248
<b>C.D. at 5%</b>		0.776	0.633	0.704

**Figure 4.1. Fruit length (cm) of different mango genotypes.**



#### 4.1.4: Fruit breadth (cm)

The data concerning to breath of fruit under different genotypes for both the year are presented in Table 4.4 and shown graphically in Fig. 4.2.

During 2018-19, significant difference in fruit breadth was observed in genotype Fazli fruits that had maximum breadth (8.31cm) followed by Langra (7.52 cm) and Chausa (7.29 cm). The minimum fruit breadth (4.13 cm) was observed in genotype MBL-6.

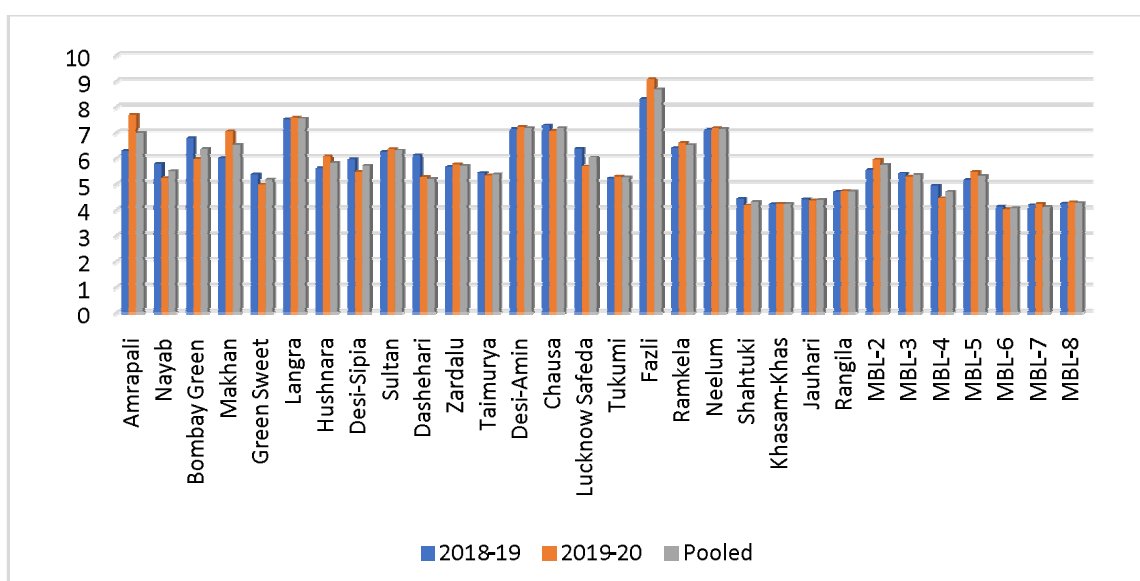
During 2019-20, also significant difference in fruit breadth was observed genotypes Fazli was at the top having (9.07 cm) breadth followed by Langra (7.59 cm) and Chausa (7.07 cm), respectively. While, minimum fruit breadth (4.02 cm) was observed in genotype MBL-6.

After critical analysis of pooled data, it was found that significant difference occurred among the different genotypes study in obvious from the data under trial that maximum fruit breadth (8.69 cm) was found in genotype Fazli followed by Langra (7.55 cm) and Chuasa (7.18cm). The lowest fruit breadth (4.07 cm) was observed in genotype MBL-6.

**Table 4.4. Fruit breadth(cm) of different mango genotypes.**

<b>Fruit breadth (cm)</b>				
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	6.29	7.70	6.99
<b>T-2</b>	<b>Nayab</b>	5.79	5.24	5.51
<b>T-3</b>	<b>Bombay Green</b>	6.78	5.97	6.37
<b>T-4</b>	<b>Makhan</b>	6.01	7.05	6.53
<b>T-5</b>	<b>Green Sweet</b>	5.38	4.98	5.18
<b>T-6</b>	<b>Langra</b>	7.52	7.59	7.55
<b>T-7</b>	<b>Hushnara</b>	5.61	6.08	5.84
<b>T-8</b>	<b>Desi-Sipia</b>	5.96	5.49	5.72
<b>T-9</b>	<b>Sultan</b>	6.26	6.36	6.31
<b>T-10</b>	<b>Dashehari</b>	6.13	5.27	5.20
<b>T-11</b>	<b>Zardalu</b>	5.67	5.78	5.72
<b>T-12</b>	<b>Taimurya</b>	5.44	5.33	5.38
<b>T-13</b>	<b>Desi – Amin</b>	7.15	7.22	7.18
<b>T-14</b>	<b>Chausa</b>	7.29	7.07	7.18
<b>T-15</b>	<b>Lucknow Safeda</b>	6.39	5.70	6.04
<b>T-16</b>	<b>Tukumi</b>	5.23	5.30	5.26
<b>T-17</b>	<b>Fazli</b>	8.31	9.07	8.69
<b>T-18</b>	<b>Ramkela</b>	6.41	6.61	6.51
<b>T-19</b>	<b>Neelum</b>	7.12	7.18	7.15
<b>T-20</b>	<b>Shahtuki</b>	4.43	4.18	4.30
<b>T-21</b>	<b>Khasam-Khas</b>	4.22	4.25	4.23
<b>T-22</b>	<b>Jauhari</b>	4.41	4.36	4.38
<b>T-23</b>	<b>Rangila</b>	4.70	4.72	4.71
<b>T-24</b>	<b>MBL-2</b>	5.56	5.95	5.75
<b>T-25</b>	<b>MBL-3</b>	5.42	5.30	5.36
<b>T-26</b>	<b>MBL-4</b>	4.95	4.46	4.70
<b>T-27</b>	<b>MBL-5</b>	5.17	5.48	5.32
<b>T-28</b>	<b>MBL-6</b>	4.13	4.02	4.07
<b>T-29</b>	<b>MBL-7</b>	4.19	4.25	4.10
<b>T-30</b>	<b>MBL-8</b>	4.26	4.29	4.27
<b>SEm±</b>		0.171	0.201	0.186
<b>C.D. at 5%</b>		0.486	0.571	0.523

**Figure 4.2: Fruit breadth of different mango genotypes.**



#### 4.1.5: Fruit Weight (g):

The data with respect to fruit weight under different genotypes are given in Table 4.5 and represented pictorially in Fig. 4.3.

A careful scrutiny of the data during the year 2018-19, indicates that there was significant variation in fruit weight among different genotypes. The highest fruit weight (496.68 g) was obtained in genotype Fazli. However, Fazli found outstanding being significantly superior to remaining genotypes followed by Langra (326.96 g) and Chausa (304.54g). The minimum fruit weight (162.04 g) was noted in genotype MBL-6.

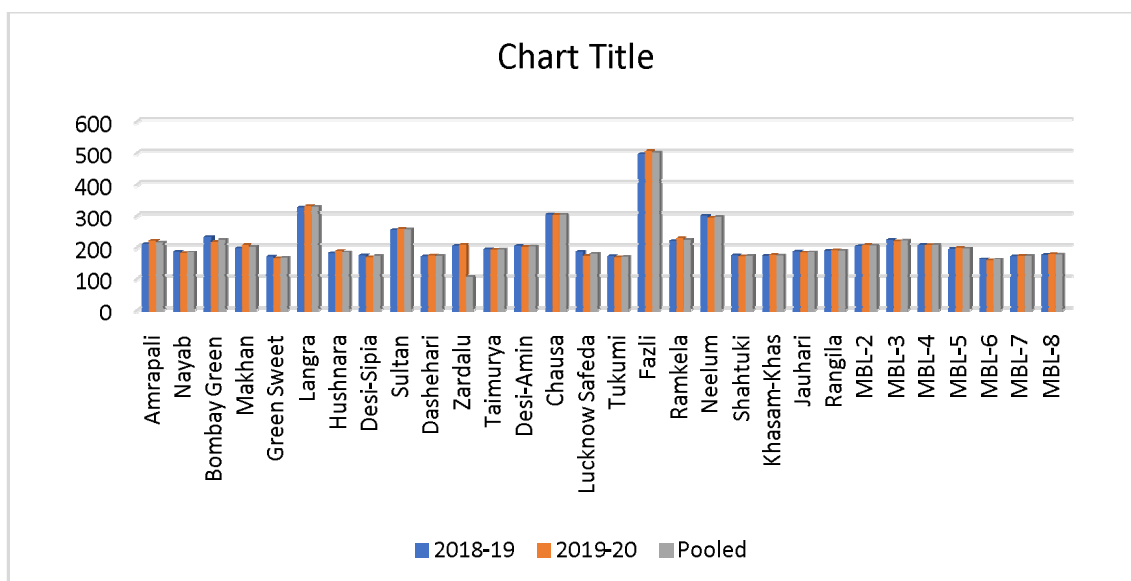
During the year 2019-20, there was also significant difference in fruit weight. Here also the maximum fruit weight was recorded in genotype Fazli (506 g) followed by Langra (329.72 g) and Chausa (302.91 g). The minimum fruit weight (158.52 g) was noted in genotype MBL-6.

The perusal of pooled data reflected that genotype Fazli produced heaviest fruits (501.56 g) and followed by Langra (328.34 g) and Chausa (303.72 g). While, minimum fruit weight (159.28 g) was observed in genotype MBL-6.

**Table 4.5. Fruit weight (g) of different mango genotypes.**

<b>Fruit weight (g)</b>				
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	209.67	220.40	215.03
<b>T-2</b>	<b>Nayab</b>	185.96	181.24	183.60
<b>T-3</b>	<b>Bombay Green</b>	232.30	216.07	224.18
<b>T-4</b>	<b>Makhan</b>	196.94	206.20	201.57
<b>T-5</b>	<b>Green sweet</b>	170.23	164.44	167.33
<b>T-6</b>	<b>Langra</b>	326.96	329.72	328.34
<b>T-7</b>	<b>Hushnara</b>	180.68	187.54	184.31
<b>T-8</b>	<b>Desi-Sipia</b>	174.37	168.66	171.51
<b>T-9</b>	<b>Sultan</b>	254.40	257.14	255.77
<b>T-10</b>	<b>Dashehari</b>	170.36	174.17	172.26
<b>T-11</b>	<b>Zardalu</b>	204.04	208.12	106.08
<b>T-12</b>	<b>Taimurya</b>	192.98	191.86	192.42
<b>T-13</b>	<b>Desi – Amin</b>	203.99	201.52	202.75
<b>T-14</b>	<b>Chausa</b>	304.54	302.91	303.72
<b>T-15</b>	<b>Lucknow safeda</b>	185.96	173.05	179.50
<b>T-16</b>	<b>Tukumi</b>	170.89	168.41	169.65
<b>T-17</b>	<b>Fazli</b>	496.68	506.45	501.56
<b>T-18</b>	<b>Ramkela</b>	219.81	227.94	223.86
<b>T-19</b>	<b>Neelum</b>	299.85	293.49	296.67
<b>T-20</b>	<b>Shahtuki</b>	174.42	170.53	172.47
<b>T-21</b>	<b>Khasam-Khas</b>	172.84	175.40	174.12
<b>T-22</b>	<b>Jauhari</b>	186.22	182.52	184.37
<b>T-23</b>	<b>Rangila</b>	188.65	190.93	189.79
<b>T-24</b>	<b>MBL-2</b>	203.50	206.03	204.76
<b>T-25</b>	<b>MBL-3</b>	222.54	219.35	220.94
<b>T-26</b>	<b>MBL-4</b>	206.60	205.47	206.03
<b>T-27</b>	<b>MBL-5</b>	194.72	197.94	196.33
<b>T-28</b>	<b>MBL-6</b>	162.04	158.52	159.28
<b>T-29</b>	<b>MBL-7</b>	170.55	172.87	171.71
<b>T-30</b>	<b>MBL-8</b>	175.35	177.18	176.26
<b>SEm±</b>		5.487	3.888	4.687
<b>C.D. at 5%</b>		15.561	11.026	13.293

**Figure 4.3: Fruit weight (g) of different mango genotypes.**



#### 4.1.6: Volume of fruit (ml)

The data pertaining to volume of fruit has been provided in Table 4.6 and illustrated graphically in Fig. 4.4.

During year 2019, a perusal of analysis of variance indicates that significant differences existed in volume of fruit produced by different genotypes. The genotype Fazli produced highest fruit volume (473.78 ml) and proved its superiority over rest of the genotypes. It was followed by Langra (313.29 ml) and Chausa (293.19 ml). The minimum fruit volume (159 ml) was noticed in genotype MBL-6.

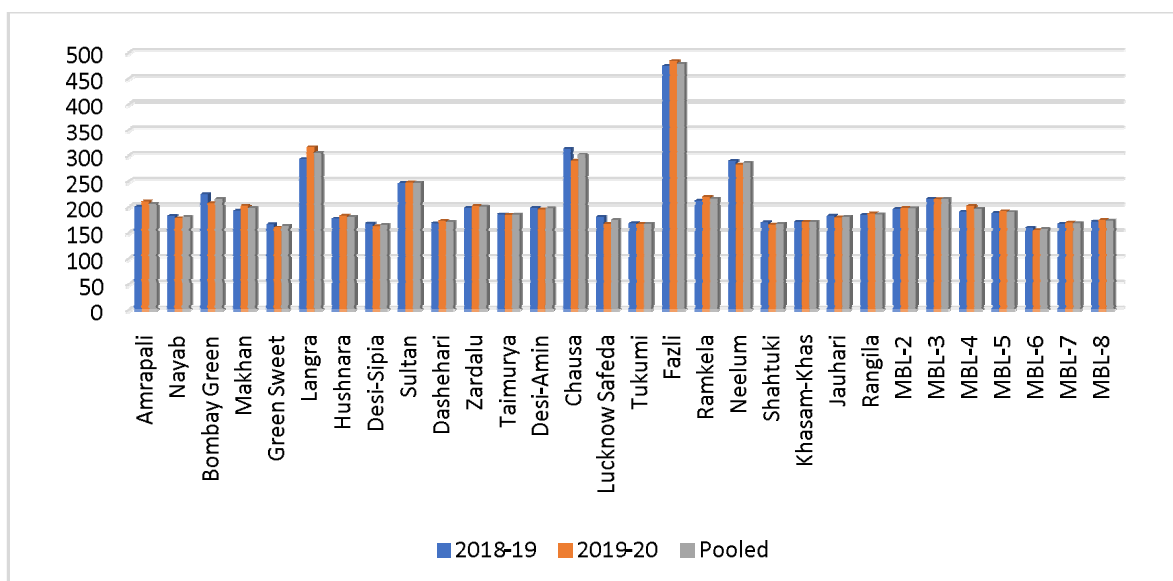
During the year 2020, there was also significant difference in fruit volume. Here also the maximum fruit volume was recorded in genotype Fazli (483.52 ml) followed by (316.43 ml) Langra and Chausa (289.86 ml). Whereas, minimum fruit volume (155.10 ml) was observed in genotype MBL-6.

The perusal of pooled data reflected that genotype Fazli (478.65 ml) produced highest fruit volume followed by Langra (314.86 ml) and Chausa (291.50 ml). While, minimum fruit volume (157.18 ml) was observed in genotype MBL-6.

**Table 4.6. Fruit Volume (ml) of different mango genotypes.**

<b>Fruit volume (ml)</b>				
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	200.39	210.70	205.54
<b>T-2</b>	<b>Nayab</b>	182.69	178.21	180.45
<b>T-3</b>	<b>Bombay Green</b>	224.58	207.22	215.90
<b>T-4</b>	<b>Makhan</b>	192.75	202.65	197.70
<b>T-5</b>	<b>Green Sweet</b>	166.07	160.19	163.13
<b>T-6</b>	<b>Langra</b>	293.19	316.43	304.81
<b>T-7</b>	<b>Hushnara</b>	177.11	182.91	180.01
<b>T-8</b>	<b>Desi-Sipia</b>	168.00	162.47	165.23
<b>T-9</b>	<b>Sultan</b>	246.04	247.88	246.96
<b>T-10</b>	<b>Dashehari</b>	168.40	172.78	170.59
<b>T-11</b>	<b>Zardalu</b>	198.67	201.92	200.29
<b>T-12</b>	<b>Taimurya</b>	185.55	185.06	185.30
<b>T-13</b>	<b>Desi – Amin</b>	198.72	195.68	197.20
<b>T-14</b>	<b>Chausa</b>	313.29	289.86	301.59
<b>T-15</b>	<b>Lucknow Safeda</b>	180.73	167.42	174.07
<b>T-16</b>	<b>Tukumi</b>	168.60	166.46	167.53
<b>T-17</b>	<b>Fazli</b>	473.78	483.52	478.65
<b>T-18</b>	<b>Ramkela</b>	212.76	219.97	216.36
<b>T-19</b>	<b>Neelum</b>	289.59	282.51	286.05
<b>T-20</b>	<b>Shahtuki</b>	169.81	165.60	167.70
<b>T-21</b>	<b>Khasam-Khas</b>	170.86	170.82	170.84
<b>T-22</b>	<b>Jauhari</b>	182.81	179.41	181.11
<b>T-23</b>	<b>Rangila</b>	184.35	186.88	185.61
<b>T-24</b>	<b>MBL-2</b>	196.35	197.98	197.16
<b>T-25</b>	<b>MBL-3</b>	215.62	214.76	215.19
<b>T-26</b>	<b>MBL-4</b>	190.30	202.11	196.20
<b>T-27</b>	<b>MBL-5</b>	187.95	191.92	189.93
<b>T-28</b>	<b>MBL-6</b>	159.17	155.10	157.18
<b>T-29</b>	<b>MBL-7</b>	167.76	169.37	168.56
<b>T-30</b>	<b>MBL-8</b>	171.75	174.10	172.92
<b>SEm±</b>		6.080	3.739	4.909
<b>C.D. at 5%</b>		17.243	10.604	13.923

**Figure 4.4: Fruit volume (ml) of different mango genotypes.**



#### 4.1.7: Specific gravity of fruits.

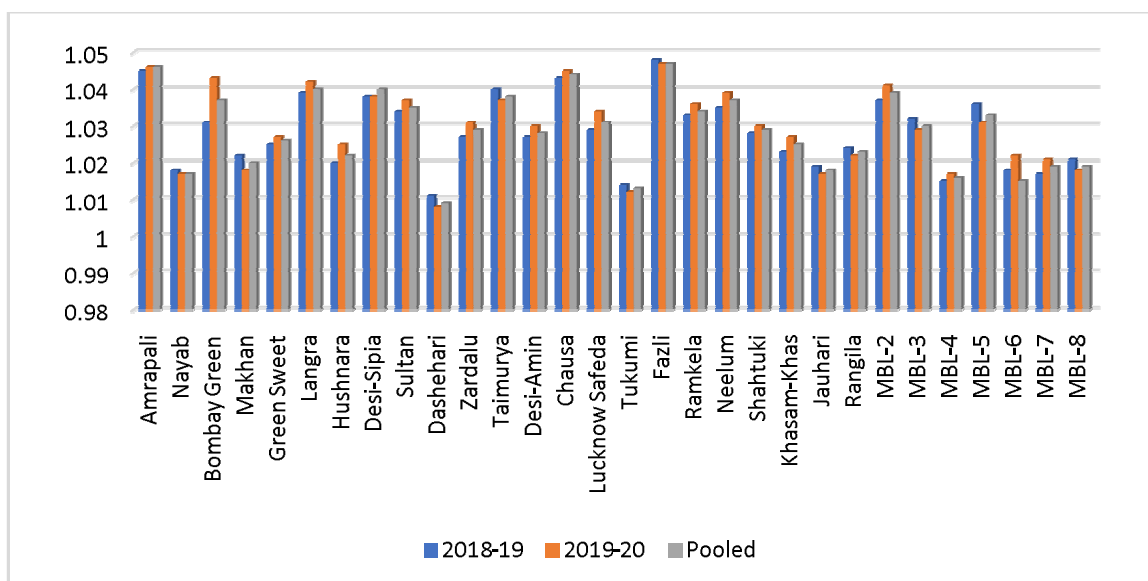
The data concerning to specific gravity of fruits for both the year and their mean are presented in Table 4.7 and illustrated graphically in Fig. 4.5.

The statistical analysis of the recorded data clearly shows that there were no significant differences in specific gravity of fruit for both the year as well as pooled data. It ranged between 1.011 to 1.048 in 2018-19 and 1.008 to 1.047. in 2019-20. Pooled specific gravity ranged between 1.009 to 1.047. Thus, it can be inferred that the fruits were harvested at accurate and suitable stage of maturity with the specific gravity range of 1.004 to 1.095.

