CHARACTERIZING SOME GUAVA (*Psidium guajava* L.) CULTIVARS AND HYBRIDS

Thesis

by

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(H-2016-46-M)

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Dr YASHWANT SINGH PARMAR UNIVERSITY OF HORTICULTURE AND FORESTRY
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CERTIFICATE-I

This is to certify that the thesis titled **"Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids"** submitted in partial fulfillment of the requirements for the award of the degree of **Master of Science (Horticulture) Fruit Science** in discipline of **Horticultural Sciences** to Dr. Yashwant Singh Parmar University of Horticulture and Forestry, (Nauni) Solan (HP) – 173 230 is a bonafide research work carried out by **Ms Megha Ahir (H-2016-46-M)** daughter of Shri Ravi Kant Ahir under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation has been fully acknowledged.

Place: Nauni, Solan
Dated:

(Dr Krishan Kumar)
Major Advisor

CERTIFICATE-II

This is to certify that the thesis titled, **"Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids"** submitted by **Ms Megha Ahir (H-2016-46-M)** daughter of Shri Ravi Kant Ahir to the Dr. Yashwant Singh Parmar University of Horticulture and Forestry, (Nauni) Solan (HP) – 173 230 India in partial fulfilment of the requirements for the degree of **Master of Science (Horticulture) Fruit Science** in the discipline of **Horticultural Sciences** has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

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Place: Nauni (Solan) **(Megha Ahir)**
Date:

CONTENTS

ABBREVIATIONS USED

Abbreviation	Description
%	Per cent
π	Pi
°B	Degree brix
°C	Degree centigrade
°E	Degree East
°N	Degree North
ANOVA	Analysis of variance
UPOV	The International Union for the Protection of New Varieties of Plants
DUS	Distinctiveness, Uniformity, Stability
PPVFRA	Protection of Plant Varieties & Farmer's Rights Authority
CD	Critical difference
cm	Centimetre
cm^3	Cubic centimetre
cv.	Cultivar
df	Degree of freedom
et al.	Co-workers
etc.	et cetera
g	Gram
HP	Himachal Pradesh
MP	Madhya Pradesh
ha	Hectare (10,000 m^2)
E-W	East-West
N-S	North-South
ICAR	Indian Council of Agricultural Research
NEH	North Eastern Hill
i.e.	That is
kg	Kilogram
l	Litre

m	Metre
m^2	Square metre
m^3	Cubic metre
mg	Milli gram
mm	Millimetres
ml	Millilitres
MT	Metric Tonne
NS	Non-significant
RBD	Randomized Block Design
SE	Standard Error
TCSA	Trunk cross sectional area
TSS	Total Soluble Solids
viz.	namely
q	quintal

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Chapter-1

INTRODUCTION

Guava (*Psidium guajava* L.) popularly known as “Apple of Tropics” is one of the important fruit crops grown in tropics and sub-tropics. It belongs to family Myrtaceae and genus *Psidium* which contains about 150 species. Most of the commercial guava cultivars are diploid (2n=22). It is one of the most common fruit in India and considered fourth most important fruit in area and production after mango, banana and citrus. It is a hardy, prolific bearer and highly remunerative fruit crop. Cultivated guava is a native of Tropical America where it occurs wild. It is believed to have been introduced in India as early as in the 17th Century.

It is found favorable with the fruit growers due to its wider adaptability and higher return per unit area. Guava can withstand adverse climatic conditions and grow under various soil types. It requires an annual rainfall of 100-200 cm with optimum temperature of 23ºC to 26ºC. In India, guava occupies an area of 2,68,000 hectares resulting in production of 39,97,000 metric tonnes (Anonymous, 2018). The leading guava producing states are Uttar Pradesh, Madhya Pradesh, Maharashtra and Bihar. The best quality fruits are produced in Uttar Pradesh. In Uttar Pradesh, about half of the total area is under guava and the district Allahabad has reputation of growing the best quality guava in the country as well as in the world (Bose *et al.*, 2002). In Himachal Pradesh, it is cultivated in an area of 2,292 hectares with an annual production of 2,660 metric tonnes (Anonymous, 2017).

Guava is a perennial, evergreen, shallow rooted shrub or small tree (3-15 cm), branching close to the ground and often producing suckers from the base of trunk. Young twigs are quadangular. The leaves are simple, opposite, oval to oblong elliptic, short petiole, smooth hairy beneath and light green in colour. The perfect epigynous flower with white petals and yellow anthers are borne solitary or in clusters of 2-3 in leaf axils on new growth from mature branches. Fruit is multiseeded berry with ovoid, spherical or pyriform in shape, topped by calyx lobes.

Guava fruits are delighted in taste when mature or ripe and freshly plucked from the tree. It is used for various purposes. Shell of the ripe fruit is used to prepare salad

and puddings. The best jelly can be prepared from common sour wild guava. It can be canned in sugar syrup. The fruit as well as its juice is freely consumed for its great taste and nutritional benefits. Its juice is used for the preparation of sherbet and ice-cream for which red fleshed guava is of great demand in world market. Guava is rich in Vitamin C (260 mg/100 g of fruit), carbohydrates, fibres and protein, and can be eaten fresh or processed for juice, jam, jelly, cheese, canned segments, nectar, R.T.S, beverage etc. Its leaves are used for curing diarrhoea and also for dyeing and tanning. It has anti-diarrhoeal, anti-hypertensive, anti-oxidant, anti-microbial, hypoglycemic and anti-mutagenic activities.

The lower hills of Himachal Pradesh are considered adequately suitable for its cultivation especially, under the changing climate scenario. More so, guava has potential to serve as an additional fruit crop from diversification point of view. In order to find out the suitability of guava cultivation under the foothills of the state, some commercial cultivars and hybrids were introduced at the Regional Horticultural Research and Training Station, Dhaulakuan, Sirmour (HP) from different parts of the country. These varieties and hybrids have started fruiting and no attempt has been made so far to describe them systematically. Varietal description and nomenclature of different guava varieties grown in India are greatly confusing. Some varieties were named according to shape of the fruit, skin colour and pulp colour, while several other varieties were named after place of origin. In order to identify properly and to produce true-to-type planting material of guava, there is an absolute and immediate need to characterize and develop a descriptive database. This is all the more necessary in the light of plant variety protection regime and to check bio-piracy, and in accordance with this, the present study titled "Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids" was undertaken with the following objective:-

1. To describe the guava cultivars and hybrids based on DUS test guidelines

Chapter-2

REVIEW OF LITERATURE

The present investigation "Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids" was aimed to assess the variation in various growth, flowering, fruiting, yield, seed and biochemical parameters. The review of literature relevant to the topic of present study is cited in this chapter under following heads:

2.1 Tree characters

2.2 Flower characters

2.3 Fruit (morpho-physical) characters

2.4 Yield characters

2.5 Seed characters

2.6 Fruit (biochemical) characters

2.1 Tree characters

Varietal description is important for the purpose of identification, genetic improvement and multiplication, particularly in cases where their characterization or nomenclature is ambiguous.

Teaotia *et al.* (1966) described tree and leaf growth characters of 10 red-fleshed guava cultivars grown in Basti, Uttar Pradesh, which exhibited a lot of variation between them. Likewise, Daulta *et al.* (1998) evaluated 15 new hybrids of guava along with three standard cultivars at three locations namely Hisar, Kaul and Gurgaon in Haryana. They reported varying tree height ranging from 3.3 m in 'Lucknow-49' to 5.8 m in 'Allahabad Safeda'. The tree growth habit varied from upright with compact crown in 'Hisar Safeda' and 'Allahabad Safeda' to spreading and broad to compact crown in 'Lucknow-49', 'Banarsi Surkha' and 'Hisar Surkha', respectively.

The growth behaviour of guava germplasm under Sabour, Bihar conditions for rainy season fruiting was studied by Dubey *et al.* (2000). Tree height ranged from 2.09 m in selections 'R_5P_3' and 'R_5P_8' to 2.99 m in 'Allahabad Safeda'. The plant spread

varied from 2.09 m in selection 'R_4P_5' to 2.79 m in 'Allahabad Safeda', whereas, trunk girth ranged from 23.38 cm in 'Safed Jam' to 38.14 cm in 'Allahabad Safeda'.

In another study in Karnataka, Athani *et al.* (2007) recorded maximum mean plant height (466.50 cm) in 'Chittidhar' and minimum in 'CIW-3' (183.67 cm), whereas, plant girth ranged from 6.45 cm in 'CIW-4' to 12.18 cm in 'Seedless'.

Twenty varieties/germplasm of guava were selected by Mahaur (2010) for his study at Department of Fruit Science, K.N.K. College of Horticulture, Mandsaur (M.P.). He further observed varied plant height which ranged from 1.43 m in China White to 2.99 m in Dharidar. Whereas, canopy spread of tree in E-W and N-S directions was maximum in Chittidar (1.30 m and 1.20 m) and minimum in Surkhi (0.81 m and 0.68 m). All varieties were observed to exhibit spreading type of growth habit except Surkhi, Dharwar, Lal Guda and Smooth Green with erect type of growth habit. Leaf shape varied from elliptical (Dharidar, Chittidar, Apple Colour, Allahabad Safeda and Gwalior-27) to lanceolate (Rewa-72, Lucknow-49, Godhliwala, Chait Abuwala, Supreme Side Malta and China White) to oblong (Surkhi, Nasik, Dharwar, Lal Guda, Smooth Green and Abuwala) and to ovate (Anakapalli, Chaitpur and China Red) with Smooth Green having maximum leaf size [length (15.34 cm); width (6.74 cm)] and China White having minimum leaf size [length (4.88 cm); width (1.65 cm)]. All were having entire leaf margin except Rewa-72, Gwalior-27, Nasik and Supreme Side Malta with undulated leaf margin. Leaf base shape was observed as oblique (Apple Colour, Rewa-72, Allahabad Safeda and Chaitpur), acute (Nasik and Abuwala) and obtuse in rest of the accessions.

In another study, Sharma *et al.* (2010) described morphological characterization of twenty cultivars and two species of guava at Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar, which exhibited a lot of variation between them. Likewise, Ran *et al*. (2017) observed 13 cultivars and two species of guava at experimental orchard of Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar for morphological characterization and found drooping tree habit in Hisar Surkha, Strawberry and Hybrid Red Supreme while, upright growth habit was found in Hisar Safeda, Chinese, Lalit and Banarasi Surkha with spreading growth habit in Supreme, Lucknow-49 and Patillo. Shape and colour of matured leaves also varied from oblong lanceolate to oblong to ovate to lanceolate and to elliptical with green, pale green and dark green colour.

Various guava genotypes were studied by Lakade *et al*. (2011) for their growth attributes. They observed vigorous growth in genotypes 'GRS_4', 'GWS_6', and 'GRS_2' with maximum tree height in 'GRS_4' (4.25 m) and lowest in 'GWS_8' (2.71 m). The tree volume varied from 25.22 m^3 in 'GWS_8' to 57.65 m^3 in 'GWS_6'.

Eleven genetically diverse genotypes of guava were evaluated by Patel *et al*. (2011) at ICAR Research Complex for NEH Region, Umiam (Meghalaya) for their growth parameters and found plant length ranging from 2.04 m in Lucknow-49 to 3.07 m in genotype RCGH-1, whereas, stem diameter was maximum in genotype RCGH-1 (6.65 cm) and minimum in Sangam (4.17 cm). The canopy spread (2.35 m^2) was minimum and shoot diameter (11.57 mm) was maximum in genotype RCG-3 whereas, maximum canopy spread was found in cv. Lalit (7.66 m^2) with minimum shoot diameter in genotype RCGH-7 (9.80 mm).

A comparative study was conducted by Deshmukh *et al.* (2013) on three newly developed guava hybrids with three commercial cultivars at ICAR Research Complex for NEH Region, Umiam Meghalaya for their plant growth characters and observed maximum mean plant height (4.55 m), plant girth (9.88 cm) and plant spread [NS (4.49 m); EW (5.20 m)] in hybrid RCGH 1, whereas, plant height was minimum in Lucknow-49 (2.43 m) and plant girth was minimum in Lalit (7.50 cm). Similar reports have been observed by Talang *et al.* (2017).

Genetically diverse nine red fleshed guava genotypes were evaluated at Fruit Research Station Aurangabad, Marathwada Krishi Vidyapeeth Parbhani, Maharashtra by Meena *et al*. (2013) during winter season and found maximum height (4.29 m), spread [NS (4.01 m); EW (4.57 m)] and stem girth (57 cm) in genotype FRSG-R_4, Lalit and FRSG-R_5, respectively. Whereas, minimum height (2.70 m), spread [NS (1.70 m); EW (1.80 m)] and stem girth (30.34 cm) was observed in genotype FRSG-R_7, FRSG-R_3, and Lalit, respectively.

In another study, Ulemale and Tambe (2015a) studied morpho-phenological characters of guava genotypes and observed maximum tree height (4.21 m) and tree volume (50.46 m^3) in genotype 'GRS_4' and minimum tree height (2.60 m) and tree volume (24.93 m^3) in genotype 'GWS_8'. They observed erect tree growth habit and acute leaf apex in 'GRS_1', 'GRS_2' and 'GRS_3' with medium dense foliage and rest were spreading type with obtuse leaf apex.

Nine guava genotypes were evaluated by Ulemale and Tambe (2015b) at Instructional-cum-Research Farm, Department of Horticulture, College of Agriculture, Latur, VNMKV, Parbhani (Maharashtra) and observed maximum mean plant height (4.21 m) in genotype GRS_4 and minimum (2.60 m) in genotype $GWS_{8,}$ whereas, tree volume ranges between 24.93 m^3 in genotype GWS_8 and 55.32 m^3 in genotype $GWS_{6.}$ The tree growth habit varied from erect and medium dense (genotype GRS_1, GRS_2 and GRS_3) to spreading and very dense (genotype GRS_4 and Lucknow-49). The colour of mature leaf varied between dark green (genotype GRS_1, GRS_2 and GRS_4), green (genotype GRS_3, GWS_6 and Lucknow-49) and pale green (genotype GWS_5, GWS_7 and GWS_8) with acute (genotype GRS_1, GRS_2 and $GRS_{3)}$ and obtuse (genotype GRS4, GWS_5, GWS_6, GWS_7, GWS_8 and Lucknow-49) leaf apex and round leaf base.

Different guava cultivars under sub-tropical condition of Dhaulakuan (HP) were evaluated by Kumari *et al.* (2016) and observed 'Allahabad Safeda' with maximum plant height (3.30 m), trunk girth (5.28 cm) and shoot extension (24.90 cm), whereas 'Lalit' with minimum tree height (2.42 m) and trunk girth (3.92 cm), whereas, shoot extension growth was found to be minimum in 'Hisar Safeda' (13.45 cm).

Pandey *et al*. (2016) assessed newly developed guava selections and cultivars at the Central Institute of Subtropical Horticulture, Rehmankhera, Lucknow observed maximum plant height in Hybrid-21(6.33 m) with minimum in Arka Amulya (4.83 m). Whereas, canopy spread of tree in E-W and N-S directions ranged from 4.77 m–7.53 m and 4.44 m–7.15 m.

Eight cultivars of guava were studied by Sarkar *et al*. (2016) at Horticultural Research Station, Mondouri, BCKV and observed Shweta with highest tree height (4.27 m), tree volume (78.11 m^3) and stock girth (20.33 inch) whereas tree height (3.40 m) and stock girth (40.74 inch) were minimum in Kohir Safeda and tree volume was minimum in Phillipines (40.74 m^3).

In another study, Bhalekar and Chalak (2017) evaluated eight different guava cultivars at National Agriculture Research Project (Plain Zone) Ganeshkhind, Pune and found maximum plant height (4.42 m), girth (61.00 cm) and spread [EW (6.06 m); NS (5.73 m)] in Behat Coconut, while minimum plant height (3.61 m) and girth (42.25 cm) in Arka Amulya and spread was minimum in Arka Mridula [EW (4.59 m); NS (4.48 m)] followed by Arka Amulya [EW (4.49 m); NS (4.71 m)].

According to Kumar *et al.* (2017) maximum plant height (4.85 m), canopy spread (5.47 m) and stem girth (7.35 m) was observed in RCGH-1 while studying the growth characters of 15 guava genotypes at Horticultural Research Centre, Department of Horticulture, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology Pantnagar, Uttrakhand, whereas, minimum in Sangareddy (2.62 m), Hisar Surkha (2.25 m) and Barafkhana (3.25 m), respectively.

Similar reports on variation in growth attributes of guava cultivars have been reported by Singh *et al*. (2016a, b; 2017).

2.2 Flower characters

The flowering season and flushes in guava varies according to region. It flowers twice in a year in Punjab and other parts of Northern India (April-May for rainy season crop and August-September for winter season crop). Whereas, in Maharashtra and Tamil Nadu, there is third crop with flowers occurring in October. In West Bengal, flowering takes place in two seasons i.e. April-May and September-October (Bose *et al*., 2002)

Chatterjee *et al.* (1992) observed variation in duration of flowering with minimum in 'Sardar' (34 days), while the duration of flowering was longer in 'Allahabad Safeda' (38 days).

Twenty varieties/germplasm of guava were selected by Mahaur (2010) for his study and observed minimum days (29 days) for 50 per cent flowering in Lucknow-49, Gwalior-27 and Surkhi, whereas, maximum days were found to be 35 in Rewa-72 and Dharwar.

In another study, Sharma *et al.* (2010) described morphological characterization of twenty cultivars and two species of guava at Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar, which exhibited a lot of variations between them. Likewise, Ran *et al*. (2017) observed 13 cultivars and two species of guava at experimental orchard of Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar for morphological characterization and found cymose/solitary type of inflorescence in all the cultivars.

An experiment was conducted by Panwar (2012) on eight different guava cultivars and found Apple Colour [(06/08/2011) and (11/09/2011)] early in opening of

first as well as last flower, respectively with minimum duration of flowering (36 days) and late in Gwalior-27 [(17/08/2011) and 27/09/2011)]. The maximum flowering duration was observed in Allahabad Safeda (43 days) with large flower size [length (2.32 cm); breadth (1.05 cm)], whereas, cv. Chittidar was having small size flower [length (1.91 cm); breadth (0.98 cm)].

Correlations between duration of flowering with their respective seasons and their yield and total yield was observed by Jana *et al*. (2015) and reported a positive correlation with yield of respective season.

Nine guava genotypes were evaluated by Ulemale and Tambe (2015b) at Instructional-cum-Research Farm, Department of Horticulture, College of Agriculture, Latur, VNMKV, Parbhani (Maharashtra) and observed all the genotypes exhibiting solitary flowers having white colour.

Different guava cultivars were evaluated by Kumari *et al.* (2016) under sub-tropical condition of Dhaulakuan (HP) and observed early flowering (20th April) and full bloom (26th May) in 'Hisar Safeda', whereas, 'Luknow-49' was last to flower (24th April) and 'Allahabad Safeda' recorded full bloom on 31st May. The duration of flowering varied between 36 (Lucknow-49) to 41 days (Allahabad Safeda).

Eight cultivars of guava were evaluated by Sarkar *et al*. (2016) at Horticultural Research Station, Mondouri, BCKV and observed early flowering in Shweta (26th February) with 63 days of duration of flowering, whereas, Allahabad Safeda was observed with longer duration of flowering (69 days) and Arka Amulya showed 56 days of flowering followed by Lucknow-49 (59 days) with shorter duration of flowering.

In another study, Singh *et al*. (2016b) studied promising guava varieties under sub-tropical humid conditions of North India and observed maximum flower size for rainy season (45.87 mm) as well as winter season crop (47.01mm) in 'Lucknow-49' with maximum fully developed petals (8 petals). They observed first sign of flower bud for winter season crop from 21st to 25th June and 'Punjab Pink' was first to open flower on 5th July. Flowering duration for rainy season and winter season crop ranged from 32 to 38 days and 37 to 42 days, respectively.

The flowering behavior of eight guava genotypes was studied by Sahoo *et al.* (2017) in both rainy as well as winter season and observed variation in initiation of

flowering from 2nd week of February in Hisar Safeda to 2nd week of March in Banaras Round and HRS Pride during rainy season, whereas, from 2nd week of July (Pant Prabhat) to 4th week of July (Shweta, Banaras Round, Allahabad Safeda and HRS Pride) during winter season and flowering ended from 2nd week of April (Pant Prabhat, Lucknow-49 and Allahabad Safeda) to 1st week of May (Hisar Surkha, Banaras Round and HRS Pride) during rainy season, whereas, from 1st week of September (Hisar Safeda, Pant Prabhat, Hisar Surkha and Lucknow-49) to 3rd week of September (HRS Pride) during winter season. The flowering duration varied between 44 days (Hisar Safeda and Lucknow-49) to 58 days (HRS Pride) during rainy season and from 46 days (Lucknow-49) to 52 days (HRS Pride) during winter season.

The flower biology of four guava cultivars was studied by Sharma *et al.* (2017) at Experimental Orchard, Department of Horticulture at Chaudhary Charan Singh Haryana Agricultural University, Hisar and observed Hisar Surkha (09.04.2004) and Hisar Safeda (07.08.2004) as earliest to start flowering in spring and autumn season, respectively, whereas, Allahabad Safeda had the shortest blooming period during both the seasons [spring season (33 days); autumn season (38 days)] and Hisar Safeda with longest blooming period [spring season (41 days); autumn season (45 days)]. The average flower length was maximum in Lucknow-49 (23.10 mm) and minimum in Allahabad Safeda (19.89 mm) with maximum number of petals/flower(10 petals), whereas, average flower breadth was maximum in Hisar Surkha (10.92 mm) with minimum number of petals/flower (7 petals) and minimum average flower breadth was observed in Allahabad Safeda (9.67 mm) during both the seasons.

The floral parameters of guava cultivars under hot-arid environment were studied by Singh *et al*. (2017) and variation in number of flowers per branch ranging from 2.66 in 'L-49' to 9.33 in 'Shweta' was further observed by them.

2.3 Fruit (morpho-physical) characters

The maximum fruit length in guava 'L-49' (5.55 cm) with diameter (4.75 cm) and fruit weight (74.58 g) was reported by Chatterjee *et al.* (1992). Whereas, maximum diameter (5.58 cm) and fruit weight (87.52 g) was observed in 'Allahabad Safeda' and minimum diameter (4.35 cm) and weight (50.25 g) in 'Red Fleshed'. However, Daulta *et al.* (1998) evaluated some new hybrids of guava along with standard cultivars and reported variation in fruit weight with maximum in 'Lucknow-49' (107 g) followed by

‘Hisar Safeda’ (92 g) and minimum in ‘Banarsi Surkha’ (72 g) followed by ‘Hisar Surkha’ (86 g) and ‘Allahabad Safeda’ (87 g).

In another study, Bal and Dhaliwal (2004) studied quality characteristics of graded guava fruits and reported Grade-A having large sized fruit with maximum fruit weight of 182 g in ‘Lucknow-49’, whereas, minimum of 157 g in ‘Allahabad Safeda’.

Whereas, Athani *et al.* (2007) recorded maximum mean fruit weight (156.32 g) in ‘Sardar’ and minimum in ‘GW-3’ and ‘GR-3’ (46.84 g). Also, Babu *et al.* (2007) studied performance of eight years old guava selections and observed maximum weight of fruit in ‘Selection-11’ (144.20 g) followed by ‘L-49’ (140.50 g) and maximum fruit length in ‘Allahabad Safeda’ (62.80 mm) followed by ‘Selection-13’ (62.60 mm).

Jana *et al.* (2009) evaluated 21 genotypes of guava and reported variation in fruit weight with maximum of 174.33 g in Chittidar followed by Sardar (146.00 g) during rainy season whereas, Allahabad Safeda (242.40 g) followed by Barbadose Superior (230.40 g) were observed with maximum fruit weight during winter season.

Twenty varieties/germplasm of guava were selected by Mahaur (2010) and observed four types of fruit shape i.e. Round (Dharidar, Apple Colour, Allahabad Safeda, Anakapalli, Chaitpur, Lal Guda and China White), Ovate (Chittidar, Rewa-72, Surkhi, Chaitabuwala and Abuwala), Oblong (Lucknow-49, Gwalior-27, Godhliwala, Supreme Side Malta and China Red) and Elliptical (Nasik, Dharwar and Smooth Green). All varieties were having greenish yellow colour of peel except Abuwala (Yellow), Apple Colour (Light Green to Red), Chittidar, Lucknow-49, Gwalior-27, Surkhi (Yellowish Green). Whereas, Allahabad Safeda was observed with maximum fruit size [length (8.79 cm); diameter (8.44 cm)] and China Red with minimum fruit size [length (3.57 cm); diameter (3.56 cm)]. Three type of colour of pulp was observed i.e. Creamy White, White and Pink and among them maximum varieties were having creamy white colour of pulp with maximum pulp thickness in Apple Colour (1.81 cm) and minimum in China White (0.67 cm).

13 cultivars and two species of guava were assessed by Ran *et al*. (2017) at Hisar for morphological characterization and observed variations in fruit surface i.e. smooth, rough, smooth & ridged and rough & ridged with round, obovate, globose, oblong, pear shaped and oblate type of shape of fruits. The variation in skin colour was

also observed i.e. yellowish green, greenish yellow, green, saffron yellow with blush and green with red spots with pulp colour from white to pink. The fruit length (7.6 cm) and diameter (7.1 cm) was observed maximum in Lucknow-49 with highest fruit weight in Shweta (195.1 g) followed by Lucknow-49 (190.2 g), while, fruit length (2.9 cm) and weight (12.9 g) was minimum in Strawberry and fruit diameter (2.4 cm) was minimum in Chinese.

Genetically diverse genotypes of guava were evaluated by Patel *et al*. (2011) at Meghalaya for their fruit quality characters and reported varied fruit length between 5.16 cm in Sangam and 7.08 cm in RCG-2 whereas, fruit diameter ranged from 5.25 cm in RCG-1 to 7.08 cm in RCGH-4.

A comparative study on three newly developed guava hybrids with three commercial cultivars was conducted by Deshmukh *et al.* (2013) at Meghalaya for their fruit quality parameters and observed maximum mean fruit length of 6.54 cm and fruit diameter of 6.99 cm in RCGH 4, whereas, minimum fruit length of 5.98 cm and fruit diameter of 6.15 cm in Allahabad Safeda.

As many as 21 guava cultivars were investigated by Ghosh *et al.* (2013) that are planted in the orchard of an agro-based organization at Jhargram and reported that fruit weight was maximum in Almond Iskbala during both the seasons i.e. rainy (177 g) as well as winter season (147 g) and minimum in Behat Coconut [rainy season (80 g); winter season (62 g)].

Genetically diverse nine red fleshed guava genotypes were studied by Meena *et al*. (2013) during winter season and found Lalit with maximum fruit weight (106.61 g) and fruit breadth (5.86 cm) while that of minimum was observed in FRSG-R_7 [fruit weight (32.35 g)] and FRSG-R_4 [fruit breadth (2.93 cm)]. Fruit length was maximum in genotype FRSG-R_6 (6.16 cm) and minimum in genotype FRSG-R_7 (3.66 cm). Variation was found in colour of pulp from light pink to dark pink and that in colour of fruit from greenish to whitish yellow along with three types of fruit shapes i.e. ovate, round and pyriform.

Fruit characters of five guava cultivars were studied by Singh *et al.* (2013) at Varanasi and observed maximum fruit length in Hisar Surkha (6.00 cm) followed by Lucknow-49 (5.60 cm) and Lalit (5.57 cm) with minimum fruit length in Allahabad

Safeda (5.22 cm) followed by Shweta (5.49 cm), whereas, fruit diameter was maximum in Lalit (6.79 cm) and minimum in Allahabad Safeda.

In another study, Kuldeep (2014) evaluated eight cultivars of guava at Varanasi for their morpho-physical parameters and found Gorakh Bilas Pasand with maximum fruit size [length (7.57 cm); breadth (7.82 cm)] and fruit weight (218.78 g), whereas, Banarasi Surkha recorded minimum fruit size [length (6.10 cm); breadth (5.49 cm)] and fruit weight (150.02 g). Ulemale and Tambe (2015c) observed highest fruit weight (214.03 g) in 'L-49' and highest pulp content (96.55 %) but pulp/seed ratio (66.42) in 'GRS_4'.

Three varieties of guava were evaluated by Ajang *et al.* (2016) at Anand, Gujrat and found maximum fruit length (6.90 cm) and diameter (7.32 cm) in Allahabad Safeda, while minimum length of 5.93 cm and diameter i.e. 6.31 cm in Lucknow-49.

Eight guava genotypes were evaluated by Dubey *et al*. (2016) for their fruit quality characters at Patharchatta and observed Allahabad Safeda with maximum average fruit weight (150.60 g) and average fruit size (6.36 x 8.01 cm), while variation was found in fruit shape (round, roundish ovate and spherical), fruit base shape (flattened and broadly rounded), fruit apex shape (rounded, broadly rounded, pointed and necked), fruit skin colour (greenish yellow, greenish yellow with red dotted, straw yellow, yellowish white and greenish yellow), fruit flesh colour (milky white, yellowish white and dark pink) and fruit skin surface (smooth, smooth to rough and slightly rough).

Six guava cultivars were evaluated by Gupta *et al*. (2016) under Jammu conditions for their fruit characteristics during rainy as well as winter season crop and observed Lucknow-49 with maximum mean fruit length [rainy season (6.5cm); winter season (7.4 cm)] and breadth [rainy season (6.9 cm); winter season (7.7 cm)], whereas, minimum fruit length [rainy season (3.7cm); winter season (5.3 cm)] and fruit diameter [rainy season (4.5cm); winter season (6.2 cm)] was found in Apple Colour.

In another study, Kumari *et al*. (2016) evaluated different guava cultivars under sub-tropical condition of Dhaulakuan (HP) and observed fruit length ranging from 5.00 cm in 'Lalit' to 6.48 cm in 'Lucknow-49'. Whereas, maximum fruit diameter and fruit weight were obtained in 'Lucknow-49' (6.53 cm, 140.29 g) and minimum fruit diameter in 'Hybrid-3' (5.18 cm) and fruit weight in 'Hybrid-1' (83.39 g).

Three guava varieties were evaluated by Mehta *et al*. (2016) at Uttrakhand and found maximum fruit weight (158.08 g), fruit length (6.10 cm) and fruit diameter (6.45 cm) in Lucknow-49 followed by Allahabad Safeda [fruit weight (148.06 g), fruit length (5.95 cm) and fruit diameter (6.10 cm)] and Pant Prabhat [fruit weight (108.18 g), fruit length (4.94 cm) and fruit diameter (5.43 cm)].

Eight guava cultivars were evaluated by Sarkar *et al.* (2016) Mondouri and reported maximum fruit length and fruit diameter in Phillipines (7.22 cm) and Lucknow-49 (7.05), respectively, whereas, minimum in Arka Amulya [length (6.07 cm); diameter (5.91 cm)].

The performance of some guava introductions were evaluated by Singh *et al*. (2016a) in arid condition. They reported pink flesh colour in 'Lalit', red in 'Red Fleshed', whereas, white in other varieties and fruit weight ranged from 87.2 g to 152.0 g in 'MPUAT Sel.1' and 'Sarbati', respectively.

Five varieties of guava were studied by Tiwari *et al*. (2016) at Varanasi for their fruit quality and observed fruit shape to vary from roundish ovate in L-49 with primrose yellow skin colour to globose in Shweta with creamy white skin colour. All varieties were having smooth surface and white flesh colour except Lucknow-49 (rough surface) and Lalit (pink flesh colour). The length of fruit (7.64 cm), breadth of fruit (7.79 cm), thickness of pericarp (1.75 cm) and thickness of placenta (4.38 cm) were maximum in Gorakh Bilas Pasand, whereas, they were found to be minimum in Lalit [length of fruit (6.51 cm), breadth of fruit (6.85 cm), thickness of pericarp (1.24 cm) and thickness of placenta (3.66 cm)].

Eight different guava cultivars at Pune was evaluated by Bhalekar and Chalak (2017) and found fruit length to vary from 5.88 cm in Seedless to 6.86 cm in Behat Coconut. The fruit diameter (6.71 cm) and fruit weight (168.41 g) were maximum in Sardar, whereas, minimum in Apple Colour [fruit diameter (5.71 cm) and fruit weight (123.88 g)].

The growth characters of fifteen guava genotypes in Uttrakhand were studied by Kumar *et al.* (2017) and observed fruit length ranging between 78.06 mm in Kayamganji to 49.31 mm in CISH-G-35, whereas, fruit diameter was found to be maximum in MPAUT Sel-1 (68.87 mm) and minimum in Hisar Surkha (47.53 mm)

with variable length/diameter ratio which ranged from 0.84 in CISH-G-35 to 1.21 in Kayamganji.

The flowering behavior of eight guava genotypes was studied by Sahoo *et al.* (2017) at Bhubaneswar in both rainy and winter season and observed variability in period required from flowering to fruit maturity between 124 days (Hisar Surkha) to 134 days (Pant Prabhat) during rainy season, whereas, it varied from 123 days (Lucknow-49) to 138 days (Pant Prabhat) during winter season. Pant Prabhat recorded maximum fruit weight during rainy (147.63 g) as well as winter season (150.60 g), whereas, minimum in Banaras Round (106.73 g) during rainy season and in Hisar Safeda (112.37 g) during winter season.

The fruit parameters of guava cultivars under hot-arid environment were studied by Singh *et al*. (2017) and observed that fruit weight ranged from 40.69 g in 'Allahabad Safeda' to 107.40 g in 'Shweta'.

Four years old six guava genotypes were evaluated by Talang *et al.* (2017) at ICAR Research Complex for NEH Region, Nagaland Centre, Jharnapani and recorded RCGH-4 with maximum fruit weight (171.28 g) and fruit size (length/width: 6.23/6.97 cm) while that of minimum was found in Allahabad Safeda [fruit weight (115.10 g) and fruit size (length/width: 4.87/4.47 cm)].

Five guava varieties were evaluated by Mehta *et al.* (2018) for their fruit quality Uttarakhand and recorded maximum fruit length (6.1 cm) and fruit diameter (6.45 cm) in Lucknow-49, whereas, minimum fruit length and fruit diameter was observed in Pant Prabhat (4.94 cm) and Lalit (5.33 cm), respectively.

2.4 Yield characters

Red-fleshed varieties of guava were evaluated by Teaotia *et al.* (1966) and observed maximum fruits per tree in 'Anakapalle' (1003.50) and minimum in 'Patilo' (85.0). However, Chatterjee *et al*. (1992) took observations after 15, 30 and 60 days of flowering and observed 92 per cent fruit set in 'Allahabad Safeda' followed by 90 per cent in 'Red Fleshed' and 84 per cent in 'Sardar'. Whereas, fruit harvested were 64 per cent in 'Allahabad Safeda', 62 per cent in 'Red Fleshed' and 60 per cent in 'Sardar'.

In another study, Daulta *et al.* (1998) evaluated some new hybrids of guava along with standard cultivars. They reported highest fruit yield in 'Hisar Safeda' (114 kg/tree/year) and lowest in 'Allahabad Safeda' (59 kg/tree/year).

According to the evaluation of Babu *et al.* (2007) in some new hybrids of guava along with standard cultivars, fruit yield ranged from lowest (59 kg/tree/year) in 'Allahabad Safeda' to highest (114 kg/tree/year) in 'Hisar Safeda'.

Twelve guava selections were evaluated by Padilla *et al.* (2007) who reported that average number of fruits per tree ranged from 636 in 'S-118' to 1252 in 'S-11'.

A total of 21 genotypes of guava were evaluated by Jana *et al.* (2009) during rainy and winter season for their yield parameters. The maximum fruit yield was recorded in the Lucknow-49 (19.20 kg/tree) followed by Allahabad Safeda (16.40 kg/tree) during rainy season, whereas, Chittidar (16.4 kg/tree) was recorded maximum fruit yield followed by Barbadose Superior (14.60 kg/tree) during winter season.

Twenty varieties/germplasm of guava (*Psidium guajava* L.) were evaluated by Mahaur (2010) in Mandsaur (M.P.) and observed Lucknow-49 (111.88 q/ha) with maximum fruit yield followed by Allahabad Safeda (110.66 q/ha), whereas, minimum fruit yield was observed in China White (08.89 q/ha) followed by China Red (10.14 q/ha).

Lakade *et al.* (2011) recorded maximum yield in genotype 'GRS_4' (21.03 tonnes/ha) and minimum in genotype 'GWS_8' (7.17 tonnes/ha).

Eleven genetically diverse genotypes of guava were evaluated by Patel *et al.* (2011) at ICAR Research Complex for NEH Region, Umiam (Meghalaya) for their yield characters and observed that fruit yield varied from 5.40 kg/tree in Sangam to 14.18 kg/tree in genotype RCGH-1 followed by Lalit (14.12 kg/tree). Similar reports were recorded by Talang *et al.* (2017) and Deshmukh *et al.* (2013) at same region.

Twenty-one guava cultivars were investigated by Ghosh *et al.* (2013) for yield at Jhargram and recorded maximum total fruit yield per plant in Banarashi (73.7 kg/plant) and minimum in Seedless (9.3 kg/ plant).