**Table 4.7. Fruit specific gravity of different mango genotypes.**

<b>Fruit specific gravity</b>				
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	1.045	1.046	1.046
<b>T-2</b>	<b>Nayab</b>	1.018	1.017	1.017
<b>T-3</b>	<b>Bombay Green</b>	1.031	1.043	1.037
<b>T-4</b>	<b>Makhan</b>	1.022	1.018	1.020
<b>T-5</b>	<b>Green Sweet</b>	1.025	1.027	1.026
<b>T-6</b>	<b>Langra</b>	1.039	1.042	1.040
<b>T-7</b>	<b>Hushnara</b>	1.020	1.025	1.022
<b>T-8</b>	<b>Desi-Sipia</b>	1.038	1.038	1.040
<b>T-9</b>	<b>Sultan</b>	1.034	1.037	1.035
<b>T-10</b>	<b>Dashehari</b>	1.011	1.008	1.009
<b>T-11</b>	<b>Zardalu</b>	1.027	1.031	1.029
<b>T-12</b>	<b>Taimurya</b>	1.040	1.037	1.038
<b>T-13</b>	<b>Desi – Amin</b>	1.027	1.030	1.028
<b>T-14</b>	<b>Chausa</b>	1.043	1.045	1.044
<b>T-15</b>	<b>Lucknow Safeda</b>	1.029	1.034	1.031
<b>T-16</b>	<b>Tukumi</b>	1.014	1.012	1.013
<b>T-17</b>	<b>Fazli</b>	1.048	1.047	1.047
<b>T-18</b>	<b>Ramkela</b>	1.033	1.036	1.034
<b>T-19</b>	<b>Neelum</b>	1.035	1.039	1.037
<b>T-20</b>	<b>Shahtuki</b>	1.028	1.030	1.029
<b>T-21</b>	<b>Khasam-Khas</b>	1.023	1.027	1.025
<b>T-22</b>	<b>Jauhari</b>	1.019	1.017	1.018
<b>T-23</b>	<b>Rangila</b>	1.024	1.022	1.023
<b>T-24</b>	<b>MBL-2</b>	1.037	1.041	1.039
<b>T-25</b>	<b>MBL-3</b>	1.032	1.029	1.030
<b>T-26</b>	<b>MBL-4</b>	1.015	1.017	1.016
<b>T-27</b>	<b>MBL-5</b>	1.036	1.031	1.033
<b>T-28</b>	<b>MBL-6</b>	1.018	1.022	1.015
<b>T-29</b>	<b>MBL-7</b>	1.017	1.021	1.019
<b>T-30</b>	<b>MBL-8</b>	1.021	1.018	1.019
<b>SEm±</b>		0.003	0.003	0.003
<b>C.D. at 5%</b>		0.008	0.007	0.0075

**Figure 4.5: Fruit specific gravity of different mango genotypes.**



#### 4.1.8: Fruit firmness (kg/cm<sup>2</sup>)

The data with respect to fruit firmness under different genotypes are given in Table 4.8 and represented pictorially in Fig. 4.6.

A careful scrutiny of the data during the year 2018-19, indicates that there was significant variation in fruit firmness among different genotypes. The highest fruit firmness (14.75 Kg/cm<sup>2</sup>) was produced by genotype Langra found outstanding being significantly superior to remaining genotypes followed by Taimurya (13.82 Kg/cm<sup>2</sup>) and Hushnara (13.70 Kg/cm<sup>2</sup>). The minimum fruit firmness (9.73 Kg/cm<sup>2</sup>) was noted in genotype MBL-8.

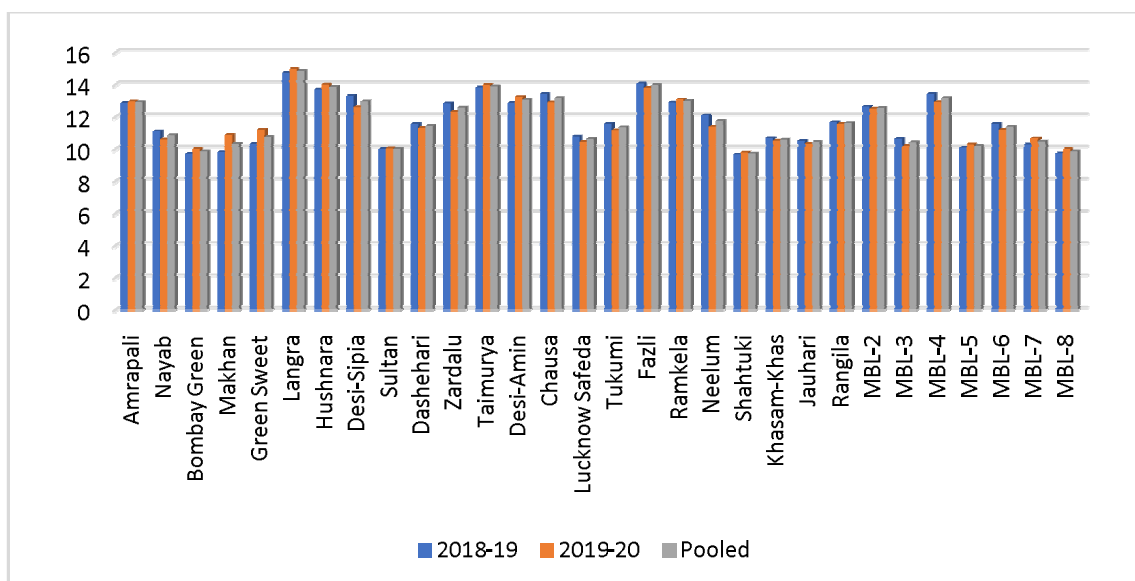
During the year 2019-20, there was also significant differences in fruit firmness. Here also the maximum fruit firmness was recorded in genotype Langra (14.96 Kg) followed by Taimurya (14.01 Kg/cm<sup>2</sup>) and (13.99 Kg/cm<sup>2</sup>)Hushnara. The minimum fruit firmness (9.98 Kg/cm<sup>2</sup>) was noted in genotype MBL-8.

The perusal of pooled data reflected that genotype Langra produced maximum fruit firmness (14.85 Kg/cm<sup>2</sup>) followed by genotype Taimurya (13.90 Kg/cm<sup>2</sup>) and Hushnara (13.85 Kg/cm<sup>2</sup>). While, minimum fruit firmness (9.85 Kg/cm<sup>2</sup>) was observed in genotype MBL-8.

**Table 4.8. Fruit firmness (kg/cm<sup>2</sup>) of different mango genotypes.**

<b>Fruit firmness (kg/cm<sup>2</sup>)</b>				
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	12.87	12.95	12.92
<b>T-2</b>	<b>Nayab</b>	11.11	10.60	10.85
<b>T-3</b>	<b>Bombay Green</b>	9.71	10.00	9.85
<b>T-4</b>	<b>Makhan</b>	9.82	10.87	10.34
<b>T-5</b>	<b>Green Sweet</b>	10.31	11.18	10.74
<b>T-6</b>	<b>Langra</b>	14.75	14.96	14.85
<b>T-7</b>	<b>Hushnara</b>	13.70	13.99	13.85
<b>T-8</b>	<b>Desi-Sipia</b>	13.30	12.60	12.95
<b>T-9</b>	<b>Sultan</b>	9.99	10.04	10.01
<b>T-10</b>	<b>Dashehari</b>	11.54	11.31	11.42
<b>T-11</b>	<b>Zardalu</b>	12.83	12.33	12.58
<b>T-12</b>	<b>Taimurya</b>	13.82	14.01	13.90
<b>T-13</b>	<b>Desi – Amin</b>	12.86	13.24	13.05
<b>T-14</b>	<b>Chausa</b>	13.41	12.91	13.16
<b>T-15</b>	<b>Lucknow Safeda</b>	10.79	10.46	10.62
<b>T-16</b>	<b>Tukumi</b>	11.57	11.16	11.36
<b>T-17</b>	<b>Fazli</b>	14.06	13.80	13.96
<b>T-18</b>	<b>Ramkela</b>	12.90	13.09	12.99
<b>T-19</b>	<b>Neelum</b>	12.10	11.38	11.74
<b>T-20</b>	<b>Shahtuki</b>	9.65	9.80	9.72
<b>T-21</b>	<b>Khasam-Khas</b>	10.68	10.51	10.59
<b>T-22</b>	<b>Jauhari</b>	10.50	10.34	10.42
<b>T-23</b>	<b>Rangila</b>	11.68	11.55	11.61
<b>T-24</b>	<b>MBL-2</b>	12.63	12.50	12.56
<b>T-25</b>	<b>MBL-3</b>	10.63	10.19	10.41
<b>T-26</b>	<b>MBL-4</b>	13.41	12.92	13.16
<b>T-27</b>	<b>MBL-5</b>	10.08	10.28	10.18
<b>T-28</b>	<b>MBL-6</b>	11.56	11.20	11.38
<b>T-29</b>	<b>MBL-7</b>	10.28	10.67	10.47
<b>T-30</b>	<b>MBL-8</b>	9.73	9.98	9.85
<b>SEm±</b>		0.335	0.383	0.359
<b>C.D. at 5%</b>		0.950	1.086	1.018

**Figure 4.6: Fruit firmness (kg/cm<sup>2</sup>) of different mango genotypes.**



## Peel characters:

### 4.1.9: Thickness of peel (mm)

Peel thickness was recorded at the time of quality study and its peel content in the fruit was calculated. The data regarding to peel thickness of different genotypes during quality study of mango are provided in Table 4.9 and depicted pictorially in Fig. 4.7.

During 2018-19, a perusal of data clearly indicates that there were significant variations in thickness of peel different genotypes. The lowest peel thickness was obtained in genotype Makhan (0.85 mm). Maximum fruit peel thickness obtained in genotype Desi-Sipia (2.56 mm) followed by Jauhari (2.49 mm).

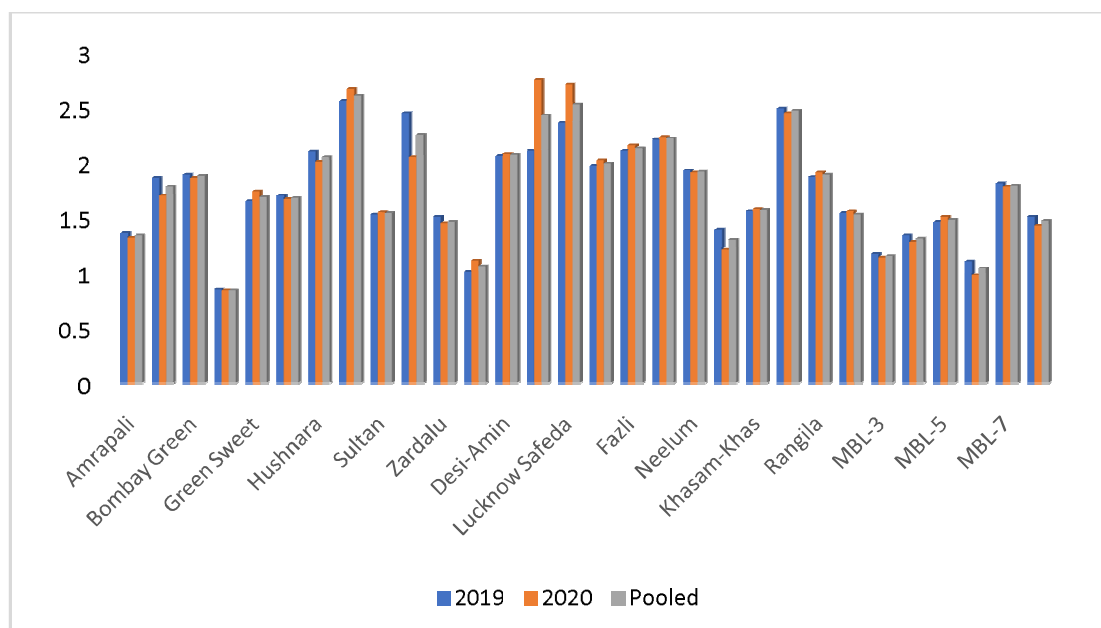
During 2019-20, again significant difference in peel thickness was observed. The lowest peel thickness was obtained in Makhan (0.84 mm). Maximum fruit peel thickness obtained in genotype Desi-Sipia (2.67 mm) followed by Jauhari (2.45 mm).

After critical analysis of pooled data, it was found that significant difference occurred among the different genotypes. It clearly indicates that minimum thickness was obtained in Makhan (0.84 mm). Whereas, maximum fruit peel thickness obtained in genotype Desi-Sipia (2.61 mm) followed by Jauhari (2.47 mm).

**Table 4.9. Thickness of the peel (mm) of different mango genotypes.**

<b>Thickness of the peel (mm)</b>				
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	1.36	1.32	1.34
<b>T-2</b>	<b>Nayab</b>	1.86	1.70	1.78
<b>T-3</b>	<b>Bombay Green</b>	1.89	1.86	1.88
<b>T-4</b>	<b>Makhan</b>	0.85	0.84	0.84
<b>T-5</b>	<b>Green Sweet</b>	1.65	1.74	1.69
<b>T-6</b>	<b>Langra</b>	1.70	1.67	1.68
<b>T-7</b>	<b>Hushnara</b>	2.10	2.01	2.05
<b>T-8</b>	<b>Desi-Sipia</b>	2.56	2.67	2.61
<b>T-9</b>	<b>Sultan</b>	1.53	1.55	1.54
<b>T-10</b>	<b>Dashehari</b>	2.45	2.05	2.25
<b>T-11</b>	<b>Zardalu</b>	1.51	1.45	1.46
<b>T-12</b>	<b>Taimurya</b>	1.01	1.11	1.06
<b>T-13</b>	<b>Desi – Amin</b>	2.06	2.08	2.07
<b>T-14</b>	<b>Chausa</b>	2.11	2.75	2.43
<b>T-15</b>	<b>Lucknow Safeda</b>	2.36	2.71	2.53
<b>T-16</b>	<b>Tukumi</b>	1.97	2.02	1.99
<b>T-17</b>	<b>Fazli</b>	2.11	2.16	2.13
<b>T-18</b>	<b>Ramkela</b>	2.21	2.23	2.22
<b>T-19</b>	<b>Neelum</b>	1.93	1.91	1.92
<b>T-20</b>	<b>Shahtuki</b>	1.39	1.21	1.30
<b>T-21</b>	<b>Khasam-Khas</b>	1.56	1.58	1.57
<b>T-22</b>	<b>Jauhari</b>	2.49	2.45	2.47
<b>T-23</b>	<b>Rangila</b>	1.87	1.91	1.89
<b>T-24</b>	<b>MBL-2</b>	1.54	1.56	1.53
<b>T-25</b>	<b>MBL-3</b>	1.17	1.14	1.15
<b>T-26</b>	<b>MBL-4</b>	1.34	1.28	1.31
<b>T-27</b>	<b>MBL-5</b>	1.46	1.51	1.48
<b>T-28</b>	<b>MBL-6</b>	1.10	0.98	1.04
<b>T-29</b>	<b>MBL-7</b>	1.81	1.78	1.79
<b>T-30</b>	<b>MBL-8</b>	1.51	1.43	1.47
<b>SEm±</b>		0.056	0.086	0.071
<b>C.D. at 5%</b>		0.158	0.245	0.201

**Figure 4.7: Peel thickness (mm) of different mango genotypes.**



#### **4.1.10: Peel weight (g).**

Peel weight per fruit in gram for both the years and their mean has been presented in Table 4.10 and illustrated in Fig. 4.8.

Mean table of 2018-19, indicated that there was significant difference in peel weight genotype Fazli had maximum peel weight (48.70g) followed by Langra (35.86g) and Zardalu (35.44 g). While, genotype Shahtuki produced minimum peel weight (17.39g).

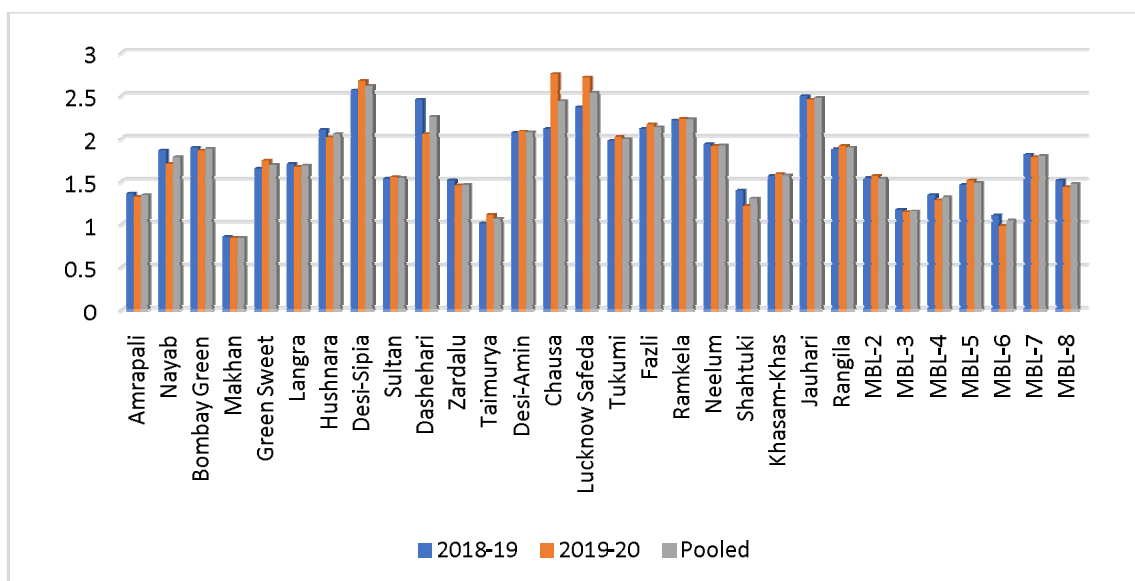
In 2019-20, again significant difference in peel weight among different genotypes was observed. genotype Fazli had maximum peel weight (51.36g) followed by Langra (37.78g) and Zardalu (35.59g). While, Shahtuki produced minimum peel weight (15.22g).

Statistical analysis of combined data revealed that there was significant difference in peel produced by the genotypes under study. Maximum peel weight per fruit was observed in genotype Fazli which had maximum peel weight (50.03g) followed by Langra (36.82g) and Zardalu (35.51g). While, Shahtuki produced minimum peel weight (16.30g).

**Table 4.10. Peel weight (g) of different mango genotypes.**

<b>Peel weight (g)</b>				
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	29.72	33.68	31.7
<b>T-2</b>	<b>Nayab</b>	24.81	23.80	24.30
<b>T-3</b>	<b>Bombay Green</b>	28.47	23.35	25.91
<b>T-4</b>	<b>Makhan</b>	19.52	20.24	19.88
<b>T-5</b>	<b>Green Sweet</b>	25.34	23.22	24.28
<b>T-6</b>	<b>Langra</b>	35.86	37.78	36.82
<b>T-7</b>	<b>Hushnara</b>	24.67	26.08	25.37
<b>T-8</b>	<b>Desi-Sipia</b>	31.57	30.09	30.83
<b>T-9</b>	<b>Sultan</b>	31.53	33.92	32.72
<b>T-10</b>	<b>Dashehari</b>	27.77	28.70	28.23
<b>T-11</b>	<b>Zardalu</b>	35.44	35.59	35.51
<b>T-12</b>	<b>Taimurya</b>	26.08	25.47	25.77
<b>T-13</b>	<b>Desi – Amin</b>	30.76	29.54	30.15
<b>T-14</b>	<b>Chausa</b>	30.59	31.09	30.84
<b>T-15</b>	<b>Lucknow Safeda</b>	28.56	25.67	27.11
<b>T-16</b>	<b>Tukumi</b>	17.92	17.26	17.59
<b>T-17</b>	<b>Fazli</b>	48.70	51.36	50.03
<b>T-18</b>	<b>Ramkela</b>	32.70	35.08	33.89
<b>T-19</b>	<b>Neelum</b>	33.50	33.01	34.22
<b>T-20</b>	<b>Shahtuki</b>	17.39	15.22	16.30
<b>T-21</b>	<b>Khasam-Khas</b>	24.45	25.61	25.03
<b>T-22</b>	<b>Jauhari</b>	23.88	21.29	22.58
<b>T-23</b>	<b>Rangila</b>	22.86	24.33	23.59
<b>T-24</b>	<b>MBL-2</b>	20.51	21.30	20.90
<b>T-25</b>	<b>MBL-3</b>	25.86	24.17	25.01
<b>T-26</b>	<b>MBL-4</b>	28.78	27.94	28.36
<b>T-27</b>	<b>MBL-5</b>	20.86	22.44	21.65
<b>T-28</b>	<b>MBL-6</b>	22.34	20.27	21.30
<b>T-29</b>	<b>MBL-7</b>	18.24	19.75	18.99
<b>T-30</b>	<b>MBL-8</b>	20.89	22.25	21.57
<b>SEm±</b>		1.328	1.243	1.281
<b>C.D. at 5%</b>		3.766	3.526	3.646

**Figure 4.8: Peel weight (g) of different mango genotypes.**



#### 4.11: Peel percentage

The data regarding to pulp percentage of mango genotypes for both the years and their mean has been given in Table 4.11 and represented graphically in Fig 4.9.

During 2018-19, perusal of data indicates that there was a significant difference in case of peel percentage for different genotypes. The maximum genotype Desi-Sipia had maximum peel percentage (18.10%) followed by Zardalu (16.42%) and Dashehari (16.30%). While, Shahtuki produced minimum peel weight (9.97%).