Meena *et al.* (2013) found maximum yield in Lalit (14.91 kg/plant) and minimum in FRSG-R_2 (5.93 kg/plant) among red fleshed genotypes in Aurangabad.

According to Kumari *et al.* (2016), the yield ranged from 5.65 kg per plant in guava 'Hybrid-1' to 10.20 kg per plant in 'Lucknow-49' under sub-tropical condition of Dhaulakuan (HP).

In another study, Dubey *et al*. (2016) observed maximum yield in Arka Kiran (25.23 kg/plant) followed by RCGH-1 (20.60 kg/plant), while minimum in RCGH-7 (08.34 kg/plant) followed by CISH-G-35 (09.81 kg/plant) among eight guava genotypes at Horticulture Research Centre, Patharchatta, Govind Ballabh Pant University of Agriculture and Technology.

Under rainfed conditions of Jammu, Gupta *et al*. (2016) evaluated six cultivars for their yield characteristics during rainy as well as winter season crop and observed Lucknow-49 with maximum mean fruit yield [rainy season (78 kg/tree); winter season (114 kg/tree)], whereas, minimum mean fruit yield during rainy season (24 kg/tree) was observed in Apple Colour, while in Hybrid-2 during winter season (43 kg/tree).

The newly developed guava selections and cultivars were assessed by Pandey *et al*. (2016) at the Central Institute of Subtropical Horticulture, Rehmankhera, Lucknow for yield parameters and observed variation in fruit yield from 30.64 kg/tree in Hybid-21 to 90.62 kg/tree in Shweta.

Performance of some guava introductions was evaluated by Singh *et al*. (2016a) in arid condition. They reported highest yield in 'Allahabad Safeda' (10.20 kg/tree) followed by 'L-49' (8.60 kg/tree).

Eight different guava cultivars were evaluated by Bhalekar and Chalak (2017) at National Agriculture Research Project (Plain Zone) Ganeshkhind, Pune and recorded yield to range from 36.24 kg/plant in Chittidar to 56.39 kg/plant in Sardar.

Yield characters of eight guava genotypes were studied by Sahoo *et al.* (2017) at Bhubaneswar in both rainy and winter season and reported variation in yield characters with maximum yield in Pant Prabhat (14.67 kg/plant) and Shweta (13.98 kg/plant), whereas, minimum in Allahabad Safeda (5.62 kg/plant) and Hisar Surkha (3.91 kg/plant) during rainy season and winter season, respectively.

Ulemale *et al*. (2018) reported maximum mean fruit yield in GRS_4 (52.90 kg/tree) followed by Lucknow-49 (47.74 kg/tree) and minimum in GWS_8 (17.27 kg/tree).

2.5 Seed characters

Srivastava and Srivastava (1965) found minimum number of seeds per fruit (301) in 'Allahabad Safeda' and maximum number of seeds per fruit in 'Red Fleshed' (552).

As regards, the seed hardness in guava, a great deal of variation ranging from soft, intermediate and hard seeds has been reported by several workers in different agro-climatic conditions of India (Teaotia *et al.*, 1966; Daulta *et al.*, 1998; Babu *et al.*, 2007; Ulemale and Tambe, 2015).

Mahaur (2010) found maximum number of seeds per fruit in Allahabad Safeda (410 seeds) followed by Lucknow-49 (402 seeds), whereas, minimum in Chaitpur (165 seeds) followed by Chittidar (172 seeds) and Lal Guda (174 seeds).

Eleven genetically diverse genotypes of guava were evaluated by Patel *et al*. (2011) and likewise, a comparative study on three newly developed guava hybrids with three commercial cultivars was done by Deshmukh *et al.* (2013) at ICAR Research Complex for NEH Region, Umiam (Meghalaya) for their seed charactersand observed maximum number of seeds per 100 g fruit weight in RCGH 4 (171.9) seeds followed by Lalit (169.07 seeds) whereas, minimum in RCGH 7 (111.18 seeds) followed by Lucknow-49 (139.21 seeds).

Singh *et al.* (2013) at Varanasi, observed highest seed weight in Allahabad Safeda (3.70 g) followed by Lucknow-49 (3.24 g) and Shweta (3.18 g), and, minimum in Lalit (2.83 g) followed by Hisar Surkha (2.97 g).

Dubey *et al*. (2016) observed maximum number of seed per 100 g fruit weight in genotype MPUAT Sel-1 (138.20 seeds) and minimum in Arka Kiran (114.00 seeds), whereas, fresh seed weight (1.35 g) and dry seed weight (1.19 g) were found maximum in genotype RCGH-1 and RCGH-7, respectively. Minimum fresh seed weight (0.78 g) and dry seed weight (0.77 g) were observed in genotype CISH-G-35 and RCGH-1, respectively.

The maximum number of seeds per 100 gram fruit weight were observed in Allahabad Safeda (146.51 seeds) followed by Lucknow-49 (139.72 seeds) and Pant Prabhat (133.45 seeds), in a study conducted by Mehta *et al*. (2016) in Uttrakhand.

Similarly, maximum number of seeds per fruit were observed in cv. Arka Amulya (306.33 seeds) followed by cv. Phillipines (302.33 seeds), whereas, minimum in cv. Shweta (242.00 seeds) followed by Lucknow-49 (252.00 seeds) by Sarkar *et al*. (2016).

Five varieties of guava were studied by Tiwari *et al*. (2016) in Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi for their seed characters and reported minimum number of seeds per hundred grams of in Gorakh Bilas Pasand (117.00 seeds), whereas the maximum seed count (151.33 seeds) was recorded in Lalit followed by Shweta (142.67 seeds).

Bhalekar and Chalak (2017) evaluated eight different guava cultivars at National Agriculture Research Project (Plain Zone) Ganeshkhind, Pune and found cv. Behat Coconut (255.33) with maximum number of seeds per fruit followed by Sardar (234.66) and minimum in Seedless (59.67). The seeds are found soft (Seedless, Arka Amulya and Arka Mridula), semi-hard (Behat Coconut, Apple Colour and Chittidar) and hard seeded (Basti Red and Sardar). Similar results were recorded by Ghosh *et al.* (2013) in his investigation period at Jhargram.

In another study, Mehta *et al.* (2018) evaluated five guava varieties for their seed characters at Horticulture Research Centre, Department of Horticulture, H.N.B. Garhwal University, Uttarakhand and observed maximum number of seeds per 100 g fruit weight in Sangam (195.61 seeds) followed by Lalit (179.16 seeds) and minimum in Pant Prabhat (133.45 seeds) followed by Lucknow-49 (139.72 seeds) and Allahabad Safeda (146.51 seeds).

2.6 Fruit (biochemical) characters

Qualitative characteristics of some guava varieties were studied by Teaotia *et al.* (1966) and reported highest per cent of total sugars in fruit of ‘China Surkha’ (10.68 %) followed by ‘Red Fleshed Allahabad’ (9.19 %) , the lowest total sugars were found in ‘Hybrid Red Supreme’ (5.79 %).

Chatterjee *et al.* (1992) reported that highest total sugars (7.27 %), TSS (9.65 %) and acidity (0.54 %) were found in ‘Allahabad Safeda’ and the lowest total sugars (6.32 %), TSS (8.45 %) and acidity (0.49 %) were found in ‘Red Fleshed’.

Evaluation of some new guava hybrids along with standard cultivars was done by Daulta *et al.* (1998). They reported maximum TSS in 'Hisar Surkha' (13.6 %) and minimum in 'Lucknow-49' (11.8 %), whereas, acidity was highest in 'Banarsi Surkha' (0.48 %) and lowest in 'Hisar Safeda' (0.38 %).

Bal and Dhaliwal (2004) studied quality characteristics of graded guava fruits and reported 11.0 per cent TSS in cv. 'L-49' (Sardar) and 10.4 per cent in cv. 'Allahabad Safeda'.

Hegde and Chharia (2004) studied developmental and ripening physiology of guava and reported 13.83 per cent TSS content and 0.50 per cent acidity in 'L-49' (Sardar) during winter and 9.31 per cent TSS and 0.41 per cent acidity during rainy season.

A comparative evaluation of guava selections under North Eastern region of India was done by Babu *et al.* (2007) and observed maximum TSS (11.0 %) in 'Selection-11', whereas, minimum in 'Selection-1' (8.5 %) and also observed maximum titrable acidity (0.70 %) in 'Selection-1', whereas, minimum in 'Selection-10' (0.28 %).

Twenty-one genotypes of guava were evaluated by Jana *et al.* (2009) during rainy as well as winter season for their chemical composition and they recorded maximum TSS (11.0 ^{o}B) and titratable acidity (0.41 %) in genotype Kairala Seedling and Chittidar respectively, during rainy season, whereas, maximum TSS (14.0 ^{o}B) were observed in Barbadose Superior and minimum titratable acidity (0.24 %) in Harijha, Allahabad Safeda, Kairala Seedling and Sindh during winter season. The highest total sugar content was found in Spear Acid (6.17 %) during winter, whereas, Chittidar accounted for minimum total sugars (3.17 %) during rainy season.

Mahaur (2010) found Dharwar having maximum acidity (2.75 %) and minimum TSS (4.00 ^{o}B), whereas, minimum acidity (0.16 %) and maximum TSS (11.50 ^{o}B) were observed in Surkhi and Anakapalli, respectively in a study carried out in Mandsaur (M.P.).

According to Ran *et al.* (2017), maximum TSS was recorded in Hybrid Red Supreme (13.7 ^{o}B) followed by Hisar Safeda (13.5 ^{o}B) and Hisar Surkha (13.1^{o}B) with

minimum TSS in Chinese (9.3 °B). The variation ranging from 0.35 per cent in Hisar Safeda to 0.96 per cent in Chinese was reported.

Patel *et al*. (2011) evaluated 11 genetically diverse genotypes of guava at Umiam (Meghalaya) for their chemical composition and observed maximum TSS, acidity and total sugars in genotype RCG-11 (11.88 %), Sangam (0.65 %) and genotype RCGH-7 (8.39 %), respectively whereas, minimum in Lalit (9.35 %), genotype RCGH-7 (0.45 %) and genotype RCG-3 (6.04 %), respectively.

In a comparative study on three newly developed guava hybrids with three commercial cultivars at ICAR Research Complex for NEH Region, Umiam Meghalaya for their chemical composition, Deshmukh *et al.* (2013) observed Lalit with minimum mean TSS (9.59 °B) and maximum mean acidity (0.67 %), whereas, RCGH 1 with maximum mean TSS (10.83 °B) and minimum mean acidity (0.50 %). Maximum mean total sugar content was reported in RCGH 1 (8.07 %) and it was at par with RCGH 7 (8.05 %) with minimum in RCGH 4 (6.42%) followed by Lalit (6.58%).

Maximum TSS during rainy season in Lucknow-49 (9.8 °B) and during winter season in Khaja (11.8 °B), whereas, minimum during rainy season in Patialo (7.6 °B) and in Patialo and Florida Seedlings (8.3 °B) during winter season was reported by Ghosh *et al.* (2013) at Jhargram. The total sugars were maximum in Seedless during both the seasons i.e. rainy (7.3 %) as well as winter season (7.8 %) and minimum in Florida Seedlings [rainy season (3.0 %); winter season (4.7 %)]. The maximum acidity was observed in Patialo during both the seasons, whereas, minimum in Khaja during rainy season and in Arka Mridula during winter season.

Under Maharashtra conditions, Meena *et al*. (2013) recorded maximum TSS (11.56 °B), total sugars (7.36 %) and non-reducing sugars (1.68 %) in cv. Lalit and maximum acidity (0.48 %) and reducing sugars (5.91 %) were observed in genotypes FRSG-R_3 and FRSG-R_2, respectively. Whereas, minimum TSS (8.86 °B), acidity (0.41 %), total sugars (5.67 %), reducing sugars (4.34 %) and non-reducing sugars (1.17 %) were observed in FRSG-R_7, FRSG-R_8, FRSG-R_3, (FRSG-R_3, FRSG-R_7) and FRSG-R_2, respectively.

In another study, Singh *et al.* (2013) reported that acidity varied between 0.512 per cent (Lalit) and 0.879 per cent (Shweta), whereas, TSS was maximum in Hisar

Surkha (15.0 °B) followed by Lucknow-49 (13.2 °B), Lalit (12.8 °B) with minimum in Allahabad Safeda (11.2 °B) followed by Shweta (11.3 °B).

According to Kuldeep (2014), the maximum reducing sugars (7.28 %), total sugars (11.36 %), TSS (13.58 °B) and minimum acidity (0.164 %) was found in Lucknow-49, whereas maximum non reducing sugars (4.26 %) and acidity (0.836 %) was observed in Allahabad Safeda and Banarasi Surkha, respectively. The minimum total sugars (8.20 %) and non reducing sugars (3.13 %) were observed in Gorakh Bilas Pasand, whereas, reducing sugars (4.98 %) and TSS (11.20 °B) were minimum in Lalit and Apple Colour, respectively.

Ajang *et al.* (2016) observed maximum TSS (13.58 %), total sugar (12.3 %) and reducing sugars (7.99 %) in cv. Allahabad Safeda, while minimum in cv. Red Guava [TSS (11.66%); total sugars (10.31 %); reducing sugars (6.96 %)], whereas, acidity was maximum in cv. Red Guava (0.46 %) and minimum in cv. Lucknow-49 (0.35 %).

Variation in TSS ranged between 8.20 per cent in genotype MPUAT Sel-1 and 6.68 per cent in genotype RCGH-1, while acidity was maximum in Arka Kiran (0.47 %) and minimum in Allahabad Safeda (0.23 %), whereas, reducing sugars (3.58 %), non reducing sugars (3.20 %) and total sugars (6.77 %) were minimum in genotype MPUAT Sel-1, while reducing sugars (7.78 %) and total sugars were maximum in Arka Kiran with maximum non reducing sugars was observed in genotype RCGH-7 (6.20 %), according to a report from Patharvhatta (Dubey *et al*., 2016).

Mehta *et al*. (2016) reported maximum TSS (11.82 °B) and total sugars (7.38 %) in Pant Prabhat followed by Lucknow-49 [TSS (10.16 °B) and total sugars (7.16 %)] and Allahabad Safeda [TSS (10.14 °B) and total sugars (6.98 %)]. The acidity was found to be maximum in Allahabad Safeda (0.60 %) followed by Lucknow-49 (0.53 %) and Pant Prabhat (0.27 %).

The maximum TSS was recorded in Hisar Surkha (14.84 °B) was assessed by Pandey *et al*. (2016). Likewise, some introductions of guava were evaluated by Singh *et al*. (2016a) in arid conditions of Western Rajasthan and observed highest TSS in 'MPUAT Sel. 1' (20.4 °B), whereas, acidity was highest in 'Lalit' (0.69%) and total sugars were highest in 'Red Fleshed' (10.16%).

Tiwari *et al*. (2016) studied five varieties of guava for their chemical parameters and observed maximum titrable acidity and TSS in Allahabad Safeda (0.63%) and Lucknow-49 (13.00 °B), respectively whereas minimum in Lucknow-49 (0.50%) and Shweta (11.17 °B), respectively.

Likewise, several other reports indicate a considerable degree of variation in major biochemical constituents (total sugars, reducing/non-reducing sugars, acidity etc.) in fruits of guava cultivars and selections (Bhalekar and Chalak, 2017; Kumar *et al*., 2017; Singh *et al.,* 2017; Talang *et al*., 2017; Mehta *et al*., 2018; Ulemale *et al*., 2018).

Chapter-3

MATERIALS AND METHODS

The present study titled **"Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids"** was conducted during the year 2017 and 2018 at the Regional Horticultural Research and Training Station, Dhaulakuan, Sirmour. The details of the materials used and methodologies employed to execute the studies have been described under following heads:

3.1 GEOGRAPHICAL FEATURES

Regional Horticultural Research and Training Station, Dhaulakuan is located between 35.5°N latitude and 77.5°E longitude at an elevation of 468 metres above mean sea level in the sub-tropical, sub-montane and low hill zone of Himachal Pradesh.

3.2 EXPERIMENTAL DETAILS

3.2.1 Plant Material

The present study was carried out on eight years old stool layered bearing trees planted at a distance of 5 x 5 metres during rainy season. Thirty six guava trees uniform in growth, vigour, productivity, free from insect, pest and diseases and growing apparently under healthy conditions, were selected for this investigation. Observations were recorded on plant growth, foliage, flowering, physico-chemical, fruit and seed characters during rainy season on nine different guava cultivars and hybrids i.e Punjab Hybrid-1 (H-1), Punjab Hybrid-2 (H-2), CISH-G-1, Lalit (CISH-G-3), Allahabad Safeda, CISH-G-4 (Shweta), Lucknow-49 (Sardar), Hisar Safeda, and Hisar Surkha and each one having four replications. The experiment was laid out on bearing guava trees in a Randomized Block Design.

3.3 OBSERVATIONS RECORDED

The observations in respect of the plant growth, foliage, flowering, fruit and seed characters were recorded following UPOV test guidelines (Anonymous, 1987) and general standard procedures detailed below:

3.2.2 Material under study

Table .1 List of guava cultivars and hybrids:

S. No.	Cultivars/Hybrids	Parentage
1.	Punjab Hybrid-1 (H-1)	Portugal x Lucknow-49 = F_1 x Apple Colour
2.	Punjab Hybrid-2 (H-2)	Portugal x Lucknow-49 = F_1 x Apple Colour
3.	CISH-G-1	Chance seedling selection
4.	Lalit (CISH-G-3)	Selection from half - sib population of Apple Colour
5.	Allahabad Safeda	Open pollinated seedling
6.	CISH-G-4 (Shweta)	Selection from half - sib population of Apple Colour
7.	Lucknow-49 (Sardar)	Open pollinated seedling selection from Allahabad Safeda
8.	Hisar Safeda	Allahabad Safeda x Seedless
9.	Hisar Surkha	Apple Colour x Banarasi Surkha

3.3.1 Tree characters

Only healthy and bearing guava trees were selected and subjected for further evaluation. The different characters studied are given below:

3.3.1.1 Tree height

The tree height was recorded by placing a marked bamboo pole on the soil surface near the base to the top of the plant and the height was measured in metres (m).

3.3.1.2 Trunk girth

The trunk girth was marked with yellow paint at 15 cm above ground level with the help of measuring tape and expressed in centimetres (cm).

3.3.1.3 Tree spread

The horizontal distance from one end of the canopy to the other end was recorded in two directions viz. North-South and East-West with the help of a marked bamboo pole which was then measured in metres (m) and their mean was recorded.