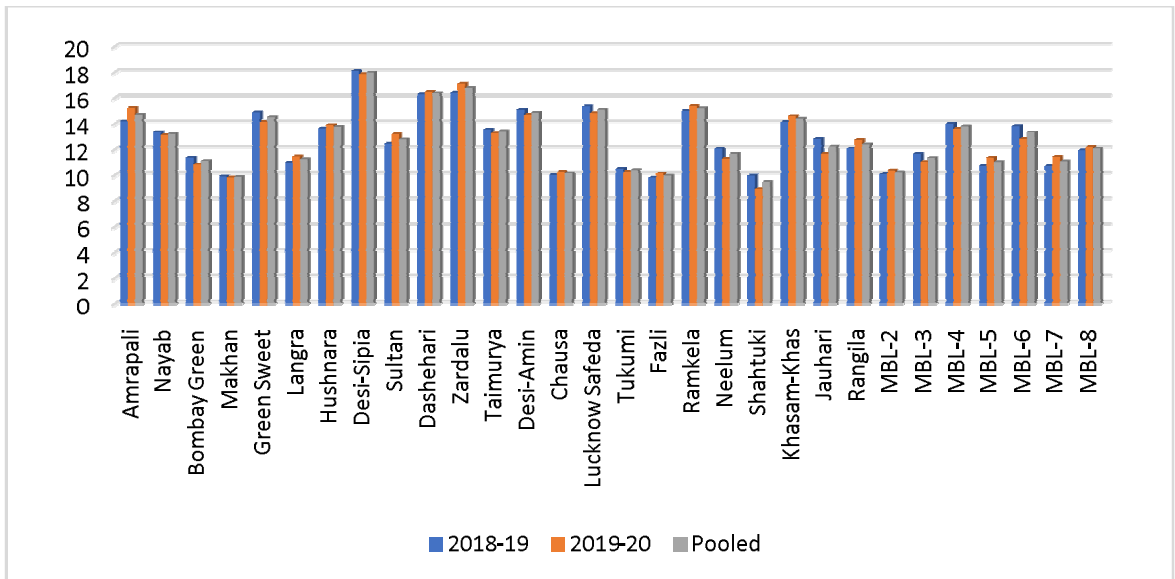
During the year 2019-20 genotype again significant difference in peel weight among different genotypes was observed. Desi-Sipia had maximum peel weight (17.84%) and followed by Zardalu (17.12%) and Dashehari (16.48%) while, genotype Shahtuki produced minimum peel weight (8.93%).

An observation of pooled data indicated that there was significant difference in peel percentage of the fruit. Genotype Desi-Sipia had maximum peel weight (17.97%) which was at par with followed by genotype Zardalu (16.72%) and Dashehari (16.77%). While, genotype Shahtuki produced minimum peel weight (9.45%).

**Table 4.11. Peel (%) of different mango genotypes.**

<b>Peel (%)</b>				
<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	14.19	15.24	14.71
<b>T-2</b>	<b>Nayab</b>	13.34	13.13	13.23
<b>T-3</b>	<b>Bombay Green</b>	11.35	10.82	11.08
<b>T-4</b>	<b>Makhan</b>	9.92	9.82	9.87
<b>T-5</b>	<b>Green Sweet</b>	14.89	14.13	14.51
<b>T-6</b>	<b>Langra</b>	10.98	11.46	11.22
<b>T-7</b>	<b>Hushnara</b>	13.64	13.90	13.77
<b>T-8</b>	<b>Desi-Sipia</b>	18.10	17.84	17.97
<b>T-9</b>	<b>Sultan</b>	12.44	13.19	12.81
<b>T-10</b>	<b>Dashehari</b>	16.30	16.48	16.39
<b>T-11</b>	<b>Zardalu</b>	16.42	17.12	16.77
<b>T-12</b>	<b>Taimurya</b>	13.53	13.27	13.40
<b>T-13</b>	<b>Desi – Amin</b>	15.07	14.67	14.87
<b>T-14</b>	<b>Chausa</b>	10.04	10.27	10.15
<b>T-15</b>	<b>Lucknow Safeda</b>	15.35	14.81	15.08
<b>T-16</b>	<b>Tukumi</b>	10.49	10.27	10.38
<b>T-17</b>	<b>Fazli</b>	9.81	10.14	9.97
<b>T-18</b>	<b>Ramkela</b>	15.02	15.39	15.20
<b>T-19</b>	<b>Neelum</b>	12.06	11.28	11.67
<b>T-20</b>	<b>Shahtuki</b>	9.97	8.93	9.45
<b>T-21</b>	<b>Khasam-Khas</b>	14.17	14.60	14.38
<b>T-22</b>	<b>Jauhari</b>	12.83	11.67	12.25
<b>T-23</b>	<b>Rangila</b>	12.07	12.74	12.40
<b>T-24</b>	<b>MBL-2</b>	10.09	10.35	10.22
<b>T-25</b>	<b>MBL-3</b>	11.64	11.03	11.33
<b>T-26</b>	<b>MBL-4</b>	14.00	13.60	13.80
<b>T-27</b>	<b>MBL-5</b>	10.71	11.34	11.02
<b>T-28</b>	<b>MBL-6</b>	13.81	12.83	13.32
<b>T-29</b>	<b>MBL-7</b>	10.70	11.43	11.06
<b>T-30</b>	<b>MBL-8</b>	11.92	12.23	12.07
<b>SEm±</b>		0.572	0.521	0.546
<b>C.D. at 5%</b>		1.623	1.479	1.551

**Figure 4.9. Peel (%) of different mango genotypes.**

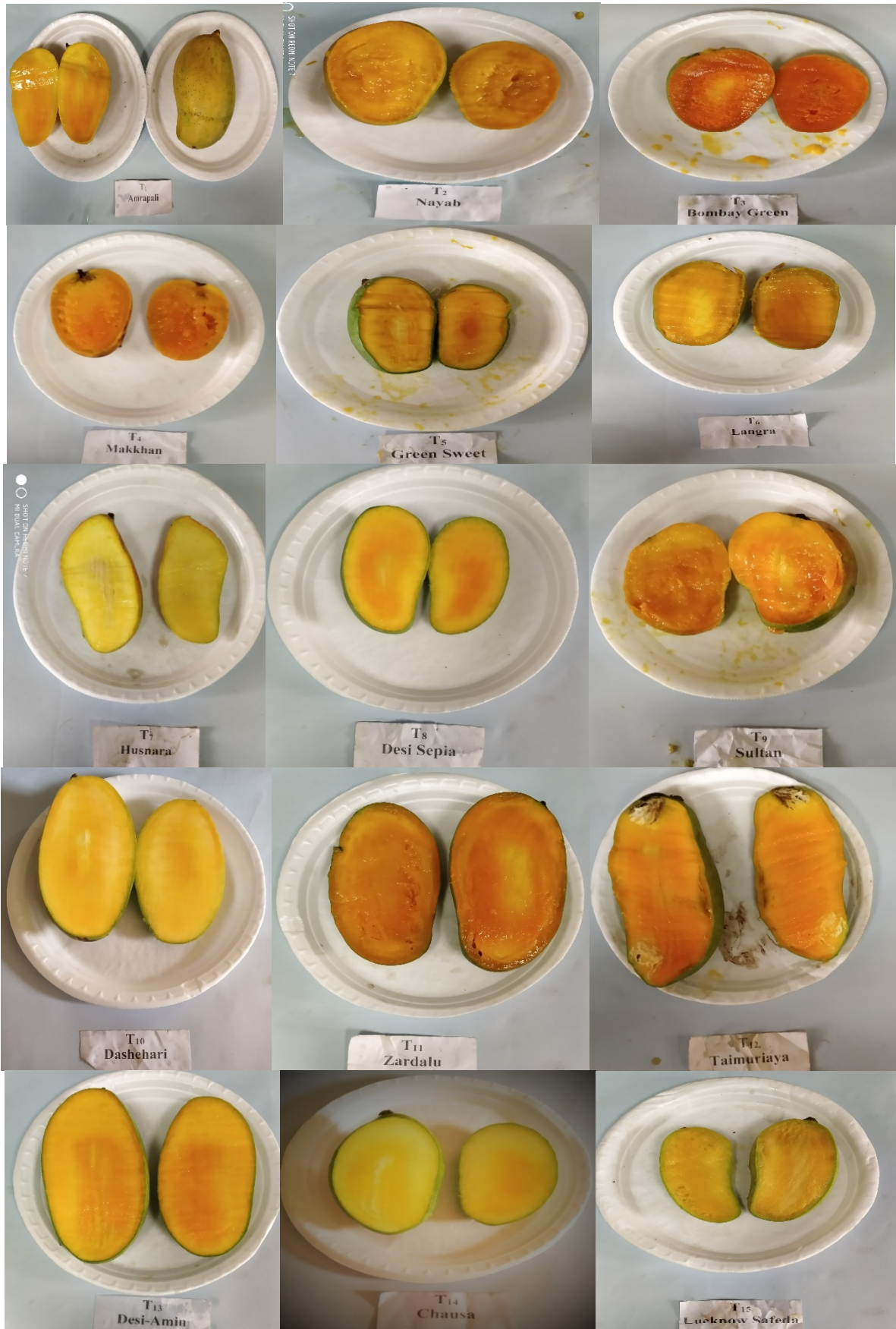


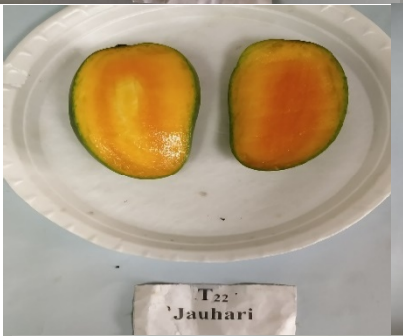
## Pulp character (Organoleptic evaluation)

### 4.1.12: Pulp colour

The data regarding Pulp colour was noted in all the genotypes under study. Maximum fruit colour score (8.50) was noted in genotype Hushnara and minimum (4.70) score was recorded in genotype MBL-8.

#### 4. A general view of different genotypes of mango pulp.





**Table 4.12. Pulp colour of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Pulp colour</b>
<b>T-1</b>	<b>Amrapali</b>	Orange cadmium
<b>T-2</b>	<b>Nayab</b>	Yellow cadmium
<b>T-3</b>	<b>Bombay Green</b>	Orange cadmium
<b>T-4</b>	<b>Makhan</b>	Yellow ochre-apricot
<b>T-5</b>	<b>Green Sweet</b>	Yellow cadmium
<b>T-6</b>	<b>Langra</b>	Lemon yellow
<b>T-7</b>	<b>Hushnara</b>	Cream yellow
<b>T-8</b>	<b>Desi-Sipia</b>	Creem yellow
<b>T-9</b>	<b>Sultan</b>	Yellow cadmium to apricot
<b>T-10</b>	<b>Dashehari</b>	Yellow cadmium
<b>T-11</b>	<b>Zardalu</b>	Raw sienna
<b>T-12</b>	<b>Taimurya</b>	Yellow cadmium
<b>T-13</b>	<b>Desi – Amin</b>	Slightly light shade of yellow cadmium
<b>T-14</b>	<b>Chausa</b>	Row sienna
<b>T-15</b>	<b>Lucknow Safeda</b>	Somewhat apricot
<b>T-16</b>	<b>Tukumi</b>	Yellow
<b>T-17</b>	<b>Fazli</b>	Yellow cadmium
<b>T-18</b>	<b>Ramkela</b>	Yellow cadmium to apricot
<b>T-19</b>	<b>Neelum</b>	Orange cadmium
<b>T-20</b>	<b>Shahtuki</b>	Lemon yellow
<b>T-21</b>	<b>Khasam-Khas</b>	Orange cadmium
<b>T-22</b>	<b>Jauhari</b>	Yellow cadmium
<b>T-23</b>	<b>Rangila</b>	Cream yellow
<b>T-24</b>	<b>MBL-2</b>	Yellow
<b>T-25</b>	<b>MBL-3</b>	Yellow cadmium
<b>T-26</b>	<b>MBL-4</b>	Raw sienna to yellow cadmium
<b>T-27</b>	<b>MBL-5</b>	Raw sienna
<b>T-28</b>	<b>MBL-6</b>	Yellow
<b>T-29</b>	<b>MBL-7</b>	Apricot
<b>T-30</b>	<b>MBL-8</b>	Yellow cadmium

#### 4.1.13: Pulp texture

The evaluation of fruit texture of different genotypes by panel of semi trained judges reflected that maximum fruit texture (8.80) was noted in genotype Amrapali, while minimum score (5.10) was recorded in genotype MBL-5.

**Table 4.13. Pulp texture of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Pulp texture</b>
<b>T-1</b>	<b>Amrapali</b>	Soft
<b>T-2</b>	<b>Nayab</b>	Firm
<b>T-3</b>	<b>Bombay Green</b>	Firm
<b>T-4</b>	<b>Makhan</b>	Soft
<b>T-5</b>	<b>Green Sweet</b>	Soft
<b>T-6</b>	<b>Langra</b>	Firm
<b>T-7</b>	<b>Hushnara</b>	Soft
<b>T-8</b>	<b>Desi-Sipia</b>	Firm
<b>T-9</b>	<b>Sultan</b>	Firm
<b>T-10</b>	<b>Dashehari</b>	Soft
<b>T-11</b>	<b>Zardalu</b>	Soft and stringy
<b>T-12</b>	<b>Taimuriaya</b>	Soft and juicy
<b>T-13</b>	<b>Desi – Amin</b>	Firm
<b>T-14</b>	<b>Chausa</b>	Soft
<b>T-15</b>	<b>Lucknow Safeda</b>	Soft and juicy
<b>T-16</b>	<b>Tukumi</b>	Soft
<b>T-17</b>	<b>Fazli</b>	Firm
<b>T-18</b>	<b>Ramkela</b>	Firm
<b>T-19</b>	<b>Neelum</b>	Soft
<b>T-20</b>	<b>Shahtuki</b>	Soft
<b>T-21</b>	<b>Khasam-Khas</b>	Firm
<b>T-22</b>	<b>Jauhari</b>	Soft
<b>T-23</b>	<b>Rangila</b>	Firm
<b>T-24</b>	<b>MBL-2</b>	Soft and stringy
<b>T-25</b>	<b>MBL-3</b>	Firm
<b>T-26</b>	<b>MBL-4</b>	Soft and juicy
<b>T-27</b>	<b>MBL-5</b>	Firm
<b>T-28</b>	<b>MBL-6</b>	Stringy and light
<b>T-29</b>	<b>MBL-7</b>	Firm
<b>T-30</b>	<b>MBL-8</b>	Soft

#### 4.14: Pulp flavour

The data regarding fruit flavour was observed in all the genotypes under study and score ranged from 4.90 to 8.70. Maximum fruit flavour (8.70) was reported in Amrapali and minimum (4.90) score was recorded in genotype MBL-4.

**Table 4.14: Pulp flavour of different mango genotypes.**

Treatments	Genotypes	Pulp flavour
T-1	Amrapali	Aromatic and pleasant
T-2	Nayab	Delightfully aroma
T-3	Bombay Green	Very slight
T-4	Makhan	Pleasant and delightful
T-5	Green Sweet	Luscious and pleasant
T-6	Langra	With a mild, sweet and melting characteristic aroma
T-7	Hushnara	Aromatic and pleasant
T-8	Desi-Sipia	Mild and pleasant
T-9	Sultan	Mildly aromatic
T-10	Dashehari	Luscious with delightful aroma
T-11	Zardalu	Aromatic and pleasant
T-12	Taimuriaya	Luscious and pleasantly aromatic
T-13	Desi – Amin	Pleasantly aromatic
T-14	Chausa	Luscious and delightful
T-15	Lucknow Safeda	Mildly aromatic and pleasant
T-16	Tukumi	Aromatic and pleasant
T-17	Fazli	Mild pleasant
T-18	Ramkela	Mildly aromatic, pleasant
T-19	Neelum	Very slight
T-20	Shahtuki	Pleasant and good
T-21	Khasam-Khas	Mildly aromatic, pleasant
T-22	Jauhari	Delightfully aroma
T-23	Rangila	Luscious and pleasant
T-24	MBL-2	Mild
T-25	MBL-3	Mild aromatic and pleasant
T-26	MBL-4	Mild pleasant
T-27	MBL-5	Aromatic and pleasant
T-28	MBL-6	Slight
T-29	MBL-7	Mild and pleasant
T-30	MBL-8	Delightfully aromatic

#### 4.1.15:Pulp taste

All the genotypes under study were evaluated for fruit taste score ranged from 5.40 to 8.60 Maximum score for fruit taste (8.60) was reported in Amrapali and minimum score (5.40) was noted in genotype MBL- 4.

**Table 4.15: Pulp test of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Pulp taste</b>
<b>T-1</b>	<b>Amrapali</b>	Very Sweet
<b>T-2</b>	<b>Nayab</b>	Sweet
<b>T-3</b>	<b>Bombay Green</b>	Very sweet
<b>T-4</b>	<b>Makhan</b>	Sweet
<b>T-5</b>	<b>Green Sweet</b>	Very sweet
<b>T-6</b>	<b>Langra</b>	Sweet
<b>T-7</b>	<b>Hushnara</b>	Sweet
<b>T-8</b>	<b>Desi-Sipia</b>	Sweet
<b>T-9</b>	<b>Sultan</b>	Sweet
<b>T-10</b>	<b>Dashehari</b>	Very sweet
<b>T-11</b>	<b>Zardalu</b>	Sweet
<b>T-12</b>	<b>Taimuriaya</b>	Very sweet
<b>T-13</b>	<b>Desi – Amin</b>	Sweet to sub-acid at stone.
<b>T-14</b>	<b>Chausa</b>	Very sweet
<b>T-15</b>	<b>Lucknow Safeda</b>	Sweet
<b>T-16</b>	<b>Tukumi</b>	Very sweet
<b>T-17</b>	<b>Fazli</b>	Sweet
<b>T-18</b>	<b>Ramkela</b>	Sweet
<b>T-19</b>	<b>Neelum</b>	Sweet but leaves a bad taste
<b>T-20</b>	<b>Shahtuki</b>	Ver sweet
<b>T-21</b>	<b>Khasam-khas</b>	Ver sweet
<b>T-22</b>	<b>Jauhari</b>	Ver sweet
<b>T-23</b>	<b>Rangila</b>	Ver sweet
<b>T-24</b>	<b>MBL-2</b>	Sweet
<b>T-25</b>	<b>MBL-3</b>	Very sweet
<b>T-26</b>	<b>MBL-4</b>	Sub acid
<b>T-27</b>	<b>MBL-5</b>	Sweet
<b>T-28</b>	<b>MBL-6</b>	Sweet
<b>T-29</b>	<b>MBL-7</b>	Sweet
<b>T-30</b>	<b>MBL-8</b>	Very sweet

#### 4.1.16: Pulp juice

The data regarding pulp juice was observed in all the varieties under study and score ranged from 5.20 to 8.60. Maximum pulp juice (8.60) was reported in Bombay green and minimum (5.20) score was recorded in genotype MBL-4.

**Table 4.16. Pulp juice of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Pulp juice</b>
<b>T-1</b>	<b>Amrapali</b>	Abundant
<b>T-2</b>	<b>Nayab</b>	Scanty
<b>T-3</b>	<b>Bombay Green</b>	Abundant
<b>T-4</b>	<b>Makhan</b>	Scanty
<b>T-5</b>	<b>Green Sweet</b>	Much
<b>T-6</b>	<b>Langra</b>	Much
<b>T-7</b>	<b>Hushnara</b>	Much
<b>T-8</b>	<b>Desi-Sipia</b>	Scanty
<b>T-9</b>	<b>Sultan</b>	Much
<b>T-10</b>	<b>Dashehari</b>	Much
<b>T-11</b>	<b>Zardalu</b>	Much
<b>T-12</b>	<b>Taimuriaya</b>	Much
<b>T-13</b>	<b>Desi – Amin</b>	Scanty
<b>T-14</b>	<b>Chausa</b>	Abundant
<b>T-15</b>	<b>Lucknow Safeda</b>	Abundant
<b>T-16</b>	<b>Tukumi</b>	Scanty
<b>T-17</b>	<b>Fazli</b>	Scanty
<b>T-18</b>	<b>Ramkela</b>	Scanty
<b>T-19</b>	<b>Neelum</b>	Much
<b>T-20</b>	<b>Shahtuki</b>	Much
<b>T-21</b>	<b>Khasam-khas</b>	Much
<b>T-22</b>	<b>Jauhari</b>	Scanty
<b>T-23</b>	<b>Rangila</b>	Scanty
<b>T-24</b>	<b>MBL-2</b>	Much
<b>T-25</b>	<b>MBL-3</b>	Much
<b>T-26</b>	<b>MBL-4</b>	Scanty
<b>T-27</b>	<b>MBL-5</b>	Much
<b>T-28</b>	<b>MBL-6</b>	Abundant
<b>T-29</b>	<b>MBL-7</b>	Much
<b>T-30</b>	<b>MBL-8</b>	Scanty

#### 4.1.17: Pulp fibre

All the genotypes under study were evaluated for pulp fibre score ranged from 4.80 to 8.40. Maximum score for pulp fibre (8.40) was reported in Amrapali and minimum score (4.80) was noted in genotype MBL-6.