PLATE 1

ERECT

SPREADING

DROOPING

ATTITUDE OF BRANCHES

3.3.1.4 Tree volume

The volume of the canopy was calculated by using the formula given by Westwood (1993) and expressed in cubic metres (m^3).

i) For a tree which was taller than its width

$$\text{Volume} = 4/3\ \pi ab^2$$

ii) For a tree which was wider than its height

$$\text{Volume} = 4/3\ \pi a^2 b$$

Where;

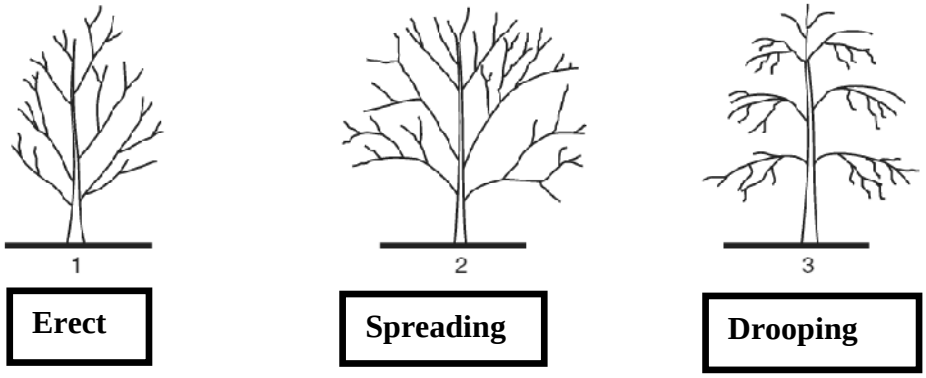
π = 3.1428

a = ½ of major axis (height)

b = ½ of minor axis (spread)

3.3.1.5 Attitude of branches

The attitude of branches was described with the help of standard descriptor for guava prescribed by UPOV (The International Union for the Protection of New Varieties of Plants) (Anonymous, 1987). Accordingly, the trees were classified as erect, spreading and drooping (Plate 1).



3.3.1.6 Inter-nodal length of twigs

The inter-nodal length of four randomly selected current season's shoots on each experimental tree was calculated by dividing the shoot length measured at the end of the growing season with total number of inter-nodes and was expressed in centimetres (cm).

3.3.1.7 Stem thickness

The thickness of stem was measured by randomly selecting four fully developed shoots from each direction and assigned as per UPOV descriptor (Anonymous, 1987) i.e. thin, medium and thick.

3.3.1.8 Extension growth of twigs

Four shoots of current season's growth were randomly selected from the periphery of the trees under each treatment in the month of September and their length was measured with the help of measuring tape. The length of twigs was recorded, computed and expressed in centimetres (cm).

3.3.1.9 Twig diameter

The twig diameter of four randomly selected current season's shoots on each experimental tree was measured from the base, middle and top of the shoot by using vernier calipers and average value was calculated and expressed in centimetres (cm).

3.3.1.10 Colour of young twigs

Colour of young twigs was assigned visually as per UPOV descriptor (Anonymous, 1987) i.e. green, green with red streaks and dark red.

Green

Green with red streaks

Dark red

3.3.2 Foliage characters

A total of four leaves sampled randomly from all directions from each individual tree were used for characterization and evaluation. The traits considered were of qualitative nature, listed according to degree of subjectivity. Different leaf characters studied are listed below:

3.3.2.1 Leaf blade length

Average of four mature leaves measured from the base to the tip of the leaf blade was calculated and expressed in centimetres (cm) and were assigned category as per UPOV descriptor (Anonymous, 1987) i.e. short (<10 cm) and long (>10 cm).

3.3.2.2 Leaf blade width

Average of four mature leaves measured at the widest point was worked out and expressed in centimetres (cm) and categorized as per UPOV descriptor (Anonymous, 1987) i.e. narrow (<4 cm) and broad (>4 cm).

3.3.2.3 Length/width ratio of leaf blade

Length/width ratio of leaf blade was measured by dividing the leaf blade length by the leaf blade width and categorization as per UPOV descriptor (Anonymous, 1987) was done as narrow (<2.5 cm) and broad (>2.5 cm).

3.3.2.4 Spacing of secondary veins

The leaves were observed visually to find out whether the spacing of secondary veins was close, medium or wide.

3.3.2.5 Leaf area

Four fully expanded leaves from each experimental tree were randomly collected in the month of July and leaf area was recorded with CI-202 Portable Laser Leaf Area Meter and the values were expressed as average leaf area per leaf in square centimetres (cm^2).

3.3.2.6 Anthocyanin colouration of young leaf

The anthocyanin colouration of young leaf was assigned as per UPOV descriptor (Anonymous, 1987), based on visual observation i.e. absent and present.

Absent

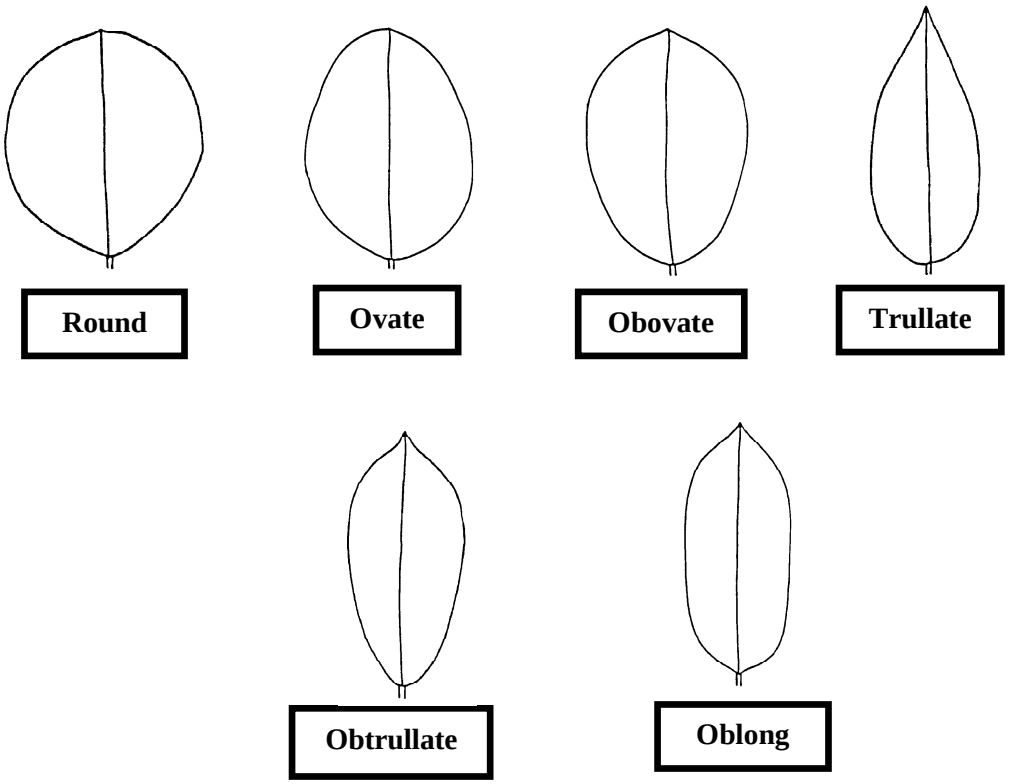
Present

3.3.2.7 Intensity of anthocyanin colouration of young leaf

Intensity of anthocyanin colouration of young leaf was assigned visually and categorized as per UPOV descriptor (Anonymous, 1987) i.e. weak, medium and strong.

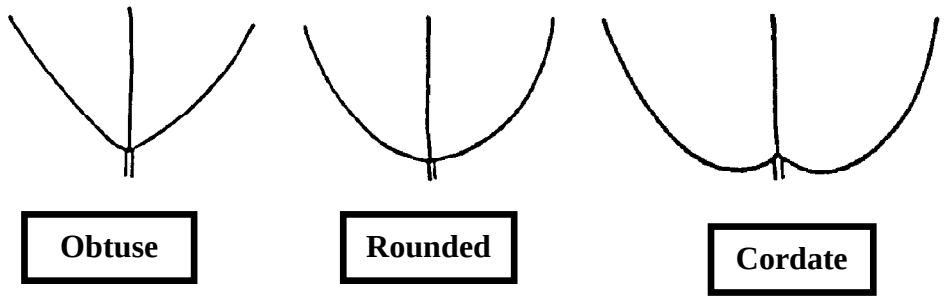
3.3.2.8 Shape of mature leaf

Shape of mature leaf was observed visually and assigned as per UPOV descriptor (Anonymous, 1987) i.e. round, ovate, obovate, trullate, obtrullate and oblong.



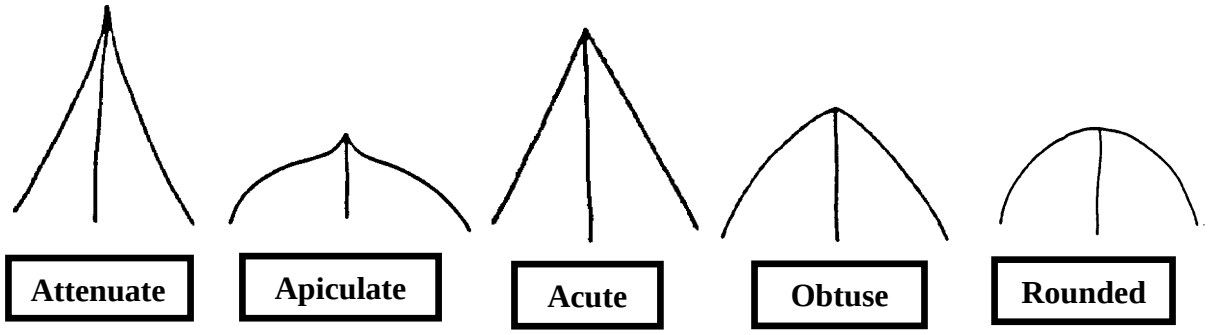
3.3.2.9 Leaf base shape

The leaf base shape was assigned as per UPOV descriptor (Anonymous, 1987) i.e. obtuse, round and cordate.



3.3.2.10 Leaf apex shape

The leaf apex shape was assigned as per UPOV descriptor (Anonymous, 1987) i.e. attenuate, apiculate, acute, obtuse and rounded.



3.3.2.11 Leaf colour

Leaf colour was assigned visually as per UPOV descriptor (Anonymous, 1987) i.e. green group and greyed red purple group.

3.3.2.12 Green colour of leaf

Green colour of leaf of already selected guava leaves was assigned as per colour chart of Royal Horticultural Society (Wilson, 1941) i.e. yellow green, grey green, green and dark green.

3.3.2.13 Relief of surface on upper side

The relief of surface on upper side of leaves was determined by using finger touch and category was assigned as per UPOV descriptor (Anonymous, 1987) i.e. smooth, medium and wrinkled.

3.3.2.14 Pubescence on the lower side of fully developed leaf

Pubescence on the lower side of fully developed leaf was assigned as per UPOV descriptor (Anonymous, 1987). Accordingly, classes were made as absent or very sparse, sparse, medium, dense and very dense.

3.3.2.15 Undulation of leaf margin

The undulation of leaf margin was observed visually and assigned as per UPOV descriptor (Anonymous, 1987) i.e. absent and present.

3.3.2.16 Degree of undulation of leaf margin

The degree of undulation of leaf margin was assigned visually and categorized as per UPOV descriptor (Anonymous, 1987) i.e. weak, medium and strong.

3.3.3 Flower characters

A total of four representative branches well spread around the periphery of the trees were selected from each individual tree and were used for characterization and evaluation in the month of April for the following parametres:

3.3.3.1 Season of flowering

3.3.3.1.1 Initiation of flowering

The day when 15 per cent flowers have opened was considered as the date of initiation of flowering.

3.3.3.1.2 End of flowering

The day when >75 per cent flowers have opened was considered as the date of end of flowering.

3.3.3.1.3 Duration of flowering

The time period between the date of initiation of flowering to the date of the end of flowering was considered as the duration of flowering.

3.3.3.2 Predominant number of flowers in inflorescence

The predominant number of flowers in inflorescence was counted in randomly selected four branches. Number of flowers in inflorescence was recorded by selecting the number which had more frequency as compared to others.

3.3.3.3 Flower size

The flower size was recorded by taking length and width of the flower and observations so recorded were averaged and category was assigned as per UPOV descriptor (Anonymous, 1987) i.e. small, medium and large.

3.3.3.4 Number of fully developed petals

The number of fully developed petals was counted in randomly selected four flowers. Number of petals was recorded by selecting the number which had more frequency as compared to others i.e. few, medium and many.

3.3.3.5 Staminoid petals

The staminoid petals were categorized as per UPOV descriptor (Anonymous, 1987) i.e. absent and present.

3.3.4 Fruit (morpho-physical) characters

A total of five fruits were selected randomly from all directions from each individual tree and observations so recorded were averaged.

3.3.4.1 First harvesting date

The time period of first harvesting of fruits was considered as the first harvesting date of fruiting.

3.3.4.2 Period from initiation of flowering to first harvesting

The period from initiation of flowering to first harvesting was recorded by counting the days from date of initiation of flowering to fruit maturity and assigned category as per UPOV descriptor (Anonymous, 1987) i.e. short (<120 days), medium (121-140 days) and long (>140 days).

3.3.4.3 Fruit length

At the physiological stage of maturity, five matured fruits were randomly selected. The fruit length was measured in centimetres (cm) with the help of vernier calipers from base to apex and category was assigned as per UPOV descriptor (Anonymous, 1987) i.e. short (<4 cm), medium (4.1-6 cm) and long (>6 cm).

3.3.4.4 Fruit width

Width of the same fruits, which were used for measuring length, was recorded by measuring distance between cheeks of fruits with the help of vernier calipers and was expressed in centimetres (cm) and categorized as per UPOV descriptor (Anonymous, 1987) i.e. narrow (<4 cm), medium (4.1-6 cm) and broad (>6 cm).

3.3.4.5 Length/width ratio

Length/width ratio was measured by dividing the fruit length by the fruit width and category was assigned as per UPOV descriptor (Anonymous, 1987) i.e. narrow (<1 cm), medium (1-1.2 cm) and broad (>1.2 cm).

3.3.4.6 Fruit weight

Five selected fruits taken for recording the fruit size data were weighed on electronic top pan balance and the average fruit weight was expressed in gram per fruit (g/fruit).

3.3.4.7 Stalk length

The stalk length was measured from the base of the stalk to the tip of the stalk by using vernier calipers and expressed in centimetres (cm) and category was assigned as per UPOV descriptor (Anonymous, 1987) i.e. short (<1.5 cm) and long (>1.5 cm).

3.3.4.8 Size of sepals

Size of sepals was measured by using vernier calipers and expressed in millimetres (mm) assigned as per UPOV descriptor (Anonymous, 1987) i.e. small, medium and large.

3.3.4.9 Diameter of calyx cavity

The diameter of the calyx cavity was measured by vernier calipers after cutting the ripe fruit length-wise into two equal halves and expressed in centimetres (cm) and then categories were assigned as per UPOV descriptor (Anonymous, 1987) i.e. small and large (Plate 2).

3.3.4.10 Prominence of neck

The prominence of neck category was assigned as per UPOV descriptor (Anonymous, 1987) i.e. absent and present (Plate 2).

3.3.4.11 Fruiting habit

The fruiting habit was categorized visually as per UPOV descriptor (Anonymous, 1987) i.e. axillary/lateral bearing and terminal bearing.

3.3.4.12 Fruit size uniformity

The fruit size uniformity was assigned based on visual observations.

3.3.4.13 Fruit shape `

Fruit shape (Plate 2) was assigned as per UPOV descriptor (Anonymous, 1987) i.e. pomi (round) and pyriform (pear shaped).

PLATE 2

A. DIAMETER OF CALYX CAVITY

SMALL (<1 CM)

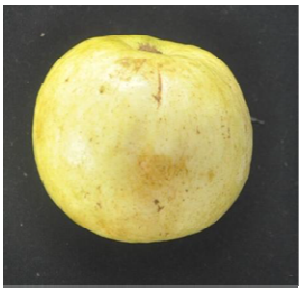
LARGE (>1 CM)

B. PROMINENCE OF NECK

ABSENT

PRESENT

C. FRUIT SHAPE



POMI (ROUND)

PYRIFORM (PEAR SHAPED)

D. COLOUR OF PEEL

YELLOW WHITE

GREYED YELLOW

YELLOW GREEN

RED BLUSH

PURPLE

PLATE 3

A. RELIEF OF FRUIT SURFACE

SMOOTH

ROUGH

B. RIDGED COLLAR AROUND CALYX CAVITY

CONSPICUOUS

INCONSPICUOUS

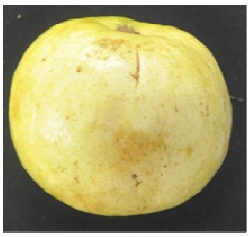
C. LONGITUDINAL RIDGES

ABSENT

PRESENT

PROMINENT

D. LONGITUDINAL GROOVES

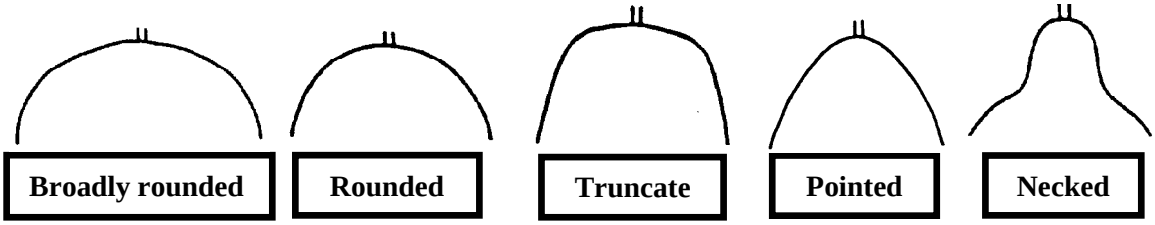


ABSENT

PRESENT

3.3.4.14 Fruit shape at stalk end

The fruit shape at stalk end was assigned as per UPOV descriptor (Anonymous, 1987) i.e. broadly rounded, rounded, truncate, pointed and necked.



3.3.4.15 Colour of peel

Colour of peel of guava fruits was assigned as per colour chart of Royal Horticultural Society (Wilson, 1941) i.e. yellow white, greyed yellow, yellow green, red blush and purple (Plate 2).

3.3.4.16 Relief of fruit surface

The relief of fruit surface was determined by using finger touch and was then categorized as per UPOV descriptor (Anonymous, 1987) i.e. smooth and rough (Plate 3).

3.3.4.17 Ridged collar around calyx cavity

The ridged collar around calyx cavity was assigned visually as per UPOV descriptor (Anonymous, 1987) i.e. inconspicuous and conspicuous (Plate 3).

3.3.4.18 Longitudinal ridges

The longitudinal ridges category was visually observed and category was assigned as per UPOV descriptor (Anonymous, 1987) i.e. absent, present and prominent (Plate 3).