**Table 4.17. Pulp fibre of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Pulp fibre</b>
<b>T-1</b>	<b>Amrapali</b>	Almost absent
<b>T-2</b>	<b>Nayab</b>	Scanty, near skin, long and fine
<b>T-3</b>	<b>Bombay Green</b>	Scanty, just near skin, fine and short
<b>T-4</b>	<b>Makhan</b>	Much near the skin
<b>T-5</b>	<b>Green Sweet</b>	Scanty
<b>T-6</b>	<b>Langra</b>	Scanty, near skin, coarse and long
<b>T-7</b>	<b>Hushnara</b>	Scanty
<b>T-8</b>	<b>Desi-Sipia</b>	Absent
<b>T-9</b>	<b>Sultan</b>	Short and fine
<b>T-10</b>	<b>Dashehari</b>	Almost absent
<b>T-11</b>	<b>Zardalu</b>	Abundant, long and coarse
<b>T-12</b>	<b>Taimuriaya</b>	Scanty near skin
<b>T-13</b>	<b>Desi – Amin</b>	Scanty at the skin, long and coarse.
<b>T-14</b>	<b>Chausa</b>	Scanty near the skin, fine and long
<b>T-15</b>	<b>Lucknow Safeda</b>	Much course near skin
<b>T-16</b>	<b>Tukumi</b>	Short and fine
<b>T-17</b>	<b>Fazli</b>	Scanty near skin, long and rough
<b>T-18</b>	<b>Ramkela</b>	Scanty near the skin, short and fine
<b>T-19</b>	<b>Neelum</b>	Scanty and short
<b>T-20</b>	<b>Shahtuki</b>	Short and fine
<b>T-21</b>	<b>Khasam-khas</b>	Scanty, near skin, long and fine
<b>T-22</b>	<b>Jauhari</b>	Scanty
<b>T-23</b>	<b>Rangila</b>	Scanty, near skin, coarse and long
<b>T-24</b>	<b>MBL-2</b>	Abundant, long and coarse
<b>T-25</b>	<b>MBL-3</b>	Abundant
<b>T-26</b>	<b>MBL-4</b>	Much, long and coarse
<b>T-27</b>	<b>MBL-5</b>	Much coarse and short fibres in the pulp
<b>T-28</b>	<b>MBL-6</b>	Abundant long and coarse
<b>T-29</b>	<b>MBL-7</b>	Scanty, long and coarse
<b>T-30</b>	<b>MBL-8</b>	Scanty

#### 4.18. Organoleptic evolution of mango pulp.

Treatments	Genotypes	Colour	Flavor	Texture	Taste	Juice	Fiber
T-1	Amrapali	8.30	8.70	8.80	8.60	8.40	8.40
T-2	Nayab	6.80	6.80	6.90	6.80	6.80	7.80
T-3	Bombay Green	7.30	7.20	7.90	7.90	8.60	7.70
T-4	Makhan	7.90	6.40	7.00	7.20	6.30	5.60
T-5	Green Sweet	7.60	6.70	6.90	7.80	7.00	6.80
T-6	Langra	8.20	8.40	8.50	8.40	8.30	8.10
T-7	Hushnara	8.50	7.80	7.60	7.80	7.60	7.10
T-8	Desi-Sipia	6.70	8.00	7.40	5.90	6.60	7.50
T-9	Sultan	6.50	7.50	7.20	6.60	7.80	5.50
T-10	Dashehari	7.20	8.60	8.60	8.50	8.20	8.20
T-11	Zardalu	6.40	5.90	5.80	7.40	7.10	7.30
T-12	Taimuriaya	4.40	5.60	6.70	6.20	7.30	6.40
T-13	Desi – Amin	6.60	6.60	6.40	6.30	6.50	6.60
T-14	Chausa	8.10	8.10	8.10	8.30	7.90	8.00
T-15	Lucknow Safeda	7.90	8.00	6.70	7.70	7.50	5.40
T-16	Tukumi	5.40	5.50	6.20	7.10	6.40	6.50
T-17	Fazli	5.30	5.70	6.10	6.10	6.20	6.20
T-18	Ramkela	5.00	6.90	5.90	6.60	5.60	6.70
T-19	Neelum	6.80	7.80	8.00	8.10	7.20	7.60
T-20	Shahtuki	7.70	6.20	6.30	6.90	6.90	6.90
T-21	Khasam-Khas	6.20	7.50	7.70	8.00	7.00	7.20
T-22	Jauhari	5.50	6.80	7.20	7.50	5.40	7.00
T-23	Rangila	7.30	5.00	6.70	5.70	5.60	5.80
T-24	MBL-2	6.40	5.10	7.10	6.00	5.90	4.90
T-25	MBL-3	6.20	6.00	5.90	7.30	6.30	5.00
T-26	MBL-4	5.20	4.90	6.00	5.40	5.20	5.10
T-27	MBL-5	5.30	7.60	5.10	6.80	7.10	5.30
T-28	MBL-6	4.80	5.40	6.50	6.70	8.00	4.80
T-29	MBL-7	5.10	5.60	7.30	5.80	6.00	5.70
T-30	MBL-8	4.70	6.70	6.80	6.50	5.30	5.20

#### 4.1.18: Stone body

The data regarding to stone body of mango genotypes for both the years have been given in Table 4.19.

**Table 4.19. Stone body of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Stone body</b>
<b>T-1</b>	<b>Amrapali</b>	Full and thick
<b>T-2</b>	<b>Nayab</b>	Full thick empty at basal end
<b>T-3</b>	<b>Bombay Green</b>	Full and thick
<b>T-4</b>	<b>Makhan</b>	Full and thick
<b>T-5</b>	<b>Green Sweet</b>	Full and uniformly thick
<b>T-6</b>	<b>Langra</b>	Full and thin, empty at basal end
<b>T-7</b>	<b>Hushnara</b>	Empty at the basal portion
<b>T-8</b>	<b>Desi-Sipia</b>	Fine fibre all over the surface, tuft of long and coarse fibre on the ventral edge specially the upper half
<b>T-9</b>	<b>Sultan</b>	Veins raised and covered by hairs
<b>T-10</b>	<b>Dashehari</b>	Full and thick
<b>T-11</b>	<b>Zardalu</b>	Full and thick
<b>T-12</b>	<b>Taimuriaya</b>	Full and thick
<b>T-13</b>	<b>Desi – Amin</b>	Full and thick basal end some- what pointed
<b>T-14</b>	<b>Chuasa</b>	Empty at the basal portion
<b>T-15</b>	<b>Lucknow Safeda</b>	Full thick
<b>T-16</b>	<b>Tukumi</b>	Full and thin
<b>T-17</b>	<b>Fazli</b>	Full and thick, empty at the basal and epical ends
<b>T-18</b>	<b>Ramkela</b>	Full and thick
<b>T-19</b>	<b>Neelum</b>	Full and thick
<b>T-20</b>	<b>Shahtuki</b>	Full and thin, empty at the basal end
<b>T-21</b>	<b>Khasam-Khas</b>	Full and thick
<b>T-22</b>	<b>Jauhari</b>	Full and thick basal end some- what pointed
<b>T-23</b>	<b>Rangila</b>	Full (except at the extreme basal end) and thick
<b>T-24</b>	<b>MBL-2</b>	Nearly full, empty at the basal end
<b>T-25</b>	<b>MBL-3</b>	Full and thick
<b>T-26</b>	<b>MBL-4</b>	Full and thick, Empty at the basal portion
<b>T-27</b>	<b>MBL-5</b>	Partially thick and thin
<b>T-28</b>	<b>MBL-6</b>	Full and thick
<b>T-29</b>	<b>MBL-7</b>	Full and thick, depressed at the basal end
<b>T-30</b>	<b>MBL-8</b>	Full and uniformly thick

#### 4.1.19: Stone shape.

The data regarding to stone body of mango genotypes for both years have been given in Table 4.20.

**Table 4.20. Stone shape of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Stone shape</b>
<b>T-1</b>	<b>Amrapali</b>	Elliptical
<b>T-2</b>	<b>Nayab</b>	Oblong
<b>T-3</b>	<b>Bombay Green</b>	Oblong
<b>T-4</b>	<b>Makhan</b>	Oblong
<b>T-5</b>	<b>Green Sweet</b>	Oblong
<b>T-6</b>	<b>Langra</b>	Almost oblong with a narrow (pointed) and empty basal end and rounded apical end
<b>T-7</b>	<b>Hushnara</b>	Oblong
<b>T-8</b>	<b>Desi-Sipia</b>	Elliptical
<b>T-9</b>	<b>Sultan</b>	Nearly Oblongish
<b>T-10</b>	<b>Dashehari</b>	Elliptical
<b>T-11</b>	<b>Zardalu</b>	Oblong
<b>T-12</b>	<b>Taimuriaya</b>	Elliptical
<b>T-13</b>	<b>Desi – Amin</b>	Oblong with basal end some -what pointed
<b>T-14</b>	<b>Chausa</b>	Oblong
<b>T-15</b>	<b>Lucknow Safeda</b>	Almost reniform
<b>T-16</b>	<b>Tukumi</b>	Oblong
<b>T-17</b>	<b>Fazli</b>	Elliptically curved
<b>T-18</b>	<b>Ramkela</b>	Nearly Oblongish
<b>T-19</b>	<b>Neelum</b>	Almost elliptical
<b>T-20</b>	<b>Shahtuki</b>	Oblong
<b>T-21</b>	<b>Khasam-Khas</b>	Elliptical
<b>T-22</b>	<b>Jauhari</b>	Oblong
<b>T-23</b>	<b>Rangila</b>	Oblong
<b>T-24</b>	<b>MBL-2</b>	Nearly oblong
<b>T-25</b>	<b>MBL-3</b>	Oblongish
<b>T-26</b>	<b>MBL-4</b>	Reniform
<b>T-27</b>	<b>MBL-5</b>	Oblong
<b>T-28</b>	<b>MBL-6</b>	Oblong
<b>T-29</b>	<b>MBL-7</b>	Oblong
<b>T-30</b>	<b>MBL-8</b>	Elliptical curved



6. A general view of stone length (cm) and stone breadth (cm) is being measured in laboratory.



#### 4.1.20: Stone size

The data regarding to stone size of mango genotypes for both years have been given in Table 4.21.

**Table 4.21. Stone size of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Stone</b>
<b>T-1</b>	<b>Amrapali</b>	Big
<b>T-2</b>	<b>Nayab</b>	Medium
<b>T-3</b>	<b>Bombay Green</b>	Medium
<b>T-4</b>	<b>Makhan</b>	Small
<b>T-5</b>	<b>Green sweet</b>	Small
<b>T-6</b>	<b>Langra</b>	Big
<b>T-7</b>	<b>Hushnara</b>	Big
<b>T-8</b>	<b>Desi-Sipia</b>	Small
<b>T-9</b>	<b>Sultan</b>	Medium
<b>T-10</b>	<b>Dashehari</b>	Big
<b>T-11</b>	<b>Zardalu</b>	Medium
<b>T-12</b>	<b>Taimuriaya</b>	Medium
<b>T-13</b>	<b>Desi – Amin</b>	Big
<b>T-14</b>	<b>Chausa</b>	Big
<b>T-15</b>	<b>Lucknow Safeda</b>	Medium
<b>T-16</b>	<b>Tukumi</b>	Medium
<b>T-17</b>	<b>Fazli</b>	Big
<b>T-18</b>	<b>Ramkela</b>	Small
<b>T-19</b>	<b>Neelum</b>	Big
<b>T-20</b>	<b>Shahtuki</b>	Small
<b>T-21</b>	<b>Khasam-Khas</b>	Small
<b>T-22</b>	<b>Jauhari</b>	Small
<b>T-23</b>	<b>Rangila</b>	Medium
<b>T-24</b>	<b>MBL-2</b>	Big
<b>T-25</b>	<b>MBL-3</b>	Medium
<b>T-26</b>	<b>MBL-4</b>	Small
<b>T-27</b>	<b>MBL-5</b>	Small
<b>T-28</b>	<b>MBL-6</b>	Medium
<b>T-29</b>	<b>MBL-7</b>	Small
<b>T-30</b>	<b>MBL-8</b>	Small

#### **4.1.21: Stone length (cm)**

The data pertaining to length of stone in cm for different genotypes has been given in Table 4.22 and represented pictorially in Fig.10. The analysis of variance table showed that the variation among the genotypes were highly significant in respect of length of stone in both the years as well as pooled analysis.

In 2018-19, the scrutiny of data clearly revealed that there was a significant difference in stone length among the genotypes. The minimum stone length (3.92 cm) was recorded in genotype Shahtuki. Maximum stone length produced Fazli (10.35 cm) followed by Chausa (8.64 cm) and Langra (8.13 cm) respectively.

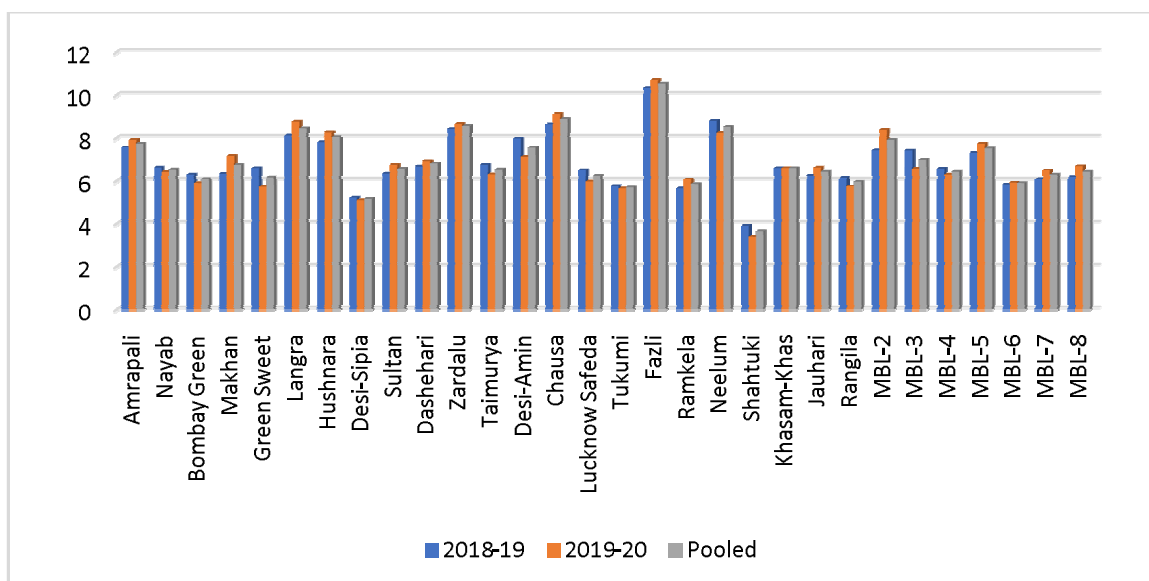
During 2019-20, the analysis of data indicated again significant result among the genotypes. The minimum stone length (3.40 cm) was recorded in genotype Shahtuki. Maximum stone length produced Fazli (10.72 cm) followed by Chausa (9.13 cm) and Langra (8.78 cm).

The analysis of combined data showed that the minimum stone length was observed in genotype Shahtuki (3.66 cm). Maximum stone length produced genotype Fazli (10.54 cm) followed by Chausa (8.89 cm) and Langra (8.46 cm).

**Table 4.22. Stone length of different mango genotypes.**

Treatments	Genotypes	Stone length (cm)		
		2018-19	2019-20	Pooled
T-1	Amrapali	7.58	7.91	7.75
T-2	Nayab	6.63	6.44	6.54
T-3	Bombay Green	6.30	5.90	6.10
T-4	Makhan	6.34	7.16	6.75
T-5	Green Sweet	6.61	5.74	6.18
T-6	Langra	8.13	8.78	8.46
T-7	Hushnara	7.81	8.28	8.05
T-8	Desi-Sipia	5.23	5.12	5.18
T-9	Sultan	6.36	6.76	6.56
T-10	Dashehari	6.69	6.94	6.82
T-11	Zardalu	8.44	8.67	8.56
T-12	Taimuriaya	6.77	6.31	6.54
T-13	Desi – Amin	7.98	7.13	7.56
T-14	Chausa	8.64	9.13	8.89
T-15	Lucknow Safeda	6.51	5.98	6.25
T-16	Tukumi	5.77	5.66	5.72
T-17	Fazli	10.35	10.72	10.54
T-18	Ramkela	5.66	6.08	5.87
T-19	Neelum	8.81	8.24	8.53
T-20	Shahtuki	3.92	3.40	3.66
T-21	Khasam-Khas	6.61	6.61	6.61
T-22	Jauhari	6.26	6.63	6.45
T-23	Rangila	6.17	5.76	5.97
T-24	MBL-2	7.45	8.39	7.92
T-25	MBL-3	7.44	6.57	7.01
T-26	MBL-4	6.59	6.30	6.45
T-27	MBL-5	7.33	7.75	7.54
T-28	MBL-6	5.85	5.94	5.90
T-29	MBL-7	6.10	6.50	6.30
T-30	MBL-8	6.20	6.70	6.45
SEm±		0.214	0.372	0.293
C.D at 5%		0.607	1.054	0.831

**Figure 4.10. Stone length (cm) of different mango genotypes.**



#### 4.1.22: Stone breadth (cm).

The data pertaining to breadth of stone in cm for different genotypes has been given in Table 4.23 and represented pictorially in Fig. 4.11. The analysis of variance table showed that the variation among the genotypes were highly significant in respect of breadth of stone in both the years as well as pooled analysis.

In 2018-19, the scrutiny of data clearly reveals that there was a significant difference in stone breadth among the genotypes. The minimum stone breadth (2.23 cm) was recorded in genotype Shahtuki. Maximum stone breadth produced genotype Fazli (4.34cm) followed by Chausa (3.97 cm) and Langra (3.79 cm).

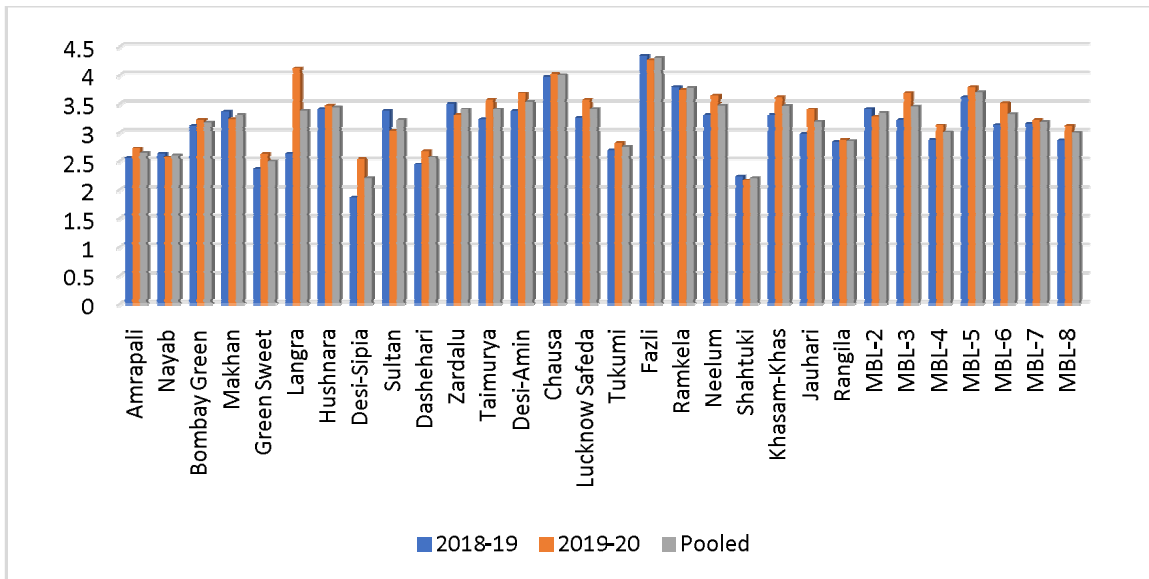
During 2019-20, the analysis of data indicated again significant result among the genotypes. The minimum stone breadth (2.16 cm) was recorded in genotypes Shahtuki. Maximum stone breadth produced genotype Fazli (4.26 cm) followed by Chausa (3.74 cm) and Langra (3.74 cm).

The analysis of combined data showed that the minimum stone breadth was observed in genotype Shahtuki (2.20 cm). Maximum stone breadth produced genotype Fazli (4.30 cm) followed by Chausa (4.00 cm) and Langra (3.77 cm).

**Table 4.23. Stone breadth (cm) of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	2.55	2.72	2.64
<b>T-2</b>	<b>Nayab</b>	2.63	2.56	2.60
<b>T-3</b>	<b>Bombay Green</b>	3.11	3.22	3.17
<b>T-4</b>	<b>Makhan</b>	3.36	3.23	3.30
<b>T-5</b>	<b>Green Sweet</b>	2.36	2.62	2.49
<b>T-6</b>	<b>Langra</b>	3.79	3.74	3.77
<b>T-7</b>	<b>Hushnara</b>	3.41	3.47	3.44
<b>T-8</b>	<b>Desi-Sipia</b>	1.86	2.53	2.20
<b>T-9</b>	<b>Sultan</b>	3.38	3.03	3.21
<b>T-10</b>	<b>Dashehari</b>	2.44	2.67	2.56
<b>T-11</b>	<b>Zardalu</b>	3.5	3.30	3.40
<b>T-12</b>	<b>Taimuriaya</b>	3.23	3.57	3.40
<b>T-13</b>	<b>Desi – Amin</b>	3.37	3.68	3.53
<b>T-14</b>	<b>Chuasa</b>	3.97	4.02	4.00
<b>T-15</b>	<b>Lucknow Safeda</b>	3.25	3.57	3.41
<b>T-16</b>	<b>Tukumi</b>	2.68	2.81	2.75
<b>T-17</b>	<b>Fazli</b>	4.34	4.26	4.30
<b>T-18</b>	<b>Ramkela</b>	3.44	3.39	3.41
<b>T-19</b>	<b>Neelum</b>	3.30	3.64	3.47
<b>T-20</b>	<b>Shahtuki</b>	2.23	2.16	2.20
<b>T-21</b>	<b>Khasam-Khas</b>	3.30	3.61	3.46
<b>T-22</b>	<b>Jauhari</b>	2.97	3.40	3.19
<b>T-23</b>	<b>Rangila</b>	2.83	2.87	2.85
<b>T-24</b>	<b>MBL-2</b>	3.41	3.27	3.34
<b>T-25</b>	<b>MBL-3</b>	3.21	3.69	3.45
<b>T-26</b>	<b>MBL-4</b>	2.87	3.12	3.00
<b>T-27</b>	<b>MBL-5</b>	2.91	2.79	2.85
<b>T-28</b>	<b>MBL-6</b>	3.13	3.51	3.32
<b>T-29</b>	<b>MBL-7</b>	3.15	3.21	3.18
<b>T-30</b>	<b>MBL-8</b>	2.86	3.11	2.99
<b>SEm±</b>		0.165	0.129	0.147
<b>C.D at 5%</b>		0.467	0.366	0.416

**Figure 4.11. Stone breadth (cm) of different mango genotypes.**



#### 4.1.23: Stone thickness (cm).

The data pertaining to thickness of stone in cm for different genotypes has been given in Table 4.24 and represented pictorially in Fig. 4.12. The analysis of variance table showed that the variation among the genotypes were highly significant in respect of thickness of stone in both the years as well as pooled analysis.

In 2018-19, the scrutiny of data clearly revealed that there was a significant difference in stone thickness among the genotypes. The minimum stone thickness (1.25 cm) was recorded in genotype Desi- Sipia. Maximum stone thickness produced Fazli (2.71 cm) followed by Chausa (2.61cm) and Zardalu (2.47 cm).

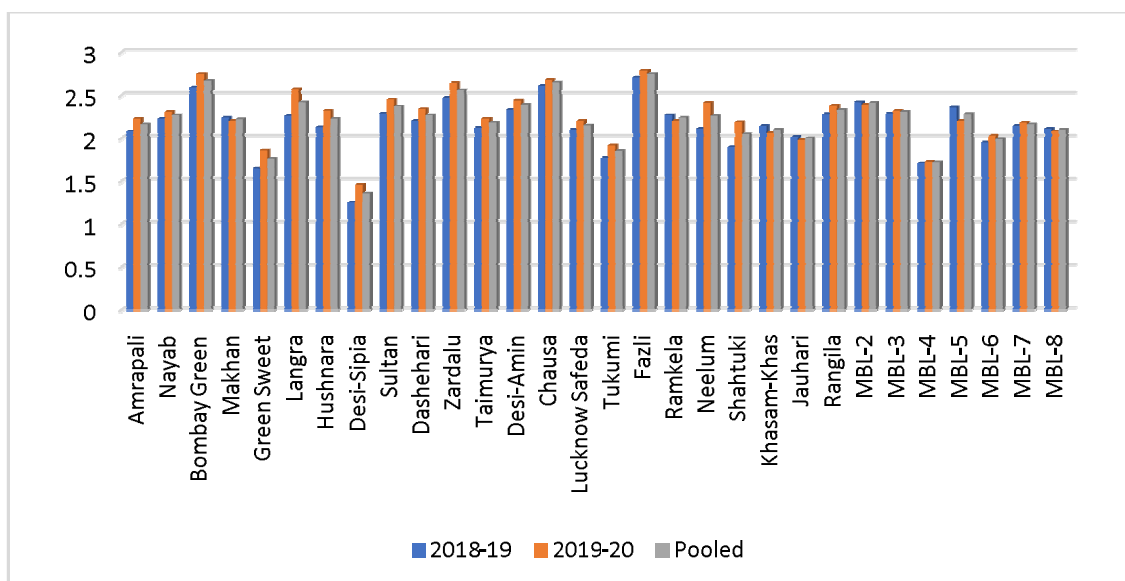
During 2019-20, the analysis of data indicated again significant result among the genotypes. The minimum stone thickness (1.46 cm) was recorded in genotype Desi-Sipia. Maximum stone thickness produced Fazli (2.79 cm). followed by Chausa (2.68 cm) and Zardalu (2.65 cm).

The analysis of combined data showed that the minimum stone thickness was observed in genotype Desi- Sipia (1.36 cm). Maximum stone thickness produced Fazli (2.75 cm). followed by Chausa (2.65 cm) and Zardalu (2.56 cm).

**Table 4.24: Stone thickness (cm) of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	2.08	2.23	2.16
<b>T-2</b>	<b>Nayab</b>	2.23	2.31	2.27
<b>T-3</b>	<b>Bombay Green</b>	2.59	2.75	2.67
<b>T-4</b>	<b>Makhan</b>	2.24	2.20	2.22
<b>T-5</b>	<b>Green Sweet</b>	1.65	1.86	1.76
<b>T-6</b>	<b>Langra</b>	2.26	2.57	2.42
<b>T-7</b>	<b>Hushnara</b>	2.13	2.32	2.23
<b>T-8</b>	<b>Desi-Sipia</b>	1.25	1.46	1.36
<b>T-9</b>	<b>Sultan</b>	2.29	2.45	2.37
<b>T-10</b>	<b>Dashehari</b>	2.20	2.34	2.27
<b>T-11</b>	<b>Zardalu</b>	2.47	2.64	2.56
<b>T-12</b>	<b>Taimuriaya</b>	2.12	2.23	2.18
<b>T-13</b>	<b>Desi – Amin</b>	2.33	2.44	2.39
<b>T-14</b>	<b>Chuasa</b>	2.61	2.68	2.65
<b>T-15</b>	<b>Lucknow Safeda</b>	2.10	2.20	2.15
<b>T-16</b>	<b>Tukumi</b>	1.77	1.92	1.85
<b>T-17</b>	<b>Fazli</b>	2.71	2.79	2.75
<b>T-18</b>	<b>Ramkela</b>	2.27	2.20	2.24
<b>T-19</b>	<b>Neelum</b>	2.11	2.41	2.26
<b>T-20</b>	<b>Shahtuki</b>	1.90	2.19	2.05
<b>T-21</b>	<b>Khasam-Khas</b>	2.14	2.06	2.10
<b>T-22</b>	<b>Jauhari</b>	2.02	1.98	2.00
<b>T-23</b>	<b>Rangila</b>	2.28	2.38	2.33
<b>T-24</b>	<b>MBL-2</b>	2.42	2.39	2.41
<b>T-25</b>	<b>MBL-3</b>	2.29	2.32	2.31
<b>T-26</b>	<b>MBL-4</b>	1.71	1.73	1.72
<b>T-27</b>	<b>MBL-5</b>	2.36	2.20	2.28
<b>T-28</b>	<b>MBL-6</b>	1.95	2.03	1.99
<b>T-29</b>	<b>MBL-7</b>	2.14	2.18	2.16
<b>T-30</b>	<b>MBL-8</b>	2.11	2.08	2.10
<b>SEm±</b>		0.114	0.111	0.112
<b>C.D at 5%</b>		0.323	0.316	0.319

**Figure 4.12. Stone thickness (cm) of different mango genotypes.**



#### 4.1.24: Stone weight (g).

The data pertaining to weight of stone in cm for different genotypes have been given in Table 4.25 and represented pictorially in Fig. 4.13. The analysis of variance table showed that the variation among the genotypes were highly significant in respect of weight of stone in both the year as well as pooled analysis.

In 2018-19, the scrutiny of data clearly revealed that there was a significant difference in stone weight among the genotypes. Maximum stone weight produced Fazli (48.44 g) followed by Chausa (47.53 g) and Zardalu (37.97 g). The minimum stone weight (23.95 g) was recorded in genotype Shahtuki.

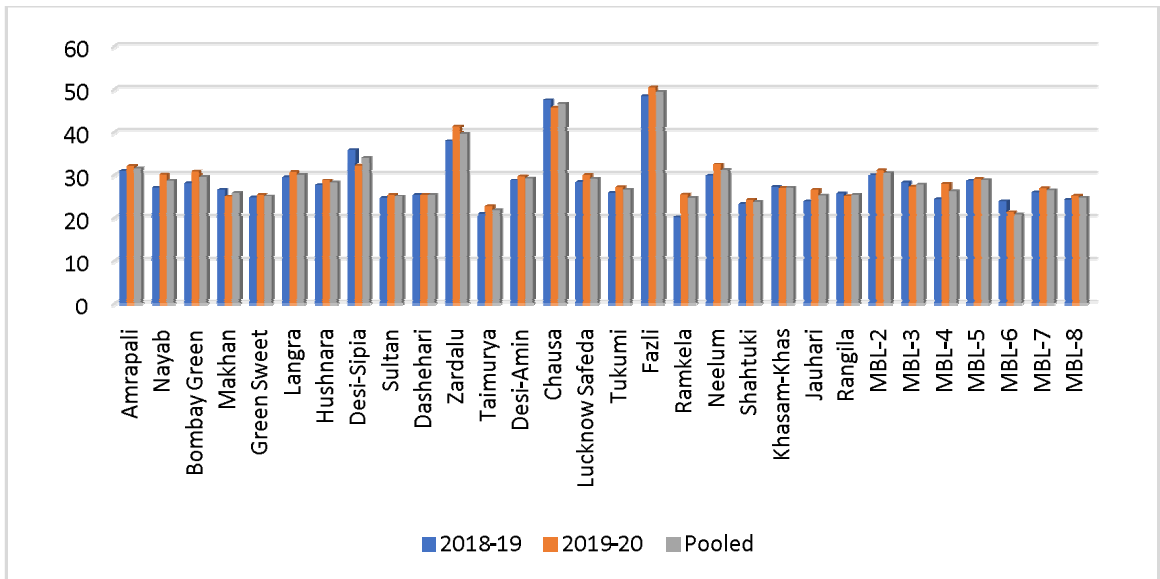
During 2019-s20, Maximum stone weight produced Fazli (50.49 g). followed by Chausa (45.82 g) and Zardalu (41.37 g). The minimum stone weight (21.39 g) was recorded in genotype Shahtuki.

The analysis of combined data showed that the minimum stone weight (21.38 g) was observed in genotype Shahtuki. Maximum stone weight produced Fazli (49.47 cm) followed by Chausa (46.70 cm) and Langra (39.67 cm) respectively.

**Table 4.25. Stone weight (g) of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Pooled</b>
<b>T-1</b>	<b>Amrapali</b>	31.02	32.06	31.54
<b>T-2</b>	<b>Nayab</b>	27.16	30.17	28.67
<b>T-3</b>	<b>Bombay Green</b>	28.15	30.93	29.54
<b>T-4</b>	<b>Makhan</b>	26.56	25.02	25.79
<b>T-5</b>	<b>Green Sweet</b>	24.82	25.40	25.11
<b>T-6</b>	<b>Langra</b>	29.48	30.78	30.13
<b>T-7</b>	<b>Hushnara</b>	27.72	28.79	28.25
<b>T-8</b>	<b>Desi-Sipia</b>	35.78	32.24	34.01
<b>T-9</b>	<b>Sultan</b>	24.76	25.37	25.07
<b>T-10</b>	<b>Dashehari</b>	25.37	25.38	25.37
<b>T-11</b>	<b>Zardalu</b>	37.97	41.37	39.67
<b>T-12</b>	<b>Taimuriaya</b>	20.98	22.77	21.88
<b>T-13</b>	<b>Desi – Amin</b>	28.79	29.76	29.28
<b>T-14</b>	<b>Chuasa</b>	47.53	45.82	46.68
<b>T-15</b>	<b>Lucknow Safeda</b>	28.38	30.10	29.24
<b>T-16</b>	<b>Tukumi</b>	25.91	27.26	26.58
<b>T-17</b>	<b>Fazli</b>	48.44	50.49	49.46
<b>T-18</b>	<b>Ramkela</b>	20.21	25.55	24.75
<b>T-19</b>	<b>Neelum</b>	29.88	32.49	31.18
<b>T-20</b>	<b>Shahtuki</b>	23.30	24.27	23.79
<b>T-21</b>	<b>Khasam-Khas</b>	27.28	27.02	27.15
<b>T-22</b>	<b>Jauhari</b>	23.95	26.56	25.26
<b>T-23</b>	<b>Rangila</b>	25.71	25.15	25.43
<b>T-24</b>	<b>MBL-2</b>	29.95	31.13	30.54
<b>T-25</b>	<b>MBL-3</b>	28.26	27.32	27.79
<b>T-26</b>	<b>MBL-4</b>	24.41	28.01	26.21
<b>T-27</b>	<b>MBL-5</b>	28.69	29.12	28.90
<b>T-28</b>	<b>MBL-6</b>	23.95	21.39	20.80
<b>T-29</b>	<b>MBL-7</b>	26.03	26.95	26.49
<b>T-30</b>	<b>MBL-8</b>	24.30	25.23	24.77
<b>SEm±</b>		0.819	1.526	1.172
<b>C.D at 5%</b>		2.322	4.328	3.32

**Figure 4.13. Stone weight (g) of different mango genotypes.**



#### 4.1.25: Stone marking

The data regarding to stone size of mango genotypes for both years have been given in Table 4.26.

**Table 4.26. Stone marking of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>Stone marking</b>
<b>T-1</b>	<b>Amrapali</b>	Veins prominently raised
<b>T-2</b>	<b>Nayab</b>	Veins almost on the surface level
<b>T-3</b>	<b>Bombay Green</b>	Veins slightly depressed or may be slightly raised
<b>T-4</b>	<b>Makhan</b>	Veins almost on the surface level
<b>T-5</b>	<b>Green Sweet</b>	Veins prominently grooved
<b>T-6</b>	<b>Langra</b>	Veins slightly depressed on the surface level
<b>T-7</b>	<b>Hushnara</b>	Veins almost on the surface level
<b>T-8</b>	<b>Desi-Sipia</b>	Veins slightly raised
<b>T-9</b>	<b>Sultan</b>	Veins depressed
<b>T-10</b>	<b>Dashehari</b>	Veins almost on the surface level
<b>T-11</b>	<b>Zardalu</b>	Veins slightly raised
<b>T-12</b>	<b>Taimuriaya</b>	Veins slightly depressed
<b>T-13</b>	<b>Desi – Amin</b>	Veins slightly depressed
<b>T-14</b>	<b>Chuasa</b>	Veins slightly depressed
<b>T-15</b>	<b>Lucknow Safeda</b>	Veins depressed and may be covered by short fibres
<b>T-16</b>	<b>Tukumi</b>	Veins on the surface level
<b>T-17</b>	<b>Fazli</b>	Veins almost surface level
<b>T-18</b>	<b>Ramkela</b>	Abundant, all over the surface, longer tuft of fibres on the ventral edge only
<b>T-19</b>	<b>Neelum</b>	Veins prominently raised
<b>T-20</b>	<b>Shahtuki</b>	Veins depressed
<b>T-21</b>	<b>Khasam-Khas</b>	Veins grooved and covered by long fibre
<b>T-22</b>	<b>Jauhari</b>	Veins slightly raised
<b>T-23</b>	<b>Rangila</b>	Veins slightly depressed
<b>T-24</b>	<b>MBL-2</b>	Veins slightly depressed
<b>T-25</b>	<b>MBL-3</b>	Veins prominently raised
<b>T-26</b>	<b>MBL-4</b>	Veins depressed
<b>T-27</b>	<b>MBL-5</b>	Veins almost on the surface level
<b>T-28</b>	<b>MBL-6</b>	Veins slightly depressed
<b>T-29</b>	<b>MBL-7</b>	Veins slightly depressed
<b>T-30</b>	<b>MBL-8</b>	Veins slightly raised

## **4.2. Biochemical characters:**

### **4.2.1. T.S.S. (<sup>0</sup>B):**

The data concerning to total soluble solids (T.S.S.) content in juice of mango fruit for both the years and their means are provided in Table 4.27 and depicted pictorially in Fig. 4.14.

The scrutiny of data in 2018-19, clearly indicated that the genotypes differed significantly with respect to T.S.S. content in fruits. The maximum T.S.S. content (23.90<sup>0</sup>Brix) was recorded in Chausa followed by Amrapali (21.32<sup>0</sup>Brix) and Langra (20.55<sup>0</sup>Brix). Minimum value was obtained in genotype MBL-4 (15.28<sup>0</sup>Brix).

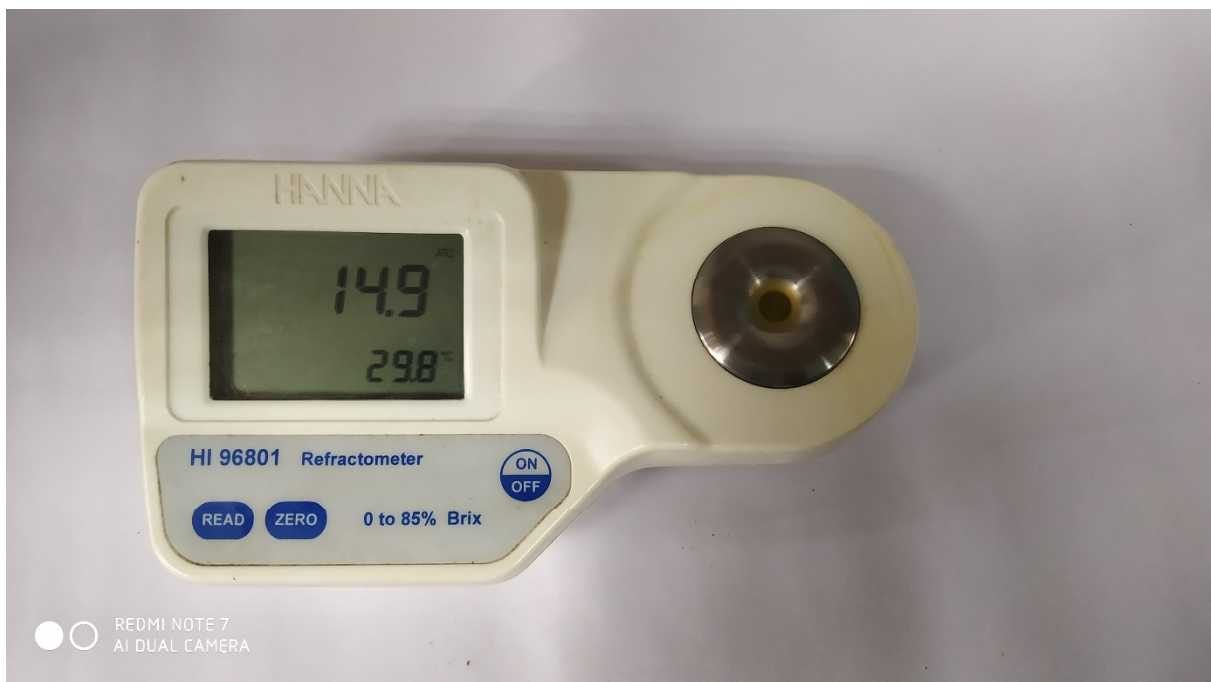
During 2019-20, again significant difference was observed in T.S.S. content and maximum value was recorded in Chausa (24.13 °Brix) followed by Amrapali (20.38<sup>0</sup>Brix) and Langra (21.38<sup>0</sup>Brix). Minimum value was obtained in genotype MBL-4 (15.57<sup>0</sup>Brix)

An observation of the pooled data indicated that there was significant difference in T.S.S among the genotypes under study. The analysis of variance indicated that Chausa had maximum T.S.S (24.02<sup>0</sup>Brix) followed by Amrapali (21.35<sup>0</sup>Brix) and Langra (20.43<sup>0</sup>Brix). Minimum value was obtained in genotype MBL-4 (15.43<sup>0</sup>Brix).