3.3.4.19 Prominence of longitudinal ridges

The prominence of longitudinal ridges was observed visually and category was assigned as per UPOV descriptor (Anonymous, 1987) i.e. weak, medium and strong.

3.3.4.20 Longitudinal grooves

Presence or absence of longitudinal grooves (Plate 3) was assigned as per UPOV descriptor (Anonymous, 1987).

3.3.4.21 Core diameter

The sample fruit was cut longitudinally and core diameter was measured by using vernier calipers and expressed in centimetres (cm).

3.3.4.22 Thickness of outer flesh in relation to core diameter

The sample fruit was cut longitudinally and the thickness of mesocarp and endocarp was measured by a vernier calipers and expressed in centimetres (cm) and was categorized as per UPOV descriptor (Anonymous, 1987) i.e. thin, medium and thick (Plate 4).

3.3.4.23 Colour of flesh

Colour of flesh of guava fruits was assigned as per colour chart of Royal Horticultural Society (Wilson, 1941) i.e. white, yellow white, greyed orange, red and red purple (Plate 4).

3.3.4.24 Evenness of colour of flesh

The evenness of colour of flesh was assigned visually as per UPOV descriptor (Anonymous, 1987) i.e. even and mottled.

3.3.4.25 Discoloration of flesh after cutting

The discoloration of flesh after cutting was assigned visually as per UPOV descriptor (Anonymous, 1987) i.e. absent and present.

3.3.4.26 Puffiness

The puffiness of fruit pulp was assigned as per UPOV descriptor (Anonymous, 1987) i.e. absent and present (Plate 4).

3.3.4.27 Muskiness

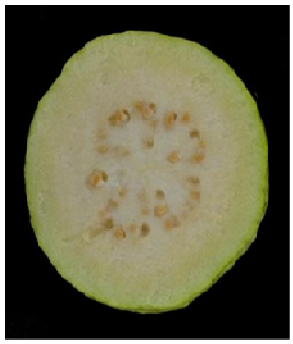
The muskiness of fruit was assigned as per UPOV descriptor (Anonymous, 1987) i.e. absent and present.

PLATE 4

A. THICKNESS OF OUTER FLESH IN RELATION TO CORE DIAMETER

THIN

MEDIUM



THICK

B. COLOUR OF FLESH

WHITE

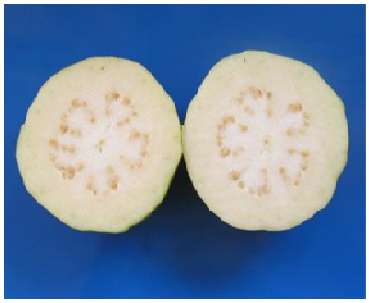
YELLOW WHITE

GREYED ORANGE

RED

RED PURPLE

C. PUFFINESS



ABSENT

PRESENT

3.3.4.28 Flavour

The flavour of fruits was evaluated by the panel of judges by giving their opinion and categorization was done as per UPOV descriptor (Anonymous, 1987) i.e. mild and strong.

3.3.4 Yield characters

3.3.5.1 Fruit yield per tree

The final yield of fruits in different cultivars and hybrids was recorded at the time of harvest by weighing the total fruits retained in particular tree. The yield was expressed in kilograms per tree (kg/tree).

3.3.5.2 Yield efficiency

The yield efficiency of each cultivar and hybrid studied was calculated as per the method given by Westwood (1978) and expressed in g/cm^2 TCSA using the formula:

$$\text{Yield efficiency (g/cm}^2\text{ TCSA)} = \frac{\text{Fruit yield (g/plant)}}{\text{Trunk cross sectional area (cm}^2\text{)}}$$

3.3.6 Fruit (biochemical) characters

Five matured fruits selected randomly from each tree were used for determination of following biochemical constituents:

3.3.6.1 Total soluble solids

Total soluble solids (TSS) content was estimated by using an "Erma–Hand Refractometer" (0 to 32 ^{o}B) by placing a drop of guava juice squeezed from the fruit flesh (at full ripe stage) on its prism and TSS was obtained from direct reading of the refractometer and expressed in ^{o}Brix.

3.3.6.2 Titratable acidity

The titratable acidity of guava pulp was determined by the standard method of Ranganna (1995) and category was assigned as per UPOV descriptor:

a) Low (<0.3-0.5 %)
b) Medium (0.5-0.7 %)
c) High (0.7-1.0 %)

The following reagents were used for the determination of titratable acidity.

1. Standard NaOH solution (0.1 N)
2. 1% phenolphthalein solution

Extraction of guava juice

The fresh guava pulp (25 g) was taken in 250 ml beaker and then it was homogenized with distilled water in blender. The homogenized pulp was then filtered and transferred to a 250 ml volumetric flask and the volume was made up to the mark with distilled water.

Procedure

Pulp solution (10 ml) was taken in a conical flask. Two to three drops of phenolphthalein indicator was added and then the conical flask was shaken vigorously. It was then titrated immediately with 0.1N NaOH from a burette till a permanent pink colour appeared. The volume of NaOH solution required for titration was noted from burette reading. Per cent titratable acidity was calculated by using the following formula:

$$\text{Acidity (\%)} = \frac{T \times N \times V_1 \times E}{V_2 \times W \times 1000} \times 100$$

Where,

T	=	Titre value
N	=	Normality of NaOH
V_1	=	Volume made up
E	=	Equivalent weight of predominant acid (Citric Acid)
V_2	=	Volume of extract
W	=	Weight of sample (g)

3.3.6.3 Total sugars

The sugar content of the fruit was determined by volumetric method based on the principle that sucrose content of fruit is quantitatively hydrolyzed to glucose and fructose in the presence of hydrochloric acid as per the method suggested by Ranganna (1995).

The remnant of the 200 ml extract left from titratable acidity was taken in a 250 ml volumetric flask and 5 ml of 45 per cent standard lead acetate was added. After 5-10 minutes, 5 ml of 22 per cent potassium oxalate was added to precipitate the excess of lead acetate and volume was made 250 ml followed by the filtration of the solution. Afterwards, 50 ml of the filtrate was taken and hydrolyzed by adding 5 ml of concentrated HCl. The solution was left overnight for hydrolysis at room temperature. The next day, the excess of HCl was neutralized with saturated 1 per cent NaOH solution and final volume of 250 ml with distilled water was made. The total sugars was then estimated by titrating boiling mixture of 5 ml each of Fehling A and Fehling B against hydrolyzed solution using methylene blue as indicator. The end point was indicated by the appearance of brick red colour. The total sugars was expressed as percentage of fresh weight of fruit pulp.

$$\text{Total sugar (\%)} = \frac{\text{*Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Weight/Volume of sample}} \times 100$$

*Factor = 0.05

3.3.6.4 Reducing sugars

The remaining unhydrolyzed, deleaded and clarified solution obtained from the total sugars estimation was titrated against a boiling solution of 5 ml each of Fehling A and Fehling B using methylene blue as an indicator (Ranganna, 1995). Reducing sugars content was expressed as percentage of fresh pulp weight.

$$\text{Reducing sugars (\%)} = \frac{* \text{ Factor} \times \text{Dilution}}{\text{Titre value} \times \text{weight of sample taken}} \times 100$$

*Factor = 0.05

3.3.6.5 Non-reducing sugars

The amount of non-reducing sugars was calculated by subtracting the reducing sugars from total sugars and multiplying the difference by a standard factor i.e. 0.95. The results were expressed as per cent sugars.

$$\text{Non} - \text{reducing sugars (\%)} = (\text{total sugars} - \text{reducing sugars}) \times 0.95$$

3.3.7 Seed descriptor

3.3.7.1 Number of seeds/fruit

The pulp of fruit was made into pieces and boiled in hot water for 15 minutes. Later, the seeds were separated by using ordinary sieve (< 20 mm) and the number of seeds were counted and assigned as per UPOV descriptor (Anonymous, 1987) i.e. few (<50), medium (51-250) and many (>250).

3.3.7.2 Seed weight/fruit

The seed weight per fruit were recorded by an electrical balance and expressed in grams (g).

3.3.7.3 Seed size

The seed size was recorded by taking length and width of the seed by using vernier calipers and observations so recorded were averaged and category assignment was done as per UPOV descriptor (Anonymous, 1987) i.e. small, medium and large.

3.3.7.4 Seed hardness

Hardness of seed was determined by a panel of judges through organoleptic test and expressed as hard, medium and soft.

3.3.7 Statistical analysis

The data generated from these investigations were appropriately computed, tabulated and analyzed by using MS-Excel and OPSTAT. The mean values of data were subjected to analysis of variance as procedures outlined by Gomez and Gomez (1984) for Randomized Block Design. Critical difference was calculated at 5 per cent level of significance.

ANOVA for RBD (Randomized Block Design):

Source of variation	**Degree of freedom**	**Sum of squares**	**Mean sum of squares**	**F_{cal}**
Treatments	(t-1)	S_t	$M_t = S_t/ (t-1)$	M_t/ M_e
Replications	(r-1)	S_r	$M_r = S_r/ (r-1)$	M_r /M_e
Error	(r-1)(t-1)	S_e	$M_e = S_e/ (r-1)(t-1)$	
Total	(rt-1)	S_T		

Where,

r	=	Number of replications
t	=	Number of treatments
S_r	=	Sum of squares due to replications
S_t	=	Sum of squares due to treatments
S_e	=	Sum of squares due to error
S_T	=	Total sum of squares
M_r	=	Mean sum of squares due to replications
M_t	=	Mean sum of squares due to treatments
M_e	=	Mean sum of squares due to error

The replication and treatment mean sum of square were tested against error mean squares by 'F' test at (r-1), (r-1) (t-1) and (t-1), (r-1) (t-1) degree of freedom for RBD at 5% level of significance.

The calculated F-values were compared with tabulated F- value. When F- test will be found significant, critical difference will be calculated to find out the superiority of one treatment over the others.

The standard error and critical difference shall be calculated as follow:

$CD_{0.05}$	=	S.E. (d) x $t_{(0.05)}$ (r-1) (t-1) df
SE (d) ±	=	$\sqrt{2\,Me/r}$
SE (m) ±	=	$\sqrt{Me/r}$

Where,

SE (m) ±	=	Standard error of mean
SE (d) ±	=	Standard error of difference
$CD_{0.05}$	=	Critical difference at 5 per cent level of significance

Chapter-4

RESULTS AND DISCUSSION

The present investigation **"Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids"** was carried out at the Regional Horticultural Research and Training Station, Dhaulakuan of Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan during the year 2017 and 2018.

The experimental results obtained were statistically analyzed and the findings of investigation are presented and discussed under the following headings:

4.1 CHARACTERIZATION

4.1.1 Tree characters

4.1.2 Foliage characters

4.1.3 Flower characters

4.1.4 Fruit (morpho-physical) characters

4.1.5 Yield characters

4.1.6 Fruit (biochemical) characters

4.1.7 Seed characters

4.2 POMOLOGICAL DESCRIPTION OF GUAVA CULTIVARS AND HYBRIDS

4.1 CHARACTERIZATION

4.1.1 Tree characters

The observations recorded on various tree growth characters of guava cultivars and hybrids under study are presented and discussed (Table 2, 3 and Plate 5) as under:

4.1.1.1 Tree height

A significant variation in tree height was observed among different guava cultivars and hybrids. The pooled value of tree height was found maximum (5.57 m) in 'Allahabad Safeda' which was statistically at par with 'CISH-G-1' (5.49 m), 'Lalit' (5.15 m) and 'Lucknow-49' (5.12 m) whereas, minimum (3.80 m) mean pooled value was observed in

‘Hisar Safeda’ which was statistically at par with ‘Punjab Hybrid-1’ (4.14 m), ‘Hisar Surkha’ (4.19 m) and ‘CISH-G-4’ (4.20 m). The overall mean for tree height was recorded as 4.73 m.

In both the years of investigation (2017 and 2018), the maximum tree height (5.23 m and 5.91 m) was also recorded for ‘Allahabad Safeda’ and minimum tree height (3.52 m and 4.08 m) was found in ‘Hisar Safeda’ as compared to other remaining cultivars and hybrids (Table 2).

4.1.1.2 Trunk Girth

Among the nine guava cultivars and hybrids, the pooled value of trunk girth was highest (53.27 cm) in ‘Allahabad Safeda’ which was statistically at par with ‘Lucknow-49’ (50.68 cm). Whereas, the corresponding pooled value was recorded minimum in ‘Punjab Hybrid-2’ (41.10 cm), and all cultivars and hybrids were at par. Mean value of trunk girth was determined as 45.41 cm.

In 2017, the trunk girth was found highest in ‘Allahabad Safeda’ (50.90 cm) and minimum in ‘Punjab Hybrid-2’ (38.20 cm). Whereas in 2018, the maximum trunk girth was found in ‘Allahabad Safeda’ (55.63 cm) followed by ‘Lucknow-49’ (53.08 cm) and minimum in ‘Punjab Hybrid-2’ (44.00 cm).

4.1.1.3 Tree spread

The maximum tree spread (pooled values) in North-South (N-S) direction was observed in ‘CISH-G-4’ (4.78 m) followed by ‘Lucknow-49’ (4.74 m), whereas, minimum pooled value was in ‘Hisar Safeda’ (3.65 m) followed by ‘Lalit’ (4.15 m). The mean value for this growth characteristic was 4.38 m in N-S direction (Table 2).

In 2017, the maximum tree spread in N-S direction was observed in ‘CISH-G-4’ (4.73 m) followed by ‘Lucknow-49’ (4.58 m), whereas, minimum in ‘Hisar Safeda’ (3.48 m) followed by ‘Lalit’ (3.95 m) and ‘Hisar Surkha’ (4.10 m). In 2018, the maximum tree spread in N-S direction was observed in ‘CISH-G-4’ (4.90 m) followed by ‘Lucknow-49’ (4.83 m), whereas minimum was in ‘Hisar Safeda’ (3.83 m) followed by ‘Lalit’ (4.35 m).

The maximum pooled values in respect of tree spread in East-West (E-W) direction was observed in ‘CISH-G-4’ (5.69 m) followed by ‘Allahabad Safeda’ (5.50 m) and ‘CISH-G-1’ (5.40 m), whereas, minimum was in ‘Hisar Safeda’ (3.98 m) followed by ‘Lalit’ (4.98 m). The mean value for this growth characteristic was 5.17 m in E-W direction (Table 2).

Table 2. Tree characters of some guava cultivars and hybrids

Characters / Cultivars/ hybrids	Tree height (m)			Trunk girth (cm)			Tree spread (m)						Tree volume (m^3)			Attitude of branches
	2017	2018	Pooled	2017	2018	Pooled	2017		2018		Pooled		2017	2018	Pooled	
							N-S	E-W	N-S	E-W	N-S	E-W				
Punjab Hybrid-1 (H-1)	3.90	4.38	4.14	41.33	47.35	44.34	4.28	5.00	4.53	5.63	4.40	5.31	37.46	51.32	44.39	Drooping
Punjab Hybrid-2 (H-2)	4.68	5.18	4.93	38.20	44.00	41.10	4.23	4.88	4.65	5.65	4.44	5.26	50.77	71.21	60.99	Drooping
CISH-G-1	5.20	5.78	5.49	40.40	45.40	42.90	4.25	5.03	4.70	5.78	4.48	5.40	58.62	83.02	70.82	Erect
Lalit (CISH-G-3)	4.85	5.45	5.15	41.90	47.75	44.83	3.95	4.60	4.35	5.35	4.15	4.98	46.54	67.15	56.85	Erect
Allahabad Safeda	5.23	5.91	5.57	50.90	55.63	53.27	4.25	4.93	4.68	6.08	4.46	5.50	57.72	89.60	73.66	Spreading
CISH-G-4 (Shweta)	3.92	4.48	4.20	39.88	46.25	43.07	4.73	5.25	4.90	6.13	4.78	5.69	40.03	57.74	48.89	Spreading
Lucknow-49 (Sardar)	4.91	5.33	5.12	48.28	53.08	50.68	4.58	5.00	4.83	5.40	4.74	5.20	56.47	71.92	64.20	Spreading
Hisar Safeda	3.52	4.08	3.80	41.80	46.88	44.34	3.48	3.70	3.83	4.25	3.65	3.98	22.64	34.15	28.40	Spreading
Hisar Surkha	3.94	4.44	4.19	40.98	47.28	44.13	4.10	4.88	4.48	5.50	4.29	5.19	36.62	51.62	44.12	Drooping
Mean	4.46	5.00	4.73	42.63	48.18	45.41	4.20	4.81	4.55	5.53	4.38	5.17	45.21	64.19	54.70	-
$CD_{0.05}$	0.60	0.54	0.54	6.10	6.06	5.724	0.27	0.31	0.23	0.26	0.24	0.27	11.87	13.21	11.85	-

In 2017, the maximum tree spread in E-W direction was observed in 'CISH-G-4' (5.25 m) followed by 'CISH-G-1' (5.03 m) and 5.00 m in 'Punjab Hybrid-1' and 'Lucknow-49', whereas minimum in 'Hisar Safeda' (3.70 m) followed by 'Lalit' (4.60 m). In 2018, the maximum tree spread in E-W direction was observed in 'CISH-G-4' (6.13 m) followed by 'Allahabad Safeda' (6.08 m), whereas it was minimum in 'Hisar Safeda' (4.25 m).

4.1.1.4 Tree volume

The volume of tree during both the years was maximum (pooled value) in 'Allahabad Safeda' (73.66 m^3) and it was statistically at par with 'CISH-G-1' and 'Lucknow-49' having values 70.82 and 64.20 m^3, respectively (Table 2). Whereas, minimum tree volume of 28.40 m^3 (pooled) was recorded in 'Hisar Safeda'. Mean value of volume was recorded as 54.70 m^3.

Data pertaining to this aspect during 2017 showed that maximum tree volume (58.62 m^3) was recorded in 'CISH-G-1' followed by 'Allahabad Safeda' (57.72 m^3) and 'Lucknow-49' (56.47 m^3), whereas, minimum of 22.64 m^3 was recorded in 'Hisar Safeda'. In 2018, maximum tree volume was recorded in 'Allahabad Safeda' (89.60 m^3) followed by 'CISH-G-1' (83.02 m^3). Minimum tree volume was recorded in 'Hisar Safeda' with value of 34.15 m^3 in 2018 (Table 2).

4.1.1.5 Attitude of branches

Among different guava cultivars and hybrids, branches showed drooping to erect growth habit (Plate 5). Plants in majority of cultivars and hybrids was found to be of spreading growth habit in 'Allahabad Safeda', 'CISH-G-4', 'Lucknow-49' and 'Hisar Safeda', whereas, drooping growth habit was observed in 'Punjab Hybrid-1', 'Punjab Hybrid-2' and 'Hisar Surkha' and erect in 'CISH-G-1' and 'Lalit'.