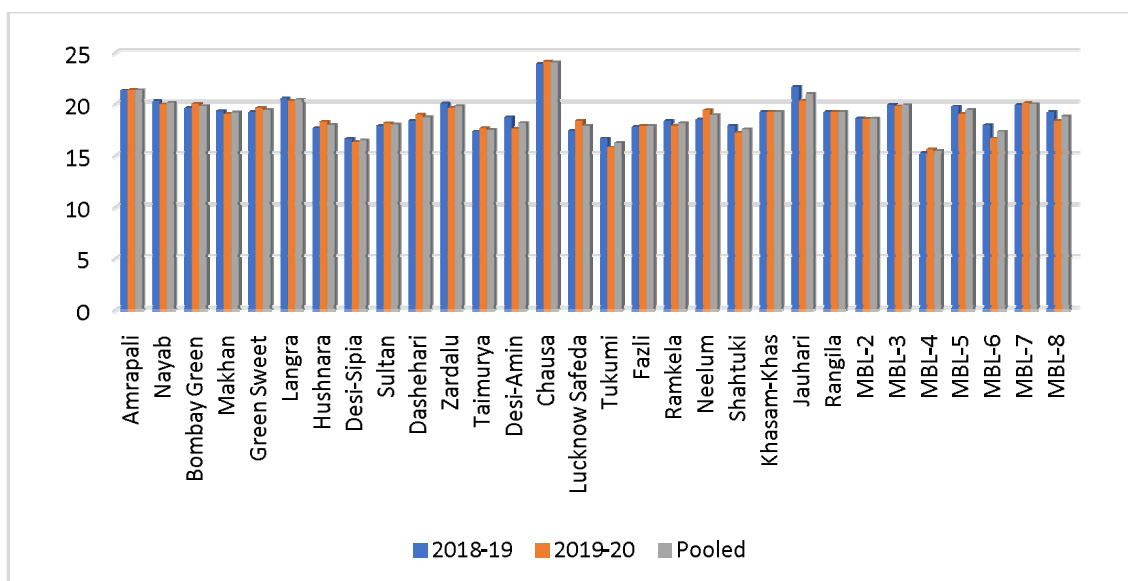
**Table 4.27. T.S.S of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Polled</b>
<b>T-1</b>	<b>Amrapali</b>	21.32	21.38	21.35
<b>T-2</b>	<b>Nayab</b>	20.29	19.99	20.14
<b>T-3</b>	<b>Bombay Green</b>	19.59	20.02	19.81
<b>T-4</b>	<b>Makhan</b>	19.31	19.03	19.17
<b>T-5</b>	<b>Green Sweet</b>	19.20	19.62	19.41
<b>T-6</b>	<b>Langra</b>	20.55	20.31	20.43
<b>T-7</b>	<b>Hushnara</b>	17.64	18.28	17.96
<b>T-8</b>	<b>Desi-Sipia</b>	16.60	16.28	16.44
<b>T-9</b>	<b>Sultan</b>	17.86	18.12	17.99
<b>T-10</b>	<b>Dashehari</b>	18.39	18.98	18.69
<b>T-11</b>	<b>Zardalu</b>	20.04	19.60	19.82
<b>T-12</b>	<b>Taimurya</b>	17.33	17.63	17.48
<b>T-13</b>	<b>Desi – Amin</b>	18.68	17.60	18.14
<b>T-14</b>	<b>Chausa</b>	23.90	24.13	24.02
<b>T-15</b>	<b>Lucknow Safeda</b>	17.41	18.36	17.89
<b>T-16</b>	<b>Tukumi</b>	16.64	15.79	16.22
<b>T-17</b>	<b>Fazli</b>	17.78	17.89	17.84
<b>T-18</b>	<b>Ramkela</b>	18.35	17.91	18.13
<b>T-19</b>	<b>Neelum</b>	18.49	19.38	18.94
<b>T-20</b>	<b>Shahtuki</b>	17.90	17.22	17.56
<b>T-21</b>	<b>Khasam-Khas</b>	19.23	19.25	19.24
<b>T-22</b>	<b>Jauhari</b>	21.65	20.34	21.00
<b>T-23</b>	<b>Rangila</b>	19.21	19.26	19.24
<b>T-24</b>	<b>MBL-2</b>	18.61	18.58	18.60
<b>T-25</b>	<b>MBL-3</b>	19.96	19.79	19.88
<b>T-26</b>	<b>MBL-4</b>	15.28	15.57	15.43
<b>T-27</b>	<b>MBL-5</b>	19.75	19.02	19.39
<b>T-28</b>	<b>MBL-6</b>	17.95	16.65	17.30
<b>T-29</b>	<b>MBL-7</b>	19.92	20.07	20.00
<b>T-30</b>	<b>MBL-8</b>	19.20	18.39	18.80
<b>SEm±</b>		0.80	0.632	0.716
<b>C.D at 5%</b>		2.27	1.79	2.04

## 7. Estimation of total soluble solids ( $^{\circ}$ Brix).



**Figure 4.14. T.S.S. (<sup>0</sup>Brix) of different mango genotypes.**



#### 4.2.2. Reducing sugar (%):

The data concerning to reducing sugar for both the years and their mean are presented in Table 4.28 and displayed graphically in Fig. 4.15.

From the analysis of variance table in year 2018-19, it is clear that the significant difference occurred in reducing sugars due to different genotypes. Maximum value (5.34%) was found in Amrapali followed by Chausa (5.18%) and Langra (5.15%). Minimum value (3.15%) was obtained in genotype MBL-4.

Further during 2019-20, analysis of variance table showed that again significant difference persists in different genotypes. Maximum value (5.27%) was found in Amrapali followed by Chausa (5.12%) and Langra (4.97%). Minimum value (3.11%) was obtained in genotype MBL-4.

The value of reducing sugar was observed in Amrapali (5.31%) followed by Chausa (5.15 %) and Langra (5.06 %) However, Minimum value (3.13%) was obtained in genotype MBL-4.

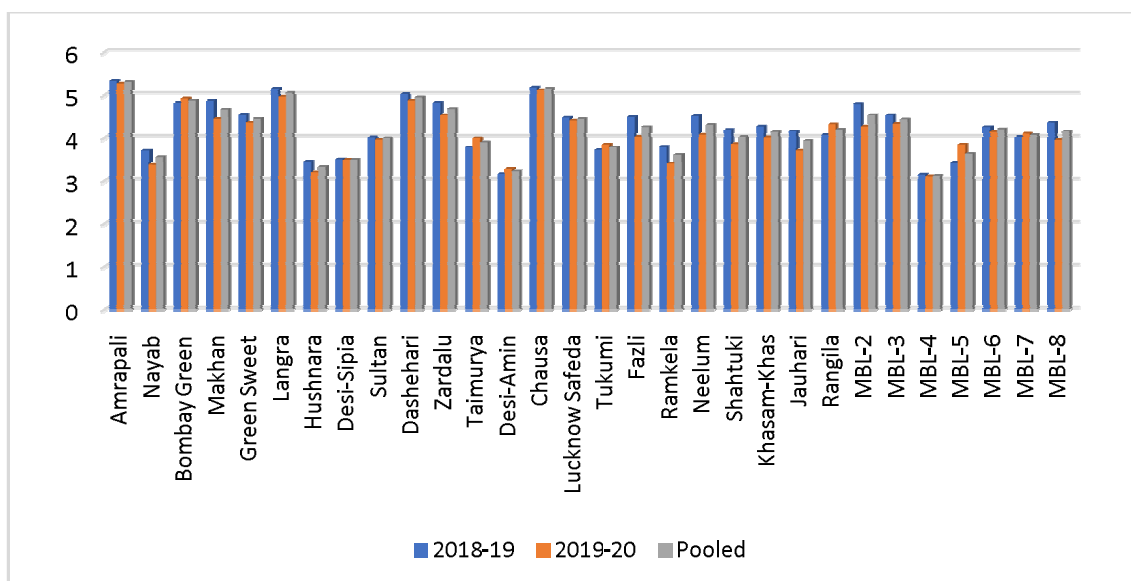
## 8. A general view of biochemical analysis.



**Table 4.28. Reducing sugar of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Polled</b>
<b>T-1</b>	<b>Amrapali</b>	5.34	5.27	5.31
<b>T-2</b>	<b>Nayab</b>	3.72	3.39	3.56
<b>T-3</b>	<b>Bombay Green</b>	4.82	4.93	4.88
<b>T-4</b>	<b>Makhan</b>	4.87	4.46	4.67
<b>T-5</b>	<b>Green sweet</b>	4.55	4.36	4.46
<b>T-6</b>	<b>Langra</b>	5.15	4.97	5.06
<b>T-7</b>	<b>Hushnara</b>	3.45	3.20	3.33
<b>T-8</b>	<b>Desi-Sipia</b>	3.51	3.49	3.50
<b>T-9</b>	<b>Sultan</b>	4.02	3.97	4.00
<b>T-10</b>	<b>Dashehari</b>	5.03	4.88	4.96
<b>T-11</b>	<b>Zardalu</b>	4.82	4.54	4.68
<b>T-12</b>	<b>Taimurya</b>	3.79	4.00	3.90
<b>T-13</b>	<b>Desi – Amin</b>	3.16	3.28	3.23
<b>T-14</b>	<b>Chausa</b>	5.18	5.12	5.15
<b>T-15</b>	<b>Lucknow Safeda</b>	4.48	4.42	4.45
<b>T-16</b>	<b>Tukumi</b>	3.73	3.85	3.79
<b>T-17</b>	<b>Fazli</b>	4.49	4.03	4.26
<b>T-18</b>	<b>Ramkela</b>	3.80	3.41	3.61
<b>T-19</b>	<b>Neelum</b>	4.52	4.09	4.31
<b>T-20</b>	<b>Shahtuki</b>	4.19	3.86	4.03
<b>T-21</b>	<b>Khasam-Khas</b>	4.27	4.02	4.15
<b>T-22</b>	<b>Jauhari</b>	4.16	3.72	3.94
<b>T-23</b>	<b>Rangila</b>	4.08	4.32	4.20
<b>T-24</b>	<b>MBL-2</b>	4.80	4.27	4.54
<b>T-25</b>	<b>MBL-3</b>	4.54	4.34	4.44
<b>T-26</b>	<b>MBL-4</b>	3.15	3.11	3.13
<b>T-27</b>	<b>MBL-5</b>	3.43	3.85	3.64
<b>T-28</b>	<b>MBL-6</b>	4.26	4.15	4.21
<b>T-29</b>	<b>MBL-7</b>	4.04	4.11	4.08
<b>T-30</b>	<b>MBL-8</b>	4.36	3.96	4.16
<b>SEm±</b>		0.28	0.21	0.25
<b>C.D at 5%</b>		0.80	0.60	0.70

**Figure 4.15.Reducing sugar (%) of different mango genotypes.**



#### 4.2.3. Non-reducing sugar (%):

Non-reducing sugar content of different genotypes of mango was estimated average non-reducing sugar percentage for both the years and their mean has been presented in Table 4.29 and illustrated in Fig. 4.16.

During 2018-19, significant difference in non-reducing sugar percentage was noted Amrapali had maximum non-reducing sugar percentage (13.13%) which was at par with Chausa (12.87 %) followed by Langra (11.51 %). Whereas, minimum non-reducing sugar percentage (6.55 %) was observed in genotype MBL-4.

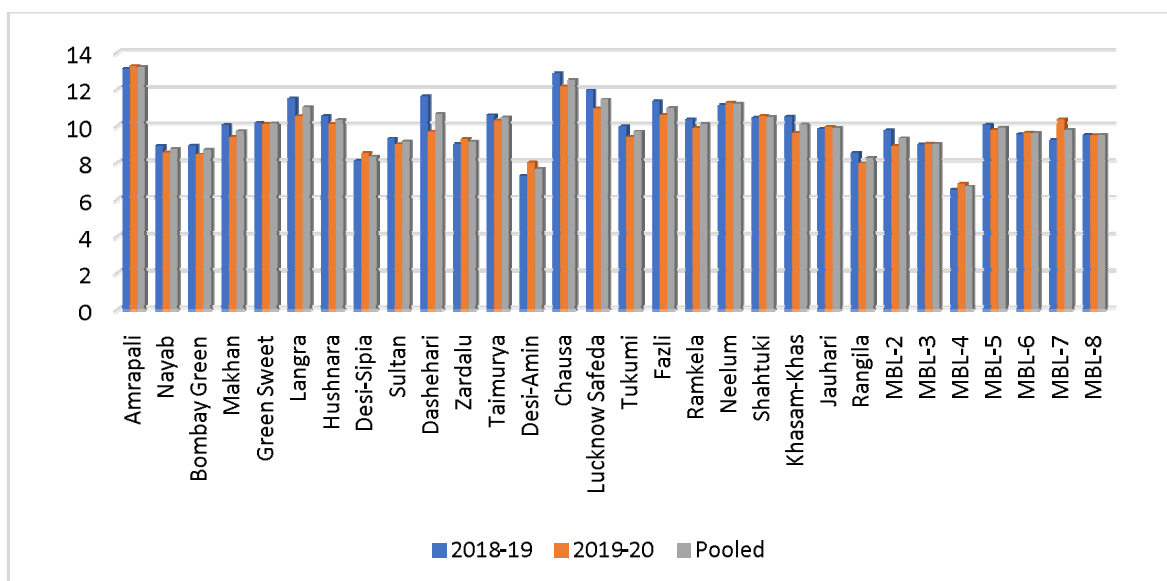
In 2019-20, again significant difference in non-reducing sugar percentage was observed. This year maximum non-reducing sugar percentage was noted in Amrapali (13.26 %) followed by Chuasa (12.17%) and Langra (10.54 %), whereas, minimum non-reducing sugar percentage was noted in genotype MBL-4 (6.86 %).

The pooled analysis of data revealed that there was significant difference in non-- reducing sugar content of different mango genotype. Amrapali was at the top with a value of (13.20%) and followed by Chuasa (12.52%) and Langra (11.03%). Minimum percentage was recorded in genotype MBL-4 (6.71%).

**Table 4.29. Non-reducing sugar of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Polled</b>
<b>T-1</b>	<b>Amrapali</b>	13.13	13.26	13.20
<b>T-2</b>	<b>Nayab</b>	8.94	8.58	8.76
<b>T-3</b>	<b>Bombay Green</b>	8.95	8.46	8.71
<b>T-4</b>	<b>Makhan</b>	10.06	9.42	9.74
<b>T-5</b>	<b>Green Sweet</b>	10.18	10.11	10.15
<b>T-6</b>	<b>Langra</b>	11.51	10.54	11.03
<b>T-7</b>	<b>Hushnara</b>	10.55	10.13	10.34
<b>T-8</b>	<b>Desi-Sipia</b>	8.12	8.54	8.33
<b>T-9</b>	<b>Sultan</b>	9.33	9.01	9.17
<b>T-10</b>	<b>Dashehari</b>	11.62	9.69	10.66
<b>T-11</b>	<b>Zardalu</b>	9.03	9.29	9.16
<b>T-12</b>	<b>Taimurya</b>	10.60	10.32	10.46
<b>T-13</b>	<b>Desi – Amin</b>	7.31	8.02	7.67
<b>T-14</b>	<b>Chausa</b>	12.87	12.17	12.52
<b>T-15</b>	<b>Lucknow Safeda</b>	11.95	10.95	11.45
<b>T-16</b>	<b>Tukumi</b>	9.98	9.43	9.71
<b>T-17</b>	<b>Fazli</b>	11.34	10.62	10.98
<b>T-18</b>	<b>Ramkela</b>	10.36	9.90	10.13
<b>T-19</b>	<b>Neelum</b>	11.15	11.29	11.22
<b>T-20</b>	<b>Shahtuki</b>	10.45	10.55	10.50
<b>T-21</b>	<b>Khasam-Khas</b>	10.52	9.64	10.08
<b>T-22</b>	<b>Jauhari</b>	9.85	9.96	9.91
<b>T-23</b>	<b>Rangila</b>	8.55	7.99	8.27
<b>T-24</b>	<b>MBL-2</b>	9.77	8.93	9.35
<b>T-25</b>	<b>MBL-3</b>	9.00	9.06	9.03
<b>T-26</b>	<b>MBL-4</b>	6.55	6.86	6.71
<b>T-27</b>	<b>MBL-5</b>	10.07	9.79	9.93
<b>T-28</b>	<b>MBL-6</b>	9.56	9.65	9.61
<b>T-29</b>	<b>MBL-7</b>	9.24	10.36	9.80
<b>T-30</b>	<b>MBL-8</b>	9.52	9.49	9.51
<b>SEm±</b>		0.60	0.39	0.50
<b>C.D at 5%</b>		1.90	1.11	1.50

**Figure 4.16. Non-reducing sugar (%) of different mango genotypes.**



#### 4.2.4. Total sugars (%):

The data regarding to totals sugars of fruit for both the years and their mean recorded under different genotypes have been given in Table 4.30 and depicted graphically in Fig. 4.17. The statistical analysis of data clearly indicated that different genotype had exerted significant variations on total sugars of fruit in both the years as well as in combined analysis.

The maximum total sugars in year 2018-19, was obtained in Amrapali (18.47 %) which was at par with Chausa (18.06 %) and Langra (16.66 %). The lower value (9.68 %) was noticed in genotype MBL-4.

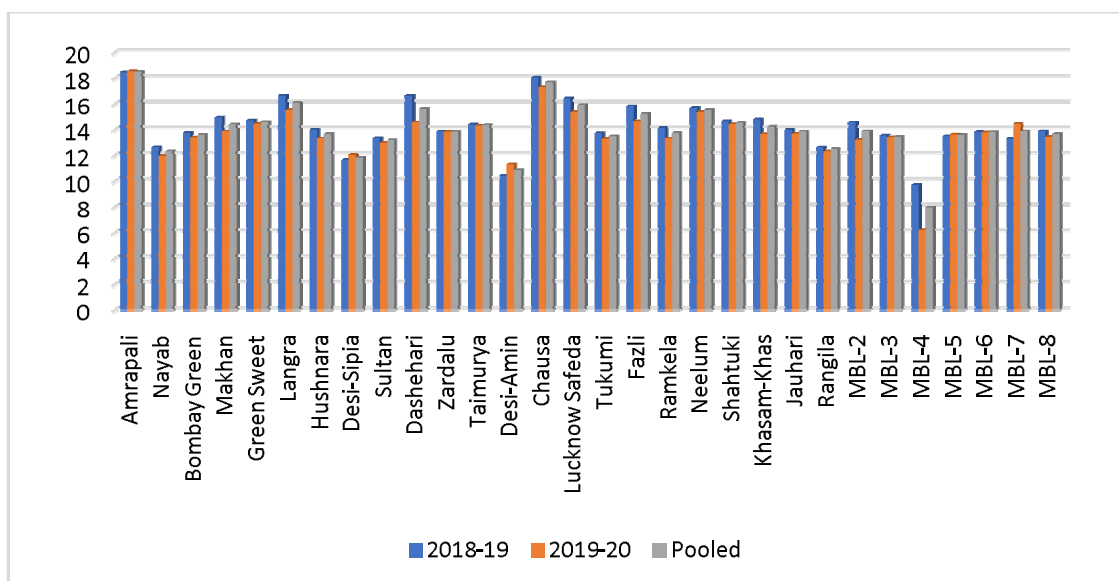
During 2019-20, the data reflected that maximum total sugars percentage was observed in genotype Amrapali (18.53 %) followed by Chausa (17.29%) and Langra (15.51%). While, minimum sugar percentage (9.97 %) was observed in genotype MBL-4.

A perusal of pooled data showed that maximum total sugar percentage was found in Amrapali (18.50%) followed by Chausa (17.68 %) and Langra (16.09 %). Whereas, minimum total sugars percentage (9.83%) was recorded in genotype MBL-4.

**Table 4.30. Total sugars of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Polled</b>
<b>T-1</b>	<b>Amrapali</b>	18.47	18.53	18.50
<b>T-2</b>	<b>Nayab</b>	12.66	11.96	12.31
<b>T-3</b>	<b>Bombay Green</b>	13.77	13.39	13.58
<b>T-4</b>	<b>Makhan</b>	14.93	13.87	14.40
<b>T-5</b>	<b>Green Sweet</b>	14.73	14.47	14.60
<b>T-6</b>	<b>Langra</b>	16.66	15.51	16.09
<b>T-7</b>	<b>Hushnara</b>	14.01	13.32	13.67
<b>T-8</b>	<b>Desi-Sipia</b>	11.64	12.03	11.84
<b>T-9</b>	<b>Sultan</b>	13.35	12.98	13.17
<b>T-10</b>	<b>Dashehari</b>	16.65	14.57	15.61
<b>T-11</b>	<b>Zardalu</b>	13.85	13.83	13.84
<b>T-12</b>	<b>Taimurya</b>	14.39	14.32	14.36
<b>T-13</b>	<b>Desi – Amin</b>	10.44	11.31	10.88
<b>T-14</b>	<b>Chausa</b>	18.06	17.29	17.68
<b>T-15</b>	<b>Lucknow Safeda</b>	16.43	15.37	15.90
<b>T-16</b>	<b>Tukumi</b>	13.71	13.28	13.50
<b>T-17</b>	<b>Fazli</b>	15.83	14.65	15.24
<b>T-18</b>	<b>Ramkela</b>	14.16	13.31	13.74
<b>T-19</b>	<b>Neelum</b>	15.67	15.38	15.53
<b>T-20</b>	<b>Shahtuki</b>	14.65	14.41	14.53
<b>T-21</b>	<b>Khasam-Khas</b>	14.79	13.66	14.23
<b>T-22</b>	<b>Jauhari</b>	14.01	13.68	13.85
<b>T-23</b>	<b>Rangila</b>	12.64	12.31	12.48
<b>T-24</b>	<b>MBL-2</b>	14.57	13.20	13.89
<b>T-25</b>	<b>MBL-3</b>	13.54	13.40	13.47
<b>T-26</b>	<b>MBL-4</b>	9.68	9.97	9.83
<b>T-27</b>	<b>MBL-5</b>	13.50	13.64	13.57
<b>T-28</b>	<b>MBL-6</b>	13.82	13.80	13.81
<b>T-29</b>	<b>MBL-7</b>	13.28	14.47	13.88
<b>T-30</b>	<b>MBL-8</b>	13.88	13.45	13.67
<b>SEm±</b>		0.59	0.46	0.52
<b>C.D at 5%</b>		1.68	1.30	1.49

**Figure 4.17. Total sugars (%) of different mango genotypes.**



#### 4.2.5 Acidity (%)

The acidity of mango juice was estimated and calculated in percentage. Value of acidity for both the years and their mean have been presented in Table 4.31 and displayed graphically in Fig 4.18.