4.1.1.6 Inter-nodal length of twigs

A significant variation in inter-nodal length (pooled values) was observed among guava cultivars and hybrids from 3.37 cm in 'Allahabad Safeda' to the tune of 5.31 cm in 'CISH-G-4' with 4.30 cm overall mean inter-nodal length of twigs for both the years (Table 3).

Maximum inter-nodal length of twigs was observed in 'CISH-G-4' as 5.21 cm and 5.41 cm in 2017 and 2018, respectively and were significantly different from rest of the cultivars and hybrids under investigation. Whereas, minimum was observed in 'Allahabad Safeda' with values of 3.35 cm and 3.39 cm in 2017 and 2018, respectively and these values were statistically at par with 'Hisar Surkha' (Table 3).

PLATE 5

ERECT

SPREADING

DROOPING

TREE GROWTH HABIT

4.1.1.7 Stem thickness

The pooled values ranged from 5.16 cm (Hisar Safeda) to 7.14 cm (Allahabad Safeda) with an overall mean value of 6.34 cm over both the years. The maximum thickness of stem recorded in 'Allahabad Safeda' (7.14 cm) was statistically at par with 'Lucknow-49' (7.08 cm), 'Punjab Hybrid-1' (7.02 cm) and 'Lalit' (6.81 cm). Minimum was observed in 'Hisar Safeda' (5.16 cm) and it was statistically at par with 'Punjab Hybrid-2' (5.39 cm) and 'CISH-G-4' (5.64 cm). Same trend for the thickness of stem was observed during both the years (Table 3).

4.1.1.8 Extension growth of twigs

Maximum (22.97 cm) pooled value of extension growth of twigs was recorded in 'Allahabad Safeda' which was statistically higher among all the cultivars and hybrids, whereas, minimum (12.01 cm) was found in 'Hisar Surkha'. Significantly least extension growth of twigs was observed in 'Hisar Surkha' and maximum in 'Allahabad Safeda' during both the years.

4.1.1.9 Twig diameter

Twig diameter during both the years and pooled value was maximum (6.77 mm) in 'Lucknow-49' and it was significantly higher than all the other cultivars and hybrids followed by 'Lalit', 'Allahabad Safeda', 'CISH-G-4' and 'Hisar Safeda', which recorded 6.49 mm, 6.41 mm, 6.27 mm and 6.22 mm twig diameter, respectively. The minimum pooled twig diameter (5.72 mm) was found in 'Hisar Surkha' which was statistically at par with 'Punjab Hybrid-1' (5.74 mm). Similar trend was observed during both the years of investigation (Table 3).

4.1.1.10 Colour of young twigs

As vivid from Table 3, colour of young twigs were found to be green in 'Punjab Hybrid-1', 'Punjab Hybrid-2', 'CISH-G-1' and 'Hisar Surkha', whereas, green with red streaks were present in 'Lalit', 'Allahabad Safeda', 'CISH-G-4', 'Lucknow-49' and 'Hisar Safeda'.

Various tree characters such as height, growth habit, tree spread and volume were observed as per UPOV (Anonymous, 1987) guidelines. These characters vary considerably amongst the guava cultivars and hybrids under study which fell into distinct classes. Among the nine guava cultivars and hybrids studied, 'Allahabad Safeda' recorded maximum tree height, tree volume, trunk girth, thickness of stem. Similar results were obtained by previous workers (Patel *et al.,* 2011; Dolkar *et al.,* 2014; Kumari *et al.,* 2016). Cultivars are known to exhibit substantial variation in tree growth. In the present study too, most of the characters

Table 3. Shoot characters of some guava cultivars and hybrids

Characters / Cultivars/hybrids	Internodal length of twigs (cm)			Stem thickness (cm)			Extension growth of twigs (cm)			Twig diameter (mm)			Colour of young twigs
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	
Punjab Hybrid-1 (H-1)	4.59	4.56	4.57	6.82	7.23	7.02	19.76	18.11	18.94	5.68	5.79	5.74	Green
Punjab Hybrid-2 (H-2)	4.79	4.62	4.70	5.18	5.60	5.39	20.37	16.15	18.26	5.97	5.99	5.93	Green
CISH-G-1	4.61	4.60	4.61	6.15	6.55	6.35	17.91	15.28	16.60	5.87	6.09	5.93	Green
Lalit (CISH-G-3)	3.85	3.74	3.79	6.69	6.93	6.81	18.34	13.05	15.70	6.58	6.40	6.49	Green with red streaks
Allahabad Safeda	3.35	3.39	3.37	7.00	7.28	7.14	24.68	21.26	22.97	6.35	6.46	6.41	Green with red streaks
CISH-G-4 (Shweta)	5.21	5.41	5.31	5.42	5.85	5.64	17.68	14.08	15.88	6.18	6.35	6.27	Green with red streaks
Lucknow-49 (Sardar)	4.26	4.40	4.33	6.88	7.26	7.08	18.33	14.59	16.46	6.81	6.72	6.77	Green with red streaks
Hisar Safeda	4.66	4.61	4.63	4.98	5.34	5.16	21.48	16.06	18.77	6.27	6.17	6.22	Green with red streaks
Hisar Surkha	3.37	3.45	3.41	6.25	6.60	6.43	12.80	11.21	12.01	5.65	5.78	5.72	Green
Mean	4.30	4.31	4.30	6.15	6.52	6.34	19.04	15.53	17.29	6.15	6.17	6.16	-
$CD_{0.05}$	0.36	0.23	0.29	0.50	0.52	0.48	2.68	1.78	2.17	0.17	0.20	0.17	-

revealed significant differences. Growth habit of the guava cultivars and hybrids was observed to be erect, spreading and drooping. PPVFRA guidelines (Anonymous, 2016) for DUS test also indicate spreading growth habit in 'Lucknow-49' (Sardar) and green with red streaks in young twigs of 'Lalit' and 'CISH-G-4' as observed in the present study. Drooping nature of 'Hisar Surkha' and erect nature of 'Lalit' as observed in present study was also reported by Ran *et al.* (2017). The extension growth of twigs was maximum in 'Allahabad Safeda' and the results were in conformity with the findings of Kumari *et al.* (2016), who also reported maximum shoot extension growth in 'Allahabad Safeda' (24.40 cm) under sub-tropical condition of Himachal Pradesh. Patel *et al.* (2011) also reported maximum shoot growth in 'Allahabad Safeda' (95.50 cm) under mid hill conditions of Meghalaya. The observed variations in growth characters of different cultivars and hybrids may be influenced by the genotype, plantation site, management practices, age of plant etc. Significant variation in growth parametres characterizing tree form has been observed earlier also (Daulta *et al.*, 1998; Dubey *et al.*, 2000; Mahaur, 2010; Sharma *et al.*, 2010; Lakade *et al.*, 2011; Deshmukh *et al.*, 2013; Meena *et al.*, 2013; Ulemale and Tambe, 2015b; Sarkar *et al.*, 2016; Singh *et al.*, 2016a, b).

4.1.2 Foliage characters

4.1.2.1 Leaf blade length

The pooled value for leaf blade length during both the years was maximum (15.03 cm) in 'Lalit' and it was significantly higher than all other cultivars and hybrids. Whereas, minimum pooled leaf blade length was recorded in 'Hisar Safeda' (11.07 cm) and it was statistically at par with 'CISH-G-1' (11.51 cm) and 'Hisar Surkha' (11.83 cm). Similar trend was observed during both the years of investigation (Table 4).

4.1.2.2 Leaf blade width

A significant variation in leaf blade width was observed among different guava cultivars and hybrids with pooled values ranging from 4.44 cm in 'CISH-G-1' to 5.60 cm in 'Hisar Surkha' which were statistically different from each other. Same trend for the leaf blade width was observed during both the years (Table 4).

4.1.2.3 Leaf length/width ratio

The maximum (2.81) pooled length/width ratio was recorded in 'Lalit' and it was significantly higher than all the other cultivars and hybrids, whereas, minimum (2.13) in 'Hisar Surkha'. It was followed by 'Hisar Safeda', 'Punjab Hybrid-1', 'Lucknow-49',

'Punjab Hybrid-2', 'CISH-G-4', 'Allahabad Safeda' and 'CISH-G-1' which recorded 2.17, 2.56, 2.53, 2.53, 2.54, 2.55 and 2.60 pooled leaf length to width ratio, respectively (Table 4). Maximum and minimum values were recorded for 'Lalit' and 'Hisar Surkha', respectively during both the years.

4.1.2.4 Spacing of secondary veins

Pooled value of spacing of secondary veins ranged from 6.19 mm in 'CISH-G-4' to 8.29 mm in 'CISH-G-1' with an overall mean pooled value of 7.08 mm over both the years. Maximum value was statistically at par with 'Punjab Hybrid-1' (8.24 mm) and 'Lalit' (7.99 mm), minimum was statistically at par with 'Allahabad Safeda' (6.24 mm), 'Lucknow-49' (6.48 mm), 'Hisar Surkha' (6.54 mm) and 'Punjab Hybrid-2' (6.64 mm). Similar trend (Table 4) was observed for spacing of secondary veins in the year 2017. But in 2018, the minimum value of 'CISH-G-4' (6.21 mm) was statistically at par with 'Lucknow-49' (6.31 mm) and 'Allahabad Safeda' (6.33 mm).

4.1.2.5 Leaf area

Maximum leaf area was found in 'Lalit' with values of 74.70 cm^2 (pooled), 77.06 cm^2 (2017) and 72.33 cm^2 (2018), respectively which was significantly higher than all the other cultivars and hybrids. The minimum mean leaf area of both the years and year 2017 and 2018 was recorded in 'CISH-G-1' with values of 45.10 cm^2, 45.21 and 44.98 cm^2, respectively which was significantly lower than all the other values (Table 4).

4.1.2.6 Anthocyanin colouration of young leaf

As clear from Table 5, anthocyanin colouration was present in young leaves among all the cultivars and hybrids except 'Punjab Hybrid-2', 'Lucknow-49' and 'Hisar Safeda' with green coloured young leaves without anthocyanin colouration.

4.1.2.7 Intensity of anthocyanin colouration of young leaf

The medium intensity of anthocyanin colouration of young leaf was found in all the cultivars except 'Lalit' with weak intensity. In rest of the cultivars and hybrids, anthocyanin colouration of young leaf was absent.

4.1.2.8 Shape of mature leaf

Variation in leaf shape was found to be obtrullate in 'Punjab Hybrid-1' and 'Punjab Hybrid-2'; ovate in 'CISH-G-4' and 'Hisar Surkha' and oblong in rest of the cultivars and hybrids (Table 5).

Table 4. Leaf characters (metric) of some guava cultivars and hybrids

Characters / Cultivars/Hybrids	Leaf blade length			Leaf blade width			Leaf length/width ratio			Spacing of secondary veins			Leaf area (cm^2)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Punjab Hybrid-1 (H-1)	12.53	12.02	12.28	5.13	4.76	4.95	2.45	2.66	2.56	8.27	8.21	8.24	58.32	51.23	54.78
Punjab Hybrid-2 (H-2)	12.25	12.27	12.26	4.87	4.89	4.88	2.53	2.53	2.53	6.47	6.82	6.64	53.65	54.00	53.83
CISH-G-1	11.43	11.59	11.51	4.48	4.40	4.44	2.56	2.64	2.60	8.35	8.23	8.29	45.21	44.98	45.10
Lalit (CISH-G-3)	15.10	14.96	15.03	5.50	5.24	5.37	2.76	2.87	2.81	7.84	8.15	7.99	77.06	72.33	74.70
Allahabad Safeda	13.10	12.98	13.04	5.14	5.11	5.13	2.55	2.54	2.55	6.16	6.33	6.24	61.37	60.34	60.86
CISH-G-4 (Shweta)	13.01	13.18	13.09	5.18	5.15	5.17	2.51	2.56	2.54	6.15	6.21	6.19	61.41	61.88	61.65
Lucknow-49 (Sardar)	12.67	12.38	12.53	5.07	4.96	5.01	2.56	2.51	2.53	6.65	6.31	6.48	58.25	55.37	56.81
Hisar Safeda	10.95	11.20	11.07	5.10	5.08	5.09	2.15	2.20	2.17	6.47	6.62	6.54	49.82	50.90	50.36
Hisar Surkha	11.78	11.87	11.83	5.58	5.62	5.60	2.13	2.16	2.13	7.09	7.21	7.15	59.66	60.72	60.19
Mean	12.53	12.50	12.51	5.12	5.02	5.07	2.45	2.50	2.48	7.05	7.12	7.08	58.31	56.86	57.58
$CD_{0.05}$	0.78	0.85	0.77	0.32	0.34	0.31	0.16	0.25	0.20	0.79	0.34	0.58	3.20	5.75	4.51

4.1.2.9 Leaf base shape

Leaf base shape was observed so as to classify them as obtuse, rounded and cordate. It was observed as rounded in ‘Punjab Hybrid-1’, ‘Punjab Hybrid-2’, ‘Allahabad Safeda’ ‘Hisar Safeda’, ‘CISH-G-1’, and ‘Lalit’, whereas, obtuse in ‘CISH-G-4’, ‘Lucknow-49’ and cordate in ‘Hisar Surkha’ (Table 5).

4.1.2.10 Leaf apex shape

As clear from Table 5, leaf apex shape was found to be apiculate in ‘Punjab Hybrid-1’, ‘Punjab Hybrid-2’, ‘Lucknow-49’, ‘CISH-G-4’ and ‘Hisar Safeda’, whereas, rest were observed to be obtuse in leaf apex shape.

4.1.2.11 Leaf colour

Leaf colour (Table 5) in all the cultivars and hybrids fell in Green Group (137 &138).

4.1.2.12 Green colour of leaf

Slight variation was observed in the shade of green colour of leaf. It was 137 B in ‘Punjab Hybrid-2’; 137 C in ‘Punjab Hybrid-1’, ‘Lalit’, ‘Allahabad Safeda’, ‘Lucknow-49’ and ‘Hisar Safeda’; 137 D in ‘CISH-G-4’; 138 A in ‘CISH-G-1’, whereas 138 B in ‘Hisar Surkha’.

4.1.2.13 Relief of surface on upper side

Relief of surface on uper side was observed so as to classify them as smooth, medium and wrinkled (Table 5). Most of the cultivars showed smooth surfaced leaves, whereas, ‘Punjab Hybrid-2’ and ‘Allahabad Safeda’ had medium rough leaf surface. On the other hand, in ‘CISH-G-1’ and ‘Hisar Surkha’, wrinkled upper leaf surface was observed (Table 5).

4.1.2.14 Pubescence on the lower side of fully developed leaf

As given in Table 5, pubescence on the lower side of fully developed leaf was found to be sparse in ‘Lalit’, ‘Allahabad Safeda’ and ‘CISH-G-4’, whereas, medium in ‘Punjab Hybrid-1’, ‘Punjab Hybrid-2’, ‘Lucknow-49’, ‘Hisar Surkha’ and dense in ‘CISH-G-1’ and ‘Hisar Safeda’.

4.1.2.15 Undulation of leaf margins

Undulation of leaf margins was present in all the guava cultivars and hybrids (Table 5) under study.

Table 5. Leaf characters (non-metric) of some guava cultivars and hybrids

Characters / Cultivars /Hybrids	Anthocyanin colouration of young leaf	Intensity of Anthocyanin colouration of young leaf	Shape of mature leaf	Leaf base shape	Leaf apex shape	Leaf colour	Green colour of leaf	Relief of surface on upper side	Pubescence on the lower side of fully developed leaf	Undulation of leaf margins	Degree of undulation of leaf margins
Punjab Hybrid-1 (H-1)	Present	Medium	Obtrullate	Rounded	Apiculate	Green group	Green group 137 C	Smooth	Medium	Present	Medium
Punjab Hybrid-2 (H-2)	Absent	-	Obtrullate	Rounded	Apiculate	Green group	Green group 137 B	Medium	Medium	Present	Weak
CISH-G-1	Present	Medium	Oblong	Rounded	Obtuse	Green group	Green group 138 A	Wrinkled	Dense	Present	Weak
Lalit (CISH-G-3)	Present	Weak	Oblong	Rounded	Obtuse	Green group	Green group 137 C	Smooth	Sparse	Present	Weak
Allahabad Safeda	Present	Medium	Oblong	Rounded	Obtuse	Green group	Green group 137 C	Medium	Sparse	Present	Weak
CISH-G-4 (Shweta)	Present	Medium	Ovate	Obtuse	Apiculate	Green group	Green group 137 D	Smooth	Sparse	Present	Weak
Lucknow-49 (Sardar)	Absent	-	Oblong	Obtuse	Apiculate	Green group	Green group 137 C	Smooth	Medium	Present	Medium
Hisar Safeda	Absent	-	Oblong	Rounded	Apiculate	Green group	Green group 137 C	Smooth	Dense	Present	Medium
Hisar Surkha	Present	Medium	Ovate	Cordate	Obtuse	Green group	Green group 138 B	Wrinkled	Medium	Present	Weak

4.1.2.16 Degree of undulation of leaf margins

Leaf margin undulation to a medium extent was observed in 'Punjab Hybrid-1', 'Lucknow-49' and 'Hisar Safeda', whereas weak degree of undulation of leaf margins was present in rest of the cultivars and hybrids.

Leaf characters are commonly used to distinguish and identify various fruit crop species and varieties. The anthocyanin colouration of young leaf was present in all the cultivars and hybrids except in 'Punjab Hybrid-2', 'Lucknow-49' and 'Hisar Safeda'. PPVFRA (Anonymous, 2016) also reported anthocyanin colouration of young leaf as present in 'Lalit'. However, Singh *et al.* (2016b) observed presence of anthocyanin colouration of young leaf in 'Allahabad Safeda', 'Lucknow-49', 'Lalit' and 'CISH-G-4', whereas, it was absent in 'Hisar Surkha' which was similar to observations made in the present study. The leaf area of different guava cultivars and hybrids varied from 45.10 cm^2 to 74.70 cm^2. Lakade *et al*. (2011) reported that the leaf area ranged from 52.05 cm^2 to 77.50 cm^2 in nine guava genotypes. These findings are largely in line with the reference varieties as per PPVFRA guidelines for DUS test as they have reported leaf length (>10 cm), oblong leaf shape in 'Lalit' and width (>4 cm) in 'Lucknow-49' and leaf length/width ratio (>2.5) in 'CISH-G-4'. They also reported green leaf colour in 'Lalit' and 'Allahabad Safeda', while, 'Lalit' and 'CISH-G-4' with rounded base shape and obtuse apex shape (Anonymous, 2016) which was similar to the observations recorded in the present study. Similar variation in leaf characters has also been reported by many workers (Mahaur, 2010; Sharma *et al.,* 2010; Ran *et al.,* 2017). The variation among guava cultivars and hybrids in respect of leaf morphology may be due to the differences in the genetic makeup of these guava cultivars and hybrids.