A critical examination of 2018-19, data clearly shows that the significant variation was noticed in different genotypes for acidity. The lowest acidity (0.161%) was obtained in Chausa followed by Amrapali (0.176%) and Langra (0.219 %). The maximum acidity of (0.378 %) was recorded in genotype MBL-4.

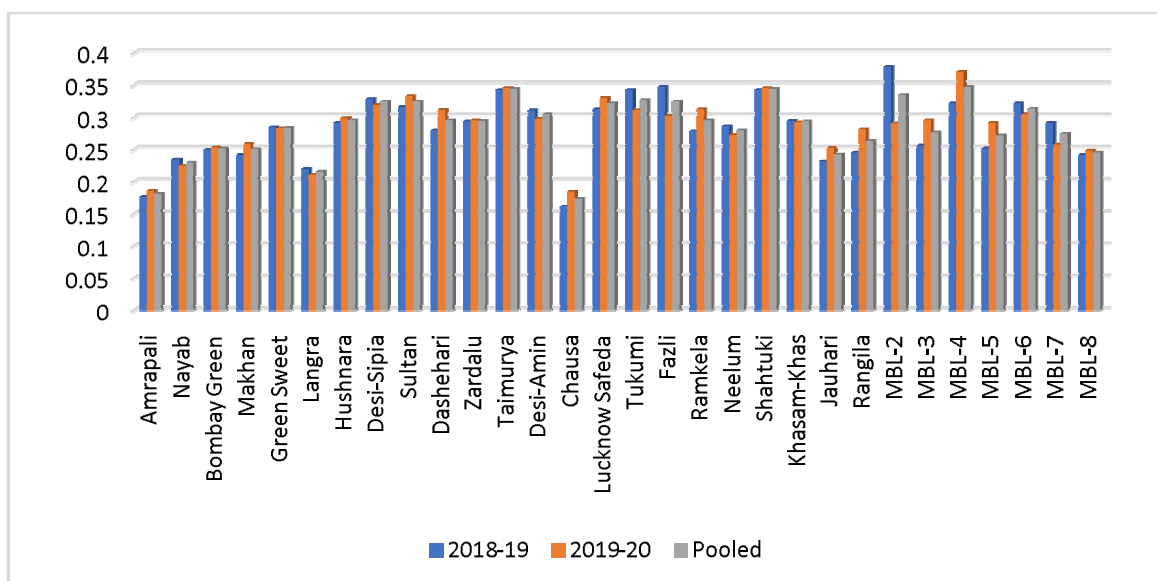
The analysis of variance of 2019-20, further indicated significant difference in acidity. Minimum acidity was recorded in Chausa (0.184%) followed by Amrapali (0.185%) and Langra (0.210 %). The maximum acidity (0.370 %) was recorded in genotype MBL-4.

The observation of combined data reflected that there was significant difference in acidity percentage. Minimum acidity was observed in Chausa (0.173 %) which was at par with genotype Amrapali (0.181 %) and Langra (0.215 %) acidity. Maximum acidity was recorded in genotype MBL-4 (0.374 %).

**Table 4.31. Acidity (%) of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Polled</b>
<b>T-1</b>	<b>Amrapali</b>	0.176	0.185	0.181
<b>T-2</b>	<b>Nayab</b>	0.234	0.224	0.229
<b>T-3</b>	<b>Bombay Green</b>	0.249	0.253	0.251
<b>T-4</b>	<b>Makhan</b>	0.241	0.258	0.250
<b>T-5</b>	<b>Green Sweet</b>	0.284	0.282	0.283
<b>T-6</b>	<b>Langra</b>	0.219	0.210	0.215
<b>T-7</b>	<b>Hushnara</b>	0.291	0.298	0.295
<b>T-8</b>	<b>Desi-Sipia</b>	0.328	0.319	0.324
<b>T-9</b>	<b>Sultan</b>	0.316	0.332	0.324
<b>T-10</b>	<b>Dashehari</b>	0.279	0.311	0.295
<b>T-11</b>	<b>Zardalu</b>	0.293	0.295	0.294
<b>T-12</b>	<b>Taimurya</b>	0.342	0.345	0.344
<b>T-13</b>	<b>Desi – Amin</b>	0.310	0.297	0.304
<b>T-14</b>	<b>Chausa</b>	0.161	0.184	0.173
<b>T-15</b>	<b>Lucknow Safeda</b>	0.312	0.330	0.321
<b>T-16</b>	<b>Tukumi</b>	0.342	0.310	0.326
<b>T-17</b>	<b>Fazli</b>	0.346	0.302	0.324
<b>T-18</b>	<b>Ramkela</b>	0.278	0.312	0.295
<b>T-19</b>	<b>Neelum</b>	0.286	0.272	0.279
<b>T-20</b>	<b>Shahtuki</b>	0.342	0.345	0.344
<b>T-21</b>	<b>Khasam-Khas</b>	0.294	0.292	0.293
<b>T-22</b>	<b>Jauhari</b>	0.231	0.252	0.242
<b>T-23</b>	<b>Rangila</b>	0.245	0.281	0.263
<b>T-24</b>	<b>MBL-2</b>	0.321	0.290	0.334
<b>T-25</b>	<b>MBL-3</b>	0.256	0.295	0.276
<b>T-26</b>	<b>MBL-4</b>	0.378	0.370	0.374
<b>T-27</b>	<b>MBL-5</b>	0.251	0.291	0.271
<b>T-28</b>	<b>MBL-6</b>	0.321	0.304	0.313
<b>T-29</b>	<b>MBL-7</b>	0.291	0.257	0.274
<b>T-30</b>	<b>MBL-8</b>	0.241	0.248	0.245
<b>SEm±</b>		0.019	0.020	0.19
<b>C.D at 5%</b>		0.054	0.058	0.56

**Figure 4.18 Acidity (%) of different mango genotypes.**



#### 4.2.6. Ascorbic acid (mg /100g)

The data with respect to ascorbic acid or vitamin C content of mango fruit of different genotypes were estimated and expressed as mg/100g. The data so obtained from both the year and their mean are provided in Table 4.32 and illustrated graphically in Fig. 4.19.

A careful scrutiny of 2018-19, data revealed that there was a significant variation in ascorbic acid among the genotype. The maximum ascorbic acid content (51 mg/100g) was found in Langra followed by Chausa (35.90 mg/100g) and Amrapali (34.23 mg/100g). Therefore, Langra was found most outstanding being significantly superior to remaining genotypes with respect to ascorbic acid content in fruit. The lowest ascorbic acid (16.95 mg/100g) was estimated in genotype MBL-2.

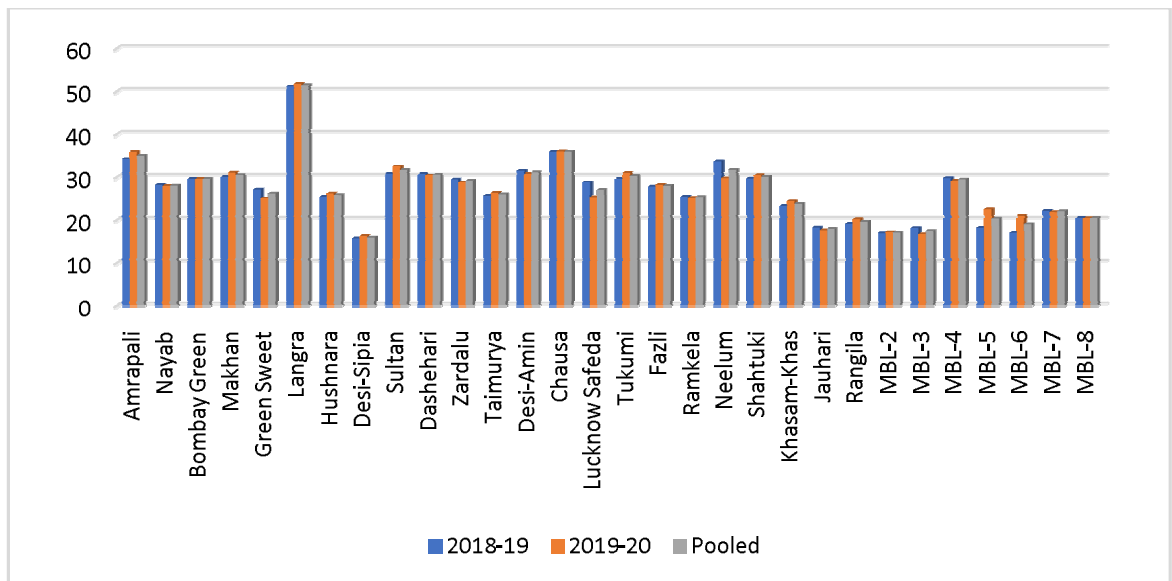
A perusal of mean data of 2019-20, revealed that the difference in ascorbic acid content was significant. This year also the maximum value of ascorbic acid was observed in Langra (51.76 mg/100g) followed by Chausa (36.01 mg/100g) and Amrapali (35.84 mg/100g). Minimum value (12.19 mg/100g). of ascorbic acid was noted in genotype MBL-2.

Statistical analysis of pooled data reflected that there were significant differences in ascorbic acid content. The maximum ascorbic acid was recorded in genotype Langra (51.44 mg/100g) which was followed by Chuasa (35.96 mg/100g) and Amrapali (35.04 mg/100g). The minimum value (17.07 mg/100g) was observed in genotypes MBL-2.

**Table 4.32. Ascorbic acid (mg) of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2019</b>	<b>2020</b>	<b>Polled</b>
<b>T-1</b>	<b>Amrapali</b>	34.23	35.84	35.04
<b>T-2</b>	<b>Nayab</b>	28.19	27.95	28.07
<b>T-3</b>	<b>Bombay Green</b>	29.57	29.57	29.57
<b>T-4</b>	<b>Makhan</b>	30.02	31.06	30.54
<b>T-5</b>	<b>Green Sweet</b>	27.18	25.07	26.13
<b>T-6</b>	<b>Langra</b>	51.12	51.76	51.44
<b>T-7</b>	<b>Hushnara</b>	25.39	26.15	25.77
<b>T-8</b>	<b>Desi-Sipia</b>	15.72	16.24	15.98
<b>T-9</b>	<b>Sultan</b>	30.88	32.49	31.69
<b>T-10</b>	<b>Dashehari</b>	30.73	30.44	30.59
<b>T-11</b>	<b>Zardalu</b>	29.43	28.76	29.10
<b>T-12</b>	<b>Taimurya</b>	25.65	26.38	26.02
<b>T-13</b>	<b>Desi – Amin</b>	31.49	30.76	31.13
<b>T-14</b>	<b>Chausa</b>	35.90	36.01	35.96
<b>T-15</b>	<b>Lucknow Safeda</b>	28.76	25.28	27.02
<b>T-16</b>	<b>Tukumi</b>	29.53	31.01	30.27
<b>T-17</b>	<b>Fazli</b>	27.77	28.17	27.97
<b>T-18</b>	<b>Ramkela</b>	25.46	25.15	25.31
<b>T-19</b>	<b>Neelum</b>	33.63	29.77	31.70
<b>T-20</b>	<b>Shahtuki</b>	29.70	30.54	30.12
<b>T-21</b>	<b>Khasam-Khas</b>	23.29	24.43	23.86
<b>T-22</b>	<b>Jauhari</b>	18.21	17.66	17.94
<b>T-23</b>	<b>Rangila</b>	19.08	20.24	19.66
<b>T-24</b>	<b>MBL-2</b>	16.95	17.19	17.07
<b>T-25</b>	<b>MBL-3</b>	18.16	16.67	17.42
<b>T-26</b>	<b>MBL-4</b>	29.79	29.07	29.43
<b>T-27</b>	<b>MBL-5</b>	18.18	22.47	20.33
<b>T-28</b>	<b>MBL-6</b>	17.02	21.01	19.02
<b>T-29</b>	<b>MBL-7</b>	22.17	21.89	22.03
<b>T-30</b>	<b>MBL-8</b>	20.49	20.40	20.45
<b>SEm±</b>		1.24	1.12	1.18
<b>C.D at 5%</b>		3.54	3.18	3.36

**Figure 4.19. Ascorbic acid (mg/100g) of different mango genotypes.**



#### **4.2.7. Total carotenoids (expressed as $\beta$ -carotene mg/100g):**

The data of total carotenoids in (mg/100g) for both the years and their mean have been presented in Table 4.33 and illustrated in Fig. 4.20.

A perusal of mean data of 2018-19, revealed that the difference in total carotenoids content was significant. The maximum value was obtained in Amrapali (8.34 mg/100g) which was at par with Lucknow safeda (5.26 mg/100g) and followed by Chausa (4.60 mg/100g). Minimum value (1.72 mg/100g). was noted in Fazli.

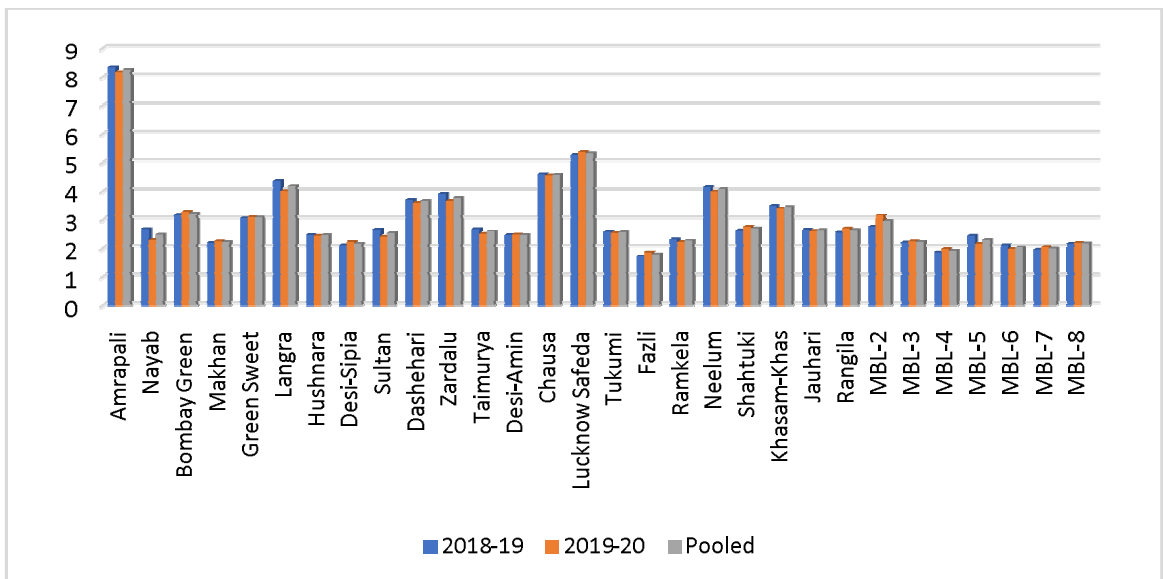
From the mean data of 2019-20, it was evident that there were highly significant differences in total carotenoids content. This year also the maximum value of total carotenoids was observed in Amrapali (8.16 mg/100g) followed by Lucknow Safeda (5.37 mg/100g) and Chuasa (4.55mg/100g) Minimum value (1.86 mg/100g) was noted in Fazli.

Statistical analysis of pooled data reflected that there were also significant differences in total carotenoids content. The maximum total carotenoids were recorded in Amrapali (8.25 mg/100g) followed by Lucknow Safeda (5.32 mg/100g) and Chuasa (4.58 mg/100g). The minimum (1.79 mg/100g) was observed in Fazli

**Table 4.33. Total carotenoids (expressed as  $\beta$ -carotene mg/100g) of different mango genotypes.**

<b>Treatments</b>	<b>Genotypes</b>	<b>2018-19</b>	<b>2019-20</b>	<b>Polled</b>
<b>T-1</b>	<b>Amrapali</b>	8.34	8.16	8.25
<b>T-2</b>	<b>Nayab</b>	2.67	2.30	2.49
<b>T-3</b>	<b>Bombay Green</b>	3.17	3.27	3.22
<b>T-4</b>	<b>Makhan</b>	2.19	2.25	2.22
<b>T-5</b>	<b>Green Sweet</b>	3.06	3.09	3.08
<b>T-6</b>	<b>Langra</b>	4.36	4.00	4.18
<b>T-7</b>	<b>Hushnara</b>	2.47	2.44	2.46
<b>T-8</b>	<b>Desi-Sipia</b>	2.11	2.23	2.17
<b>T-9</b>	<b>Sultan</b>	2.65	2.42	2.54
<b>T-10</b>	<b>Dashehari</b>	3.69	3.60	3.65
<b>T-11</b>	<b>Zardalu</b>	3.91	3.65	3.78
<b>T-12</b>	<b>Taimurya</b>	2.67	2.51	2.59
<b>T-13</b>	<b>Desi – Amin</b>	2.47	2.49	2.48
<b>T-14</b>	<b>Chausa</b>	4.60	4.55	4.58
<b>T-15</b>	<b>Lucknow Safeda</b>	5.26	5.37	5.32
<b>T-16</b>	<b>Tukumi</b>	2.58	2.55	2.57
<b>T-17</b>	<b>Fazli</b>	1.72	1.86	1.79
<b>T-18</b>	<b>Ramkela</b>	2.32	2.21	2.27
<b>T-19</b>	<b>Neelum</b>	4.14	3.99	4.07
<b>T-20</b>	<b>Shahtuki</b>	2.62	2.75	2.69
<b>T-21</b>	<b>Khasam-Khas</b>	3.49	3.39	3.44
<b>T-22</b>	<b>Jauhari</b>	2.65	2.61	2.63
<b>T-23</b>	<b>Rangila</b>	2.56	2.69	2.63
<b>T-24</b>	<b>MBL-2</b>	2.75	3.15	2.95
<b>T-25</b>	<b>MBL-3</b>	2.20	2.25	2.23
<b>T-26</b>	<b>MBL-4</b>	1.86	1.98	1.92
<b>T-27</b>	<b>MBL-5</b>	2.44	2.16	2.30
<b>T-28</b>	<b>MBL-6</b>	2.11	1.97	2.04
<b>T-29</b>	<b>MBL-7</b>	1.95	2.05	2.00
<b>T-30</b>	<b>MBL-8</b>	2.16	2.19	2.18
<b>SEm<math>\pm</math></b>		0.22	0.28	0.25
<b>C.D at 5%</b>		0.64	0.84	0.74

**Figure 4.20. Total carotenoids (expressed as  $\beta$ -carotene mg/100g) of different mango genotypes.**



## Results and Discussion

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Mango is very nutritious and has great health benefits both, when eaten as raw and ripe fruit. The present investigation entitled “**Studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes**” was carried out at the orchards of local farmers’ in the vicinity of Malihabad and Unnao region for recording observations of morphological and biochemical characters on various genotypes works were done in the laboratory of Horticulture, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow (U.P), India during both the years (2018-19 and 2019-20), respectively. The results obtained from the investigation in respect to morphological and biochemical characteristics are presented in the proceeding chapter and attempts have been made to collaborate the findings with those of various workers in the past.

### **5.1. Morphological characters:**

#### **Fruit characters:**

##### **5.1.1. Fruit size length and width (cm):**

It clearly indicates that maximum length and breadth (12.74 cm and 8.69 cm) of fruits were observed in Fazli and the lowest fruit length and breadth (5.61 cm and 4.07 cm) was observed in genotype MBL-6. Similar result findings were also reported by Islam *et al.* (2019) who mentioned that the higher fruit length and breadth (13.64 cm and 8.85 cm) in Fazli. The variation in length and breadth of fruits in mango was also observed by Mannan *et al.* (2003), Pandey *et al.* (2006), Kundu *et al.* (2009), Majumder *et al.* (2011) and Mishra *et al.* (2014). Several researchers have studied the fruit size of the mango and reported that mango cultivars differed in fruit length and breadth according to their genetic makeup. Rai *et al.* (2001) reported that the fruit size in various cultivars differed in length and breadth. Fruit size is governed by polygenes in mango. The increase in size with an increase in age can be justified as the fruit shows single sigmoid growth in early stages and the size becomes constant after maturity because of the fact that all metabolites are involved in another physiological

process as ripening. The different parameters like cell size, intercellular space etc. Lead to differences in fruit size of different mango cultivars. The overall increase in cell size and intercellular spaces have a direct effect on the increase in fruit size. Some researchers have suggested the accumulation of carbohydrates to be the reason behind the increase in fruit size. Such variation is supposed to be a genetic character that might be influenced by the environment to some extent also.

### **5.1.2. Fruit weight (g):**

Fazli produced maximum fruit weight (501.56 g), while minimum fruit weight was observed in genotype MBL-6 (159.28 g). The result obtained on fruit weight in the present study was also in conformity with the observations made by Islam *et al.* (2019) who mentioned that the higher fruit weight (490.66 g) was obtained in Fazli. Syamal and Mishra (1989) also reported that the fruit weight varied within the cultivars. Hoda *et al.* (2003), Chatterjee *et al.* (2005) and Mannan *et al.* (2003) reported that the significant variation in size of fruits. The weight of fruits may be assigned to the factor of assimilation and accumulation of photosynthates. The higher or lower fruit weight might be ascribed due to varietal or genetic characters.