4.1.3 Flower characters

The time and duration of flowering during rainy season varied among different cultivars and hybrids (Table 6).

4.1.3.1 Initiation of flowering

The flowering in different cultivars and hybrids commenced at different dates. All the cultivars and hybrids commenced flowering in last week of April to first week of May during 2017. 'Lalit' and 'Allahabad Safeda' were earliest (26th April) to start flowering followed by 'Punjab Hybrid-1' and 'CISH-G-4' (27th April), whereas, 'CISH-G-1' and 'Hisar Safeda' were last in initiation of flowering on 7th May (Table 6).

Table 6. Time and duration of flowering in some guava cultivars and hybrids

Characters / Cultivar/ Hybrid	Initiation of flowering (15% flowering)		End of flowering (> 75% flowering)		Flowering duration (days)		
	2017	2018	2017	2018	2017	2018	Pooled
Punjab Hybrid-1 (H-1)	27/04/2017	03/05/2018	04/06/2017	10/06/2018	38.75	38.25	38.50
Punjab Hybrid-2 (H-2)	28/04/2017	04/05/2018	06/06/2017	13/06/2018	39.75	40.25	40.00
CISH-G-1	07/05/2017	14/05/2018	14/06/2017	25/06/2017	39.25	42.25	40.75
Lalit (CISH-G-3)	26/04/2017	02/05/2018	04/06/2017	09/06/2018	39.50	38.75	39.13
Allahabad Safeda	26/04/2017	02/05/2018	07/06/2017	14/06/2018	43.00	43.75	43.38
CISH-G-4 (Shweta)	27/04/2017	03/05/2018	05/06/2017	10/06/2018	40.50	38.25	39.38
Lucknow-49 (Sardar)	29/04/2017	05/05/2018	05/06/2017	09/06/2018	37.50	35.50	36.50
Hisar Safeda	07/05/2017	14/05/2018	14/06/2017	21/06/2018	39.25	38.50	38.88
Hisar Surkha	28/04/2017	04/05/2018	07/06/2017	13/06/2018	41.75	40.25	41.00
Mean	-	-	-	-	39.92	39.53	39.72
$CD_{0.05}$	-	-	-	-	1.19	0.87	3.04

In 2018, cultivars and hybrids commenced flowering in 1st week of May to 2nd week of May. Again, 'Lalit' and 'Allahabad Safeda' were earliest (2nd May), whereas, 'CISH-G-1' and 'Hisar Safeda' were last in initiation of flowering (14th May).

4.1.3.2 End of flowering

As given in Table 6, end of flowering during 2017 was observed on 4th June till 14th June and 9th June to 25th June during 2018 for different guava cultivars and hybrids. Cultivars and hybrids viz. 'Punjab Hybrid-1', 'Lalit', 'CISH-G-4', 'Lucknow-49', 'Punjab Hybrid-2', 'Allahabad Safeda' and 'Hisar Surkha' were first to complete flowering during2017 and 'Lalit', 'Lucknow-49', 'Punjab Hybrid-1' and 'CISH-G-4' during 2018 as compared to other cultivars and hybrids. Whereas, 'Hisar Safeda' and 'CISH-G-1' were last to end bloom among different guava cultivars and hybrids under investigation during both the years.

4.1.3.3 Flowering duration

Flowering duration (Table 6) for rainy season crop ranged from 36.50 days in 'Lucknow-49' to 43.38 days in 'Allahabad Safeda' during both the years and the maximum pooled value was statistically at par with 'Hisar Surkha' (41.00 days), 'CISH-G-1' (40.75 days), whereas minimum pooled value was statistically at par with 'Punjab Hybrid-1' (38.50 days), 'Hisar Safeda' (38.88 days), 'Lalit' (39.13 days) and 'CISH-G-4' (39.38 days). Same trend with maximum duration in 'Allahabad Safeda' and minimum duration in 'Lucknow-49' was observed during both the years (2017 and 2018).

4.1.3.4 Predominant number of flowers in inflorescence

Table 7 shows that predominant number of flowers ranged from 119 to 2.50. The minimum number (pooled value) of flowers in inflorescence were found to be 1.19 in 'Lucknow-49' which was at par with 'CISH-G-1' (1.41). The maximum pooled number of flowers were found in 'Allahabad Safeda' (2.50) and it was at par with 'Punjab Hybrid-1' (2.47) and 'Punjab Hybrid-2' (2.31). Similar trend was recorded in both the years (Table 7).

4.1.3.5 Flower size

Significant variation for flower size was observed among different guava cultivars and hybrids for both the years. Data shown in Table 7 reveals that maximum mean flower size during both the years, in 2017 and 2018 was observed in 'Lucknow-49' with the values of 46.90 mm, 47.19 mm and 46.61 mm, respectively and it was significantly higher than all the other guava cultivars and hybrids. Whereas, minimum flower size was observed in 'Lalit'

PLATE 6

ONE (1)

ONE TO THREE (1-3)

THREE (3)

PREDOMINANT NUMBER OF FLOWERS IN INFLORESCENCE

with values of 36.12 mm (pooled), 34.66 mm (2017) and 37.58 mm (2018), respectively (Table 7).

4.1.3.6 Number of fully developed petals

Data pertaining to number of fully developed petals is given in Table 7 and it reveals that pooled values ranged from 5.44 to 7.47 with an overall mean value of 6.36 over both the years. Maximum number of fully developed petals was found in 'Lucknow-49' with value of 7.47 (pooled) as well as for both the years 2017 and 2018 with values 7.50 and 7.44, respectively and was statistically at par with 'CISH-G-4' (7.34) and 'Punjab Hybrid-2' (7.13). Lower pooled values of both years for number of fully developed petals were recorded in 'CISH-G-1' (5.44) followed by 'Hisar Surkha' (5.50), 'Lalit' (5.59) and 'Allahabad Safeda' (5.84). Similar trend was observed during both the years of investigation.

4.1.3.7 Staminoid petals

As clear from Table 7, staminoid petals were found to be present in. 'Punjab Hybrid-1', 'Punjab Hybrid-2', 'CISH-G-4' and 'Hisar Surkha' during both the years, whereas, absent in rest of the cultivars and hybrids.

Similar to foliage characters, some floral characters also varied considerably among guava cultivars and hybrids. The flower initiation was earliest in 'Lalit' and 'Allahabad Safeda', whereas, 'CISH-G-4' and 'Hisar Safeda' were last to initiate flowers (Table 6). Kumari *et al.* (2016) also reported 'Lalit' and 'Allahabad Safeda' to be early in flowering. The end of flowering was earliest in 'Lalit' (Table 6). Sarkar *et al.* (2016) reported similar variation in period of end of flowering. The duration of end of flowering ranged from 36.50 to 43.38 days in all the guava cultivars and hybrids with 'Allahabad Safeda' having longer duration of flowering and the shorter duration in 'Lucknow-49'. The similar variations in flowering duration were observed by Kumari *et al*. (2016), Panwar (2012), Sarkar *et al*. (2016). Sharma *et al.* (2017) also reported that the flowering duration ranged from 33 to 41 days among all genotypes. The large flower size with maximum number of fully developed petals was observed in 'Lucknow-49' and small size of flower in 'Lalit'. Singh *et al.* (2016b) reported similar variation in flower size as well as in number of fully developed petals. A significant variation in flower characters has also been observed by Dolkar *et al.* (2014) and Sahoo *et al.* (2017).

Table 7. Flower characters of some guava cultivars and hybrids

Characters / Cultivars /Hybrids	Predominant number of flowers in inflorescence			Flower size (mm)			Number of fully developed petals			Staminoid petals	
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018
Punjab Hybrid-1 (H-1)	2.38	2.56	2.47	39.17	38.76	38.96	6.38	6.81	6.59	Present	Present
Punjab Hybrid-2 (H-2)	2.19	2.44	2.31	39.82	40.72	40.77	7.06	7.19	7.13	Present	Present
CISH-G-1	1.44	1.38	1.41	36.91	39.97	39.94	5.25	5.63	5.44	Absent	Absent
Lalit (CISH-G-3)	1.75	1.63	1.69	34.66	37.58	36.12	5.44	5.75	5.59	Absent	Absent
Allahabad Safeda	2.44	2.56	2.50	39.06	38.63	38.84	5.75	5.94	5.84	Absent	Absent
CISH-G-4 (Shweta)	1.75	1.63	1.69	42.01	40.84	41.43	7.31	7.38	7.34	Present	Present
Lucknow-49 (Sardar)	1.13	1.25	1.19	47.19	46.61	46.90	7.50	7.44	7.47	Absent	Absent
Hisar Safeda	1.69	1.88	1.78	42.78	41.82	42.80	6.31	6.44	6.38	Absent	Absent
Hisar Surkha	1.88	2.25	2.06	42.55	44.39	44.47	5.38	5.63	5.50	Present	Present
Mean	1.85	1.95	1.90	40.46	41.03	40.46	6.26	6.47	6.36	-	-
$CD_{0.05}$	0.33	0.31	0.31	0.85	0.70	0.75	0.50	0.36	0.44	-	-

4.1.4 Fruit (morpho-physical) characters

4.1.4.1 First harvesting date

For rainy season crop, 'Punjab Hybrid-1' was earliest to harvest the fruits on 22nd August and 5th September during 2017 and 2018, respectively (Table 8). Whereas, 'Allahabad Safeda' and 'Hisar Safeda' were found to be last to harvest the fruits during 2017 (30th August) and 2018 (10th September).

4.1.4.2 Period from initiation of flowering to first harvesting

Table 8 clearly shows that the days (pooled values) from initiation of flowering to first harvesting ranged from 116.75 days in 'CISH-G-1' to 129.50 days in 'Allahabad Safeda'. All the cultivars were showing similar trend during both the years of investigation.

Table 8. Season and period of fruiting in some guava cultivars and hybrids

Characters / Cultivars/ hybrids	First harvesting date		Period from initiation of flowering to first harvesting		
	2017	2018	2017	2018	Pooled
Punjab Hybrid-1 (H-1)	22/08/2017	05/09/2018	117.25	126.25	121.75
Punjab Hybrid-2 (H-2)	25/08/2017	07/09/2018	119.75	127.25	123.50
CISH-G-1	28/08/2017	09/09/2018	114.25	119.25	116.75
Lalit (CISH-G-3)	24/08/2017	06/09/2018	121.25	128.25	124.75
Allahabad Safeda	30/08/2017	10/09/2018	126.75	132.25	129.50
CISH-G-4 (Shweta)	27/08/2017	06/09/2018	122.75	127.25	125.00
Lucknow-49 (Sardar)	28/08/2017	08/09/2018	122.50	129.25	125.88
Hisar Safeda	30/08/2017	10/09/2018	116.50	120.25	118.38
Hisar Surkha	29/08/2017	09/09/2018	124.50	129.25	126.88
Mean	-	-	120.61	126.58	123.60
$CD_{0.05}$	-	-	1.43	0.60	1.47

4.1.4.3 Fruit length

Data pertaining to fruit length for rainy season crop is given in Table 9a which reveals that 'Lucknow-49' recorded maximum mean fruit length to the tune of 71.35 mm (pooled value) and it also produces longer fruits during both the years. The maximum value was statistically at par with 'Allahabad Safeda' (66.16 mm) and 'CISH-G-4' (67.51 mm). On the other hand, least pooled fruit length (48.82 mm) was observed in 'CISH-G-1'. The overall mean fruit length was recorded 60.70 mm (Table 9a).

The data depicts that again ‘Lucknow-49’ recorded maximum fruit length (72.15 mm) during 2018 followed by ‘CISH-G-4’ (68.48 mm) and ‘Allahabad Safeda’ (67.74 mm) and these cultivars were statistically at par with each other. Minimum fruit length (50.90 mm) was observed in ‘CISH-G-1’ which was statistically at par with ‘Punjab Hybrid-2’ (51.60 mm). Similar trend was followed in the year 2017 (Table 9a).

4.1.4.4 Fruit width

Significant variation for fruit width was also observed in guava cultivars and hybrids as given in Table 9a shows that in rainy season, during both the years, maximum pooled fruit width (69.70 mm) was recorded in ‘Lalit’ and this was followed by ‘Lucknow-49’, ‘Hisar Safeda’ and ‘Allahabad Safeda’. Minimum pooled fruit width (57.90 mm) was observed in ‘Hisar Surkha’ with 63.79 mm as overall pooled fruit width of both the years. Similar trend was observed in both the years i.e. 2017 as well as in 2018.

4.1.4.5 Fruit length/width ratio

Fruit length to width ratio depicts the fruit shape as fruits with higher values possesses pyriform shape while lower values indicates round (pomi) fruit shape. Data pertaining to fruit length to width ratio for both the years is presented in Table 9a which depicts that maximum pooled fruit length to width ratio of both the years was also noted to be highest in ‘CISH-G-4’ (1.07) and it was followed by ‘Lucknow-49’ (1.05), ‘Punjab Hybrid-1’ and ‘Hisar Surkha’ (1.01). The lowest pooled value for the trait was observed in ‘CISH-G-1’ (0.80) for both the years and this was statistically at par with ‘Punjab Hybrid-2’ (0.83) and ‘Lalit’ (0.86).

4.1.4.6 Fruit weight

A significant variation in fruit weight was recorded among different guava cultivars and hybrids Table 9a The mean fruit weight data reveals that ‘Lalit’ (171.71 g) had the maximum fruit weight (pooled value) and it was followed by ‘Lucknow-49’, ‘Allahabad Safeda’ and ‘Hisar Safeda’ which recorded 164.44 g, 161.91 g and 157.90 g fruit weight, respectively. Lighter fruit weight was noticed in ‘CISH-G-4’ (139.24 g), ‘Punjab Hybrid-1’ (110.75 g), ‘Punjab Hybrid-2’ (105.88 g), ‘Hisar Surkha’ (105.18 g) and least fruit weight was recorded in ‘CISH-G-1’ (103.29 g) with a mean overall fruit weight of 135.59 g. Similar trend during both the years was observed for fruit weight (Table 9a).

Table 9a. Fruit (morpho-physical) characters of some guava cultivars and hybrids

Characters / Cultivars/ hybrids	Fruit length (mm)			Fruit width (mm)			Fruit Length/width ratio			Weight of fruit (g)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Punjab Hybrid-1 (H-1)	60.76	62.78	61.77	57.92	59.97	58.94	1.04	1.05	1.05	109.50	112.00	110.75
Punjab Hybrid-2 (H-2)	48.09	51.60	49.85	58.70	61.23	59.96	0.82	0.84	0.83	104.98	106.78	105.88
CISH-G-1	46.74	50.90	48.82	59.49	62.10	60.80	0.79	0.82	0.80	101.93	104.65	103.29
Lalit (CISH-G-3)	59.07	62.08	60.57	68.01	71.38	69.70	0.85	0.87	0.86	169.45	173.98	171.71
Allahabad Safeda	64.58	67.74	66.16	66.85	68.68	67.76	0.97	0.99	0.98	160.85	162.98	161.91
CISH-G-4 (Shweta)	66.54	68.48	67.51	61.62	64.45	63.04	1.08	1.06	1.07	137.98	140.50	139.24
Lucknow-49 (Sardar)	70.54	72.15	71.35	67.12	69.13	68.12	1.05	1.04	1.05	163.43	165.45	164.44
Hisar Safeda	60.30	62.89	61.59	67.03	68.79	67.91	0.90	0.91	0.91	156.55	159.25	157.90
Hisar Surkha	57.23	60.15	58.69	56.81	58.99	57.90	1.01	1.02	1.01	104.35	106.00	105.18
Mean	59.32	62.08	60.70	62.62	64.97	63.79	0.95	0.96	0.95	134.33	136.84	135.59
$CD_{0.05}$	5.90	6.25	5.74	5.06	5.06	4.78	0.07	0.07	0.07	30.15	32.13	29.56

4.1.4.7 Stalk length

As shown in Table 9b, it is clear that the ‘CISH-G-1’ possessed shortest stalk of 21.61 mm, 20.24 mm and 22.98 mm for both the years, year 2017 and year 2018, respectively. Whereas, longest stalk (36.57 mm, 33.83 mm and 39.32 mm for both the years, year 2017 and year 2018, respectively) was recorded in ‘Lucknow-49’. For both the years, ‘Lucknow-49’ was followed by ‘CISH-G-4’ (34.23 mm) and ‘Punjab Hybrid-2’ (31.64 mm). Short stalk were observed in ‘Allahabad Safeda’ (29.03 mm), ‘Lalit’ (28.48 mm), ‘Hisar Safeda’ (25.13 mm), ‘Hisar Surkha’ (24.13 mm) and ‘Punjab Hybrid-1’ (23.95 mm) for both the years.

4.1.4.8 Size of sepals

The size of sepals ranged from 7.61 mm in ‘CISH-G-1’ to 12.66 mm in ‘Hisar Safeda’ as average of both the years with an overall average of 9.70 mm throughout the investigation period Table 9b. A similar trend for the year 2017 as well as 2018 was observed as ‘CISH-G-1’ showed minimum value while ‘Allahabad Safeda’ showed maximum value for the size of sepals.

4.1.4.9 Diameter of calyx cavity

Data presented in Table 9b represents that least calyx cavity diameter was recorded in ‘CISH-G-4’ during both the years with the mean value of 11.12 mm. However, maximum value for the trait was observed in ‘Hisar Safeda’ with a mean calyx cavity diameter of 16.57 mm of both the years. This value was statistically at par with ‘Punjab Hybrid-1’ (14.26 mm), ‘Punjab Hybrid-2’ (15.11 mm), ‘Lucknow-49’ (15.17 mm), ‘Allahabad Safeda’ (15.34 mm) and ‘Lalit’ (15.64 mm) during both the years. Whereas minimum value was statistically at par with ‘CISH-G-1’ (11.64 mm) and ‘Hisar Surkha’ (12.26 mm).

On the other hand, during the year 2017 and 2018, the minimum diameter of calyx cavity was observed in ‘CISH-G-4’ with values of 10.41 mm and 11.82 mm, respectively. Whereas, maximum was found in ‘Hisar Safeda’ with values of 15.52 mm and 17.62 mm during year 2017 and 2018, respectively (Table 9b).

4.1.4.10 Prominence of neck

As presented in Table 9b, prominence of neck among different guava cultivars and hybrids was absent in all the cultivars and hybrids during both the years.