### **5.1.3. Fruit Volume (ml), specific gravity and Fruit firmness (kg/cm<sup>2</sup>):**

Fazli produced maximum Fruit volume (478.65 ml), while, minimum fruit volume (157.18 ml) was observed in genotype MBL-6. The result obtained on fruit volume in the present study was also in conformity as observed by Anil and Radha (1994) and Zaied *et al.* (2007). The volume of fruit is directly proportional to the size of fruits and it is a purely varietal character influenced by environments and locations. Fruits were harvested at an accurate and suitable stage of maturity with a specific gravity range of 1.009 to 1.047. The specific gravity of the fruit is governed not only by physical growth but also by its internal compositions. Langra produced maximum fruit firmness (14.85 Kg/cm<sup>2</sup>) and followed by genotype Taimurya (13.90 Kg/cm<sup>2</sup>) While, minimum fruit firmness was observed in (9.85 Kg) genotype MBL-8. Ahmad *et al.* (2011) reported that the significant variation in fruit firmness.

## **Peel characters:**

### **5.1.4. Thickness of peel (mm) and Peel weight (g)**

Minimum peel thickness (0.84 cm) recorded in genotype Makhan and maximum peel thickness was recorded in genotype Desi-Sipia (2.61 cm) the present findings related to peel thickness are also in accordance with the results obtained by Mannan *et al.* (2003). Minimum peel weight was recorded in Shahtuki (16.30g). while maximum peel weight was observed in Fazli (50.03 g). The present findings related to peel weight are also in corroborate with the findings Anila and Radha (2003) who observed the highest peel weight (51.74 g) in the case of Ratna. Mitra *et al.* (2001) valuated 19 cultivars and reported different peel weights in various cultivars. Maximum peel weight (34.52 g) was recorded in Selection - 5, while, it was minimum (14.90 g) in Selection - 4 (Bakshiet *al.*, 2013).

### **5.1.5. Peel percentage:**

Minimum peel percentage (9.45%) was observed in genotype Shahtuki, while maximum peel percentage was observed in Desi-Sipia (17.97%). According to Avilane *et al.* (1998), the ideal mango fruit benefits from high pulp content, small stone, thinnest peel and fibre absence. The variation in peel percentage was also recorded by Kumar (1994), Kalra *et al.* (1994), Singh and Singh (2004), Kumar and Singh (2005) and Begum *et al.* (2012). This variation in peel content might be due to genetic makeup, rate of photosynthetic assimilation and translocation and effect of different growth hormones. The differences in the percentage of peel are natural because environmental and seasonal variations were observed by the earlier researcher (Kumar and Singh, 2005, Chatterjee *et al.* 2005 and Sinha *et al.* 2007). The peel percentage depends on the diversion of food assimilates towards epicarp.

## **Stone characters:**

### **5.1.6. Stone length (cm), breadth (cm), thickness (cm) and weight (g):**

Minimum stone length, breadth and weight (3.66 cm, 2.20 cm and 21.38 g) was observed in Shahtuki, while maximum stone length, breadth and weight was observed in Fazli (10.54 cm, 4.30cm and 49.47 g). Minimum stone thickness was recorded in genotype (1.36 cm) and maximum thickness genotype (2.75 cm). This

variation in stone might be due to differences in fruit and stone size, genetic makeup, rate of photosynthetic assimilation & translocation and effect of different growth hormones. The differences in the weight of stone from place to place are due to environmental variations. The results are corroborated with the findings of Kumar and Singh, (2005), Chatterjee *et al.* (2005) and Sinha *et al.* (2007). The stone percentage depends on the diversion of food assimilates towards epicarp.

## **5.2. Biochemical characters:**

### **5.2.1. T.S.S (°Brix):**

The analysis of variance indicated that Chausa had maximum T.S.S (24.02°Brix) and the minimum value was noted genotype MBL-4 (15.43°Brix). However, the present findings partially agreed with the results of Bhuyan and Guha (1995) who found 16.22 to 24.14% T.S.S. in 14 mango germplasms. A similar variation was also reported by Sengupta *et al.* (2006), Kumare *et al.* (2008) and Gill and Dhillon (2008) in mango. Uddin *et al.* (2006) observed that Chausa contained highest T.S.S. (26.27 %), while minimum T.S.S. (21.17 %) was reported in the case of Tommy Atkin. Similar findings have been reported by Bakshiet *al.* (2013), Okoth *et al.* (2013), Shafique *et al.* (2006) and Abourayya *et al.* (2011). This variation in T.S.S is obvious as it is an inherent character of the variety. High T.S.S. is desirable to yield a higher recovery of processed products. The hydrolysis of polysaccharides and their conversion into sugars gives an indication of T.S.S. The mobilization of carbohydrates to organic acids may be the possible cause behind the inherent T.S.S. of a particular variety.

### **5.2.2. Total sugars, reducing sugar and non-reducing sugar (%):**

Maximum total sugars percentage was found in Amrapali (18.50 %). Whereas, the minimum was noted in genotype MBL-4 (9.83 %). These results partially agreed with the findings of Sengupta *et al.* (2006). This difference might be due to varietal differences as well as growing conditions. Maximum reducing sugar was observed in Amrapali (5.31%) and minimum percentage in this respect was noted in genotype MBL-4 (3.13%). The results are in agreement with that of Chaudhari *et al.* (1997) who reported 2.6 to 7.1 percent reducing sugar in 19 South Indian mango varieties. On the other hand, the non-reducing sugar content of the fruit pulp of mango varied

from 13.20 to 6.71 percent. Amrapali was at the top with a value of (13.20) percent non-reducing sugar. These findings are confirmed by the findings of Uddin *et al.* (2006) observed that reported minimum reducing sugar(6.71%). Total sugars was reported to be in the range of 20.34% to 12.17%. Similar findings have been reported by Bakshiet *al.* (2013) and Shafique *et al.* (2006). The increase in total sugars might be the conversion of starch and polysaccharides into soluble sugars.

### **5.2.3. Acidity percentage:**

Maximum acidity was recorded in genotype MBL-4 (0.374 %) while, minimum acidity percentage was observed in Chausa (0.173%). These findings related to acidity are in accordance with the result of Kumar (1997) who reported the range of 0.17 to 0.33% in different mango cultivars. Chaudhari *et al.* (1997) also noted 0.14% to 0.59% acidity in mango cultivars. The variation in the acidity in different varieties of mango could be due to their varietal characters. Variable values of acidity due to different varieties of mango were also reported by Singh *et al.* (1985). A study conducted by Uddin *et al.* (2006) confirm the findings with cultivar Amrapali with the least acidity (0.24 %) and Mixed Special having maximum (0.53%) acidity. Similar findings have also been reported by Bakshiet *al.* (2013), Okoth *et al.* (2013), Shafique *et al.* (2006), Abourayya *et al.* (2011) and Modesto *et al.* (2016). Fruit acidity is respondent to the ripening stage of the variety. It is also dependent on prevailing environmental conditions.

### **5.2.3. Ascorbic acid (mg/100g):**

The maximum ascorbic acid was recorded in the Langra (51.44 mg/100 g) and minimum ascorbic acid was observed in genotype MBL-2 (17.07mg/100g juice). Variation in ascorbic acid content (2.90 mg/100g -136.50 mg/100g) was reported by Gowda and Ramanjaneya (1994). Mitra *et al.* (2001) observed ascorbic acid content in the range of (21.66 mg/100g - 125.40 mg/100g). The ascorbic acid content in the range of (17.92 mg/100g - 39.25 mg/100g was also observed by Bhowmick and Banik (2005). The higher value of ascorbic acid in Langra was also reported by Chatterjee *et al.* (2005) and Sengupta *et al.* (2006). Such variation in ascorbic acid could be attributed to the nature and extent of genetic variability present in the experimental material. Similar findings have also been reported by Uddin *et al.* (2006), Shafique *et*

*al.* (2006) and Modesto *et al.* (2016). The higher level of ascorbic acid might be due to the perpetual synthesis of glucose 6- phosphate during the growth and development of fruits, which is considered to be the precursor of ascorbic acid. The increase in ascorbic acid content is probably due to the catalytic influence of growth substances on the biosynthesis of ascorbic acid from sugars.

### **Total carotenoids (mg/100g)**

There were highly significant differences in total carotenoid content. The maximum total carotenoids were recorded in Amrapali (8.25 mg/100 g) and the minimum value was noted in Fazli (1.79 mg/100 g). These findings related to total carotenoids are in accordance with the results of Hoda *et al.* (2003), Singh and Singh (2004), Kumar and Singh (2005) and Modesto *et al.* (2016). Highest 17.36 mg/100g carotenoids present in Gp no. 44 while the lowest 1.30 mg/100g in Gp no. 55 as reported by Hossain *et al.* (2015). Carotenoid content in green mango was 3.09 pg/100mg while that of semi-ripe mango was 70.875 pg/100g and ripe mango was 251.74 pg/100g. Among the mango cultivars, Amrapali contained the highest amount of carotenoid which is about 444.66 pg/100g. Kali Bhog and Lakshmon Bhog contained 352.41 pg/100g and 345.09 pg/100g carotenoid, respectively. Surmi Fazli contained the lowest amount of carotenoid which is about 94.22 pg/100g (Haque *et al.*, 2015). Total carotenoids provide an expression of natural appearance to the fruit product and their higher content in fruits offers distinct advantages, particularly in the international trade where the addition of artificial colour is discouraged.

### **Organoleptic evaluation**

Maximum score (8.50) for pulp colour was noted in Hushnara, pulp flavour (8.70), texture (8.80), taste (8.60), pulp fibre (8.40) was found in Amrapali and pulp juice (8.60) was found in Bombay Green. Visual examination by the consumers is of significant importance parameter that determines the selection of any food for consumption. In mangoes, the pulp colour are the important quality parameters, flavour is the sensory impression of a food or other substance and it is mainly determined by the chemical senses of taste and smell. The overall flavor impression is the result of the tastes perceived by the taste buds in the mouth and aromatic compounds detected by epithelium in the olfactory organ in the nose (Jeyavanan and Sivachandran, 2015).

## Summary and Conclusion

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The present investigation entitled “**Studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes.**” was carried out at the orchards of local farmers’ in the vicinity of Malihabad and Unnao region for recording observations of Physico- chemical characters of various genotypes/cultivars on works was done in laboratory of Horticulture, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow (U.P), India during both the year (2018-19 and 2020), respectively. The results of the present study concerning studies on genetic diversity for morphological and biochemical aspects of mango (*Mangifera indica* L.) genotypes have been summarized in this chapter.

1. Fazli produced the heaviest fruit weight, length and breadth (501.56 g, 12.74 cm and 8.69 cm). While, the lowest fruit weight, length and fruit breadth (160.68g, 5.61 cm and 4.07cm) were observed in the genotype MBL-6. Highest fruit volume (478.65 ml) observed in Fazli. Whereas, minimum fruit volume (157.18ml) observed in genotype MBL-6. The specific gravity of fruits ranged between 1.009 to 1.047. Langra produced maximum fruit firmness (14.85 kg/cm<sup>2</sup>). Whereas, minimum fruit firmness (9.85 kg/cm<sup>2</sup>) was observed in genotype MBL-6
2. Maximum peel thickness (2.67mm) was recorded in genotype Desi-Sipia. Whereas, minimum peel thickness (0.84mm) recorded in genotype Makhan. Minimum peel weight (16.30 g) was recorded in genotype Shahtuki. While, maximum peel weight (50.03g). was observed in Fazli. Minimum peel percentage (9.45%) was observed in genotype Shahtuki. While, maximum peel percentage (17.97%) was observed in Desi-Sipia.
3. Minimum stone length, breadth and weight (3.66 cm, 2.20cm and 21.38g) was recorded in genotype Shahtuki. While, maximum stone length, breadth and weight was found in Fazli (10.54 cm, 4.30 cm and 49.47g). Minimum stone

thickness (1.36 cm) was recorded in genotype Desi-Sipia. Whereas, maximum thickness (2.75 cm) was recorded in Fazli.

4. Chausa had maximum T.S.S. percentage (24.02 °Brix). Whereas, minimum T.S.S. percentage (15.43°Brix) genotype MBL-4.
5. Maximum reducing sugar, non-reducing sugar, total sugars percentage was observed in Amrapali (5.31%,13.20% and 18.50%). Whereas, Minimum percentage (3.13 %, 6.71 % and 9.84 %) in this respect was noted in genotype MBL-4.
6. The minimum acidity (0.173%). was observed in Chausa. Whereas, maximum acidity was recorded in genotype MBL-4 (0.374%).
7. The maximum ascorbic acid was recorded in Langra (51.44 mg/100g). Whereas, minimum (17.07mg/100g). was observed in genotype MBL-2.
8. The maximum total carotenoids were recorded in Amrapali (8.25mg/100g). Whereas, the minimum (1.79mg/100g) was observed in genotype MBL-4.
9. Maximum score for pulp colour recorded in Hushnara (8.50), flavour (8.70), texture (8.80), taste (8.60), fibre (8.40), recorded in Amrapali and Juice (8.60) found in Bombay Green.

## **Conclusion**

Based on the present findings, it can be concluded that the Fazli showed highest fruit weight, length, breadth, volume, peel thickness, stone length, breadth and weight, Langra showed maximum fruit firmness and ascorbic acid, Desi-Sipia showed peel thickness and peel percentage. Chausa showed maximum T.S.S, minimum acidity percentage, Amrapali showed reducing sugar, non-reducing sugar, total sugar and total carotenoids. Hence based on sensorial attributes and overall acceptability of fruit, the cultivar Amrapali can be recommended for commercial cultivation under Malihabad region of Lucknow.

## Bibliography

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## Appendices

### Appendix-1

#### Analysis of variance of fruit length (cm) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	247.441	8.532	37.958	0.00000
Error	60	13.487	0.225		
Total	89	260.928			

### Appendix-2

#### Analysis of variance of fruit length (cm) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	292.697	10.093	67.516	-0.00000
Error	60	8.969	0.149		
Total	89	301.666			

### Appendix-3

#### Analysis of variance of fruit breadth (cm) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	103.826	3.580	40.647	0.00000
Error	60	5.285	0.088		
Total	89	109.111			

#### Appendix-4

##### Analysis of variance of fruit breadth (cm) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	137.038	4.725	38.804	0.00000
Error	60	7.307	0.122		
Total	89	144.345			

#### Appendix-5

##### Analysis of variance of fruit weight (g) 2018-19

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	397,412.242	13,703.870	151.716	0.00000
Error	60	5,419.558	90.326		
Total	89	402,831.800			

#### Appendix-6

##### Analysis of variance of fruit weight (g) 2019-20

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	417,158.678	14,384.782	317.211	0.00000
Error	60	2,720.862	45.348		
Total	89	419,879.540			

### Appendix-7

#### Analysis of variance of fruit volume (ml) 2018-19

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	352,294.041	12,148.070	109.539	-0.00000
Error	60	6,654.092	110.902		
Total	89	358,948.133			

### Appendix-8

#### Analysis of variance of fruit volume (ml) 2019-20

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	369,648.927	12,746.515	303.891	0.00000
Error	60	2,516.665	41.944		
Total	89	372,165.592			

### Appendix-9

#### Analysis of variance of specific gravity 2018-19

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	0.009	0.000	12.360	0.00000
Error	60	0.001	0.000		
Total	89	0.010			

### Appendix-10

#### Analysis of variance of specific gravity 2019-20

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	0.010	0.000	17.796	-0.00000
Error	60	0.001	0.000		
Total	89	0.011			

### Appendix-11

#### Analysis of variance of fruit firmness (Kg/cm<sup>2</sup>) 2018-19

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	207.630	7.160	21.261	0.00000
Error	60	20.205	0.337		
Total	89	227.835			

### Appendix-12

#### Analysis of variance of fruit firmness (Kg/cm<sup>2</sup>) 2019-20

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	184.911	6.376	14.504	0.00000
Error	60	26.377	0.440		
Total	89	211.288			

### Appendix-13

#### Analysis of variance of peel thickness (mm) 2018-19

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	17.397	0.600	64.691	0.00000
Error	60	0.556	0.009		
Total	89	17.954			

### Appendix-14

#### Analysis of variance of peel thickness (mm) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	17.012	0.587	26.200	0.00000
Error	60	1.343	0.022		
Total	89	18.356			

### Appendix-15

#### Analysis of variance of peel weight (g) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	3,822.655	131.816	24.916	-0.00000
Error	60	317.427	5.290		
Total	89	4,140.082			

### Appendix-16

#### Analysis of variance of peel weight (g) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	4,678.118	161.314	34.778	0.00000
Error	60	278.304	4.638		
Total	89	4,956.422			

### Appendix-17

#### Analysis of variance of peel percentage 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	435.912	15.031	15.298	0.00000
Error	60	58.953	0.983		
Total	89	494.865			

### Appendix-18

#### Analysis of variance of peel percentage (%) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	455.307	15.700	19.249	-0.00000
Error	60	48.938	0.816		
Total	89	504.245			

### Appendix-19

#### Analysis of variance of stone length (cm) 2018-19

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	134.541	4.639	33.770	0.00000
Error	60	8.243	0.137		
Total	89	142.784			

### Appendix-20

#### Analysis of variance of stone length (cm) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	175.418	6.049	14.597	0.00000
Error	60	24.863	0.414		
Total	89	200.281			

### Appendix-21

#### Analysis of variance of stone breadth (cm) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	20.026	0.691	8.500	0.00000
Error	60	4.874	0.081		
Total	89	24.900			

### Appendix-22

#### Analysis of variance of stone breadth (cm) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	22.445	0.774	15.462	-0.00000
Error	60	3.003	0.050		
Total	89	25.448			

### Appendix-23

#### Analysis of variance of stone thickness (cm) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	7.133	0.246	6.313	0.00000
Error	60	2.338	0.039		
Total	89	9.471			

### Appendix-24

#### Analysis of variance of stone thickness (cm) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	7.539	0.260	6.987	0.00000
Error	60	2.232	0.037		
Total	89	9.771			

### Appendix-25

#### Analysis of variance of stone weight (g) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	3,623.074	124.934	62.127	0.00000
Error	60	120.656	2.011		
Total	89	3,743.730			

### Appendix-26

#### Analysis of variance of stone weight (g) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	3,508.771	120.992	17.319	-0.00000
Error	60	419.154	6.986		
Total	89	3,927.925			

### Appendix-27

#### Analysis of variance of total soluble solids TSS (°Brix) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	188.529	6.501	3.359	0.00004
Error	60	116.120	1.935		
Total	89	304.649			

### Appendix-28

#### Analysis of variance of total soluble solids TSS (°Brix) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	257.836	8.891	7.414	0.00000
Error	60	71.953	1.199		
Total	89	329.789			

### Appendix-29

#### Analysis of variance of reducing sugar (%) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	25.121	0.866	3.629	0.00001
Error	60	14.322	0.239		
Total	89	39.443			

### Appendix-30

#### Analysis of variance of reducing sugar (%) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	27.882	0.961	7.119	0.00000
Error	60	8.103	0.135		
Total	89	35.985			

### Appendix-31

#### Analysis of variance of non-reducing sugar (%) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	129.925	4.480	3.323	0.00004
Error	60	80.882	1.348		
Total	89	210.808			

### Appendix-32

#### Analysis of variance of non-reducing sugar (%) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	138.528	4.777	10.274	0.00000
Error	60	27.897	0.465		
Total	89	166.425			

### Appendix-33

#### Analysis of variance of total sugars (%) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	316.361	10.909	10.258	0.00000
Error	60	63.807	1.063		
Total	89	380.168			

### Appendix-34

#### Analysis of variance of total sugars (%) 2018-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	359.986	12.413	19.430	-0.00000
Error	60	38.333	0.639		
Total	89	398.319			

### Appendix-35

#### Analysis of variance of acidity (%) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	0.168	0.006	5.226	0.00000
Error	60	0.066	0.001		
Total	89	0.234			

### Appendix-36

#### Analysis of variance of acidity (%) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	0.173	0.006	4.788	0.00000
Error	60	0.075	0.001		
Total	89	0.248			

### Appendix-37

#### Analysis of variance of ascorbic acid (%) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	4,690.365	161.737	34.557	0.00000
Error	60	280.817	4.680		
Total	89	4,971.182			

### Appendix-38

#### Analysis of variance of ascorbic acid (%) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	4,479.876	154.478	40.709	-0.00000
Error	60	227.682	3.795		
Total	89	4,707.558			

### Appendix-39

#### Analysis of variance of total carotenoids (mg/100g) 2018-19.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	152.656	5.264	34.336	0.00000
Error	60	9.199	0.153		
Total	89	161.855			

### Appendix-40

#### Analysis of variance of total carotenoids (mg/100g) 2019-20.

Source of Variation	DF	Sum of Squares	Mean Squares	F- Calculated	Significance
Treatments	29	150.434	4.235	29.247	0.00000
Error	60	8.126	0.120		
Total	89	155.453			