Table 9b. Fruit characters (morpho-physical) of some guava cultivars and hybrids

Characters / Cultivars/ Hybrids	Stalk length (mm)			Size of sepals (mm)			Diameter of calyx cavity (mm)			Prominence of Neck	
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018
Punjab Hybrid-1 (H-1)	23.60	24.31	23.95	8.92	8.29	8.60	13.07	15.45	14.26	Absent	Absent
Punjab Hybrid-2 (H-2)	32.05	31.22	31.64	10.52	9.07	9.79	14.31	15.91	15.11	Absent	Absent
CISH-G-1	20.24	22.98	21.61	7.11	8.11	7.61	10.78	12.51	11.64	Absent	Absent
Lalit (CISH-G-3)	27.16	29.80	28.48	11.22	9.20	10.21	14.70	16.59	15.64	Absent	Absent
Allahabad Safeda	27.38	30.68	29.03	9.35	8.54	8.94	14.54	16.14	15.34	Absent	Absent
CISH-G-4 (Shweta)	32.54	35.92	34.23	10.12	8.07	9.09	10.41	11.82	11.12	Absent	Absent
Lucknow-49 (Sardar)	33.83	39.32	36.57	10.83	8.65	9.74	14.33	16.00	15.17	Absent	Absent
Hisar Safeda	24.08	26.18	25.13	13.05	12.28	12.66	15.52	17.62	16.57	Absent	Absent
Hisar Surkha	22.78	25.48	24.13	11.77	9.45	10.61	11.29	13.24	12.26	Absent	Absent
Mean	27.07	29.54	28.31	10.32	9.07	9.70	13.22	15.03	14.12	-	-
$CD_{0.05}$	2.56	4.01	3.36	1.09	2.14	1.72	1.06	3.34	2.39	-	-

4.1.4.11 Fruiting habit

As shown in Table 9c, terminal and lateral type of fruiting habit were observed in all the cultivars and hybrids under study and as such no variation was observed.

4.1.4.12 Fruit size uniformity

As clear from Table 9c, all the guava cultivars and hybrids under study exhibited uniformity in fruit size, by and large.

4.1.4.13 Fruit shape

All the cultivars and hybrids were observed pomi (round) in fruit shape except ovate in 'Punjab Hybrid-1', 'CISH-G-4' and 'Lucknow-49' as shown in Table 9c.

4.1.4.14 Fruit shape at stalk end

As presented in Table 9c, three type of fruit shapes were observed. 'Allahabad Safeda', 'Hisar Safeda' and 'Hisar Surkha' showed rounded fruit shape at stalk end, whereas, pointed fruit shape at stalk end was found in 'Punjab Hybrid-1', 'Lucknow-49' and 'CISH-G-4', while, remaining cultivars were broadly rounded in shape at stalk end.

4.1.4.15 Colour of peel

Fruit peel colour showed least variation among different cultivars and hybrids under study Table 9c. Yellow-Green 151 A class was observed for 'Punjab Hybrid-2', 'CISH-G-1' and 'Lalit', whereas, Yellow-Green 145 A class was found in 'Punjab Hybrid-1', 'Lucknow-49' and 'Hisar Surkha', while two type of classes were found in 'Allahabad Safeda' (Yellow-Green 153D & 145 A), 'CISH-G-4' (Yellow-Green 151 D & 145 A) and 'Hisar Safeda' (Yellow-Green 153 A & 145 A).

4.1.4.16 Relief of fruit surface

As shown in Table 9c, fruit surface was found to be rough in 'Punjab Hybrid-2', 'CISH-G-1', 'Lalit', 'CISH-G-4', 'Lucknow-49' and 'Hisar Safeda', whereas, smooth surface was observed in 'Punjab Hybrid-1', 'Allahabad Safeda' and 'Hisar Safeda'.

4.1.4.17 Ridged collar around calyx cavity

Ridged collar around calyx cavity was found to be inconspicuous in all the cultivars and hybrids except in 'Hisar Safeda', it was conspicuous (Table 9c).

Table 9c. Fruit characters (morpho-physical) of some guava cultivars and hybrids

Characters / Cultivars/ hybrids	Fruiting habit	Fruit size uniformity	Fruit shape	Fruit shape at stalk end	Colour of peel	Relief of fruit surface	Ridged collar around calyx cavity	Longitudinal ridges	Prominence of longitudinal ridges	Longitudinal grooves
Punjab Hybrid-1 (H-1)	Terminal and Lateral	Uniform	Ovate	Pointed	Yellow-Green 145 A	Smooth	Inconspicuous	Absent	-	Absent
Punjab Hybrid-2 (H-2)	Terminal and Lateral	Uniform	Pomi (Round)	Broadly Rounded	Yellow-Green 151 A	Rough	Inconspicuous	Absent	-	Absent
CISH-G-1	Terminal and Lateral	Uniform	Pomi (Round)	Broadly Rounded	Yellow-Green 151 A	Rough	Inconspicuous	Absent	-	Present
Lalit (CISH-G-3)	Terminal and Lateral	Uniform	Pomi (Round)	Broadly Rounded	Yellow-Green 151 A	Rough	Inconspicuous	Absent	-	Present
Allahabad Safeda	Terminal and Lateral	Uniform	Pomi (Round)	Rounded	Yellow-Green 153 D & 145 A	Smooth	Inconspicuous	Absent	-	Present
CISH-G-4 (Shweta)	Terminal and Lateral	Uniform	Ovate	Pointed	Yellow-Green 151 D & 145 A	Rough	Inconspicuous	Present	Weak	Absent
Lucknow-49 (Sardar)	Terminal and Lateral	Uniform	Ovate	Pointed	Yellow-Green 145 A	Rough	Inconspicuous	Present	Medium	Absent
Hisar Safeda	Terminal and Lateral	Uniform	Pomi (Round)	Rounded	Yellow –Green 153 A & 145 A	Rough	Conspicuous	Present	Weak	Absent
Hisar Surkha	Terminal and Lateral	Uniform	Pomi (Round)	Rounded	Yellow-Green 145 A	Smooth	Inconspicuous	Absent	-	Absent

4.1.4.18 Longitudinal ridges

As vivid from Table 9c, longitudinal ridges were observed in 'CISH-G-4', 'Lucknow-49' and 'Hisar Safeda', while absent in rest of the cultivars and hybrids.

4.1.4.19 Prominence of longitudinal ridges

As the Table 9c showed that longitudinal ridges were found to be weak in 'CISH-G-4' and 'Hisar Safeda', whereas, it was medium in 'Lucknow-49'.

4.1.4.20 Longitudinal grooves

Table 9c showed that longitudinal grooves were present in 'CISH-G-1', 'Lalit' and 'Allahabad Safeda', while absent in remaining cultivars and hybrids.

4.1.4.21 Core diameter

Quality of guava fruit is also judged by size of its seed core diameter, as it often reflects the seed content of the fruit. Fruits with smaller core and thick flesh are preferred over fruits with large seed core. Data depicting core diameter among different cultivars and hybrids is given in Table 10. Least seed core diameter (pooled values) was observed in 'Hisar Surkha' (46.01 mm) and it was statistically at par with 'Punjab Hybrid-2' (46.84 mm), 'Punjab Hybrid-1' (47.28 mm), 'Lucknow-49' (48.33 mm) and 'CISH-G-1' (48.94 mm). While maximum core diameter among all the cultivars and hybrids was observed in 'Lalit' (56.43 mm) and the value was statistically at par with 'CISH-G-4' (51.79 mm), 'Allahabad Safeda' (52.74 mm) and 'Hisar Safeda' (54.68 mm). Same trend was observed in both the years.

4.1.4.22 Thickness of outer flesh in relation to core diameter

This is an important parametre governing fruit quality in guava. Fruits with thick flesh are considered desirable as compared to fruits with thin flesh. Significant variation in flesh thickness was noticed among different guava cultivars and hybrids. The thickness of flesh (pooled values) in relation to core diameter ranged from 9.75 mm to 16.88 mm with an overall mean of 12.36 mm with 'Lucknow-49' recording thickest flesh among all other cultivars and hybrids (Table 10). Thinnest flesh (9.75 mm) was observed in 'CISH-G-4' and it was statistically at par with 'Punjab Hybrid-1' (10.66 mm) and 'CISH-G-1' (10.86 mm). Similar results were obtained for the year 2017 as well as year 2018.

4.1.4.23 Colour of flesh

Flesh colour of fruit also showed variation and five different kind of fruit flesh colours were observed among all cultivars and hybrids. 'CISH-G-1' showed Yellow-White

158 A coloured flesh. Greyed-Red 180 C was observed in 'Punjab Hybrid-1', 'Punjab Hybrid-2' and 'Lalit', whereas, Greyed-Red 180 B was found in 'Hisar Surkha'. Orange-White 159 C was found in 'Lucknow-49' and along with Orange-White 159 C, Orange-White 159 D was also found in 'Allahabad Safeda'. Greyed-Yellow 160 D was found in 'CISH-G-4' and 'Hisar Safeda'.

4.1.4.24 Evenness of colour of flesh

As clear from Table 10, all the guava cultivars and hybrids studied were observed with even colour of flesh.

4.1.4.25 Discolouration of flesh after cutting

Discolouration of flesh after cutting was observed in 'Hisar Safeda', whereas, it was absent in rest of the cultivars and hybrids.

4.1.4.26 Puffiness

It is clear from the Table 10, puffiness was absent in all the guava cultivars and hybrids studied.

4.1.4.27 Muskiness

As guava is highly an aromatic crop, so, muskiness was found to be present in all the cultivars and hybrids (Table 10).

4.1.4.28 Flavour

Table 10 depicts that all the cultivars and hybrids were found to have mild flavour of fruits in rainy season.

4.1.5 Yield characters

4.1.5.1 Fruit yield (kg/tree)

Fruit yield (pooled values) during both the years was maximum (16.45 kg/tree) in 'Lalit' and it was statistically at par with 'Lucknow-49' (15.48 kg/tree). Whereas, minimum fruit yield of 12.09 kg/tree was recorded in 'Hisar Surkha' and it was significantly lower than all the other cultivars. Data pertaining to this aspect during 2017 and 2018 showed that maximum fruit yield (15.22 kg/tree) and (17.68 kg/tree) was recorded in 'Lalit' followed by 'Lucknow-49' and 'Allahabad Safeda', whereas, minimum in 'Hisar Surkha' with values 11.59 and 12.60 kg/tree, respectively (Table 11).

Table 10. Fruit flesh characters of some guava cultivars and hybrids

Characters / Cultivars/hybrids	Core diameter (mm)			Thickness of outer flesh in relation to core diameter (mm)			Colour of flesh	Evenness of colour of flesh	Discolouration of flesh after cutting	Puffiness	Muskiness	Flavour
	2017	2018	Pooled	2017	2018	Pooled						
Punjab Hybrid-1 (H-1)	45.85	48.71	47.28	10.07	11.26	10.66	Greyed-Red 180 C	Even	Absent	Absent	Present	Mild
Punjab Hybrid-2 (H-2)	45.84	47.83	46.84	11.86	13.40	12.63	Greyed-Red 180 C	Even	Absent	Absent	Present	Mild
CISH-G-1	47.07	50.80	48.94	10.42	11.31	10.86	Yellow-White 158 A	Even	Absent	Absent	Present	Mild
Lalit (CISH-G-3)	54.90	57.96	56.43	12.11	13.43	12.77	Greyed-Red 180 C	Even	Absent	Absent	Present	Mild
Allahabad Safeda	51.53	53.94	52.74	13.33	14.74	14.03	Orange-White 159 C & 159 D	Even	Absent	Absent	Present	Mild
CISH-G-4 (Shweta)	50.04	53.53	51.79	8.58	10.92	9.75	Greyed-Yellow 160 D	Even	Absent	Absent	Present	Mild
Lucknow-49 (Sardar)	47.05	49.60	48.33	15.89	17.87	16.88	Orange-White 159 C	Even	Absent	Absent	Present	Mild
Hisar Safeda	53.80	55.55	54.68	11.23	13.24	12.23	Greyed-Yellow 160 D	Even	Present	Absent	Present	Mild
Hisar Surkha	45.12	46.90	46.01	10.69	12.10	11.39	Greyed-Red 180 B	Even	Absent	Absent	Present	Mild
Mean	49.02	51.65	50.34	11.57	13.14	12.36	-	-	-	-	-	-
$CD_{0.05}$	4.71	5.21	4.69	0.56	1.93	1.38	-	-	-	-	-	-

4.1.5.2 Yield efficiency

Data pertaining to this trait is given in Table 11. 'Lalit' recorded least mean yield efficiency (7.43 g/cm^2 TCSA) and maximum value for the trait was observed in 'CISH-G-4' (10.41 g/cm^2 TCSA). All the values were statistically at par with each other.

Table 11. Fruit yield and yield efficiency of some guava cultivars and hybrids

Characters / Cultivars/ hybrids	Yield (kg/tree)			Yield efficiency (g/cm^2 TCSA)		
	2017	2018	Pooled	2017	2018	Pooled
Punjab Hybrid-1 (H-1)	12.42	13.95	13.18	9.35	7.94	8.64
Punjab Hybrid-2 (H-2)	11.77	13.27	12.52	10.51	8.85	9.68
CISH-G-1	10.27	11.70	10.98	8.06	7.26	7.66
Lalit (CISH-G-3)	15.22	17.68	16.45	7.54	7.32	7.43
Allahabad Safeda	14.01	15.53	14.77	10.69	9.03	9.86
CISH-G-4 (Shweta)	13.09	14.59	13.84	11.69	9.14	10.41
Lucknow-49 (Sardar)	14.67	16.30	15.48	8.20	7.51	7.85
Hisar Safeda	13.76	15.02	14.39	10.07	8.75	9.41
Hisar Surkha	11.59	12.60	12.09	8.99	7.30	8.14
Mean	12.98	14.51	13.75	9.46	8.12	8.79
$CD_{0.05}$	1.21	0.61	1.00	NS	NS	2.87

4.1.6 Fruit (biochemical) characters

4.1.6.1 Total soluble solids

This is one of the most important trait governing fruit quality. Data pertaining to this trait is presented in Table 12. The maximum mean soluble content (10.98 °B) was recorded in 'Hisar Safeda' followed by 'CISH-G-4' (10.84 °B), 'Lalit' (10.70 °B), 'Punjab Hybrid-2' (10.64 °B) and was statistically at par with each other. Lower soluble solid content was recorded in 'Lucknow-49' (10.61 °B), 'Punjab Hybrid-1' (10.36 °B), 'CISH-G-1' (10.29 °B), 'Hisar Surkha' (9.98 °B) and least TSS (9.89 °B) was recorded in 'Allahabad Safeda' (Table 12). Similar trend was observed in both the years.

4.1.6.2 Titratable acidity

Data presented in Table 12 shows significant variation in fruit titrable acidity among guava cultivars and hybrids under study. The maximum mean fruit acidity (0.32 %) was observed in 'Punjab Hybrid-2' followed by 'Allahabad Safeda' (0.29 %), 'Punjab Hybrid-1' (0.28 %). The minimum mean fruit acidity (0.19 %) was recorded in 'Hisar Safeda' and 'CISH-G-4' and it was statistically at par with 'CISH-G-1' (0.22 %). Similar trend was observed with maximum acidity in 'Punjab Hybrid-2' and minimum was found in 'Hisar Safeda' during both the years.

4.1.6.3 Total sugars

Average total sugars among different cultivars and hybrids varied from 6.57 per cent in ‘Allahabad Safeda’ to 7.30 per cent in ‘Hisar Safeda’. Similarly, in 2017 as well as in 2018, the maximum total sugars were observed in ‘Hisar Safeda’ with the values of 7.22 per cent and 7.38 per cent, respectively. Whereas, minimum in ‘Allahabad Safeda’ with values of 6.48 per cent and 6.67 per cent, respectively (Table 12).

4.1.6.4 Reducing sugars

Data pertaining to this trait is given in Table 12. ‘CISH-G-1’ recorded least reducing sugars (4.30 %) and this was observed to be statistically at par with ‘Hisar Surkha’ (4.34 %) and ‘Lalit’ (4.41 %). Whereas, maximum value for the trait was observed in ‘Hisar Safeda’ (4.84 %) and the value was statistically at par with ‘Allahabad Safeda’ (4.79 %), ‘Punjab Hybrid-2’ (4.73 %) and ‘CISH-G-4’ (4.67 %).

Similarly, reducing sugars were maximum in ‘Hisar Safeda’ and minimum in ‘CISH-G-1’ during both the years.

4.1.6.5 Non-reducing sugars

Table 12 presents that average non-reducing sugars were recorded minimum (1.70 %) in ‘Allahabad Safeda’ and this was observed that lower non-reducing sugars were also observed in ‘Hisar Surkha’, ‘Punjab Hybrid-2’ and ‘Punjab Hybrid-1’ having of values 2.18 per cent, 2.23 per cent and 2.26 per cent, respectively. Maximum value for the trait was observed in ‘Lalit’ (2.57 %) which was found to be statistically at par with ‘CISH-G-1’ (2.42 %), ‘CISH-G-4’ (2.41 %), ‘Lucknow-49’ (2.41 %) and ‘Hisar Safeda’ (2.34 %). Same trend was observed in both the years.

4.1.7 Seed characters

4.1.7.1 Number of seeds per fruit

Fruit quality in guava also depends upon seed content of fruit and generally guava contains higher seed content when compared to others. Data regarding number of seeds per fruit is given in Table 13. The average seed number per fruit showed considerable variation among different cultivars and hybrids during both the years. The seed number per fruit varied from 123.50 in ‘Lucknow-49’ to 337.63 in ‘Allahabad Safeda’. The minimum as well as maximum values differ significantly during both the years among all the cultivars and hybrids. Similar trend of observations were recorded in both the years.

Table 12. Fruit (biochemical) characters of some guava cultivars and hybrids

Characters / Cultivars/ hybrids	Total soluble solids (^{0}B)			Acidity (%)			Total sugars (%)			Reducing sugars (%)			Non-reducing sugars (%)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Punjab Hybrid-1 (H-1)	10.20	10.53	10.36	0.28	0.27	0.28	6.78	7.00	6.89	4.54	4.50	4.52	2.14	2.38	2.26
Punjab Hybrid-2 (H-2)	10.48	10.80	10.64	0.33	0.31	0.32	6.97	7.18	7.07	4.72	4.74	4.73	2.14	2.32	2.23
CISH-G-1	10.13	10.45	10.29	0.22	0.21	0.22	6.73	6.95	6.84	4.28	4.32	4.30	2.34	2.50	2.42
Lalit (CISH-G-3)	10.53	10.88	10.70	0.27	0.25	0.26	7.00	7.23	7.12	4.39	4.44	4.41	2.48	2.65	2.57
Allahabad Safeda	9.75	10.03	9.89	0.30	0.28	0.29	6.48	6.67	6.57	4.77	4.81	4.79	1.63	1.77	1.70
CISH-G-4 (Shweta)	10.70	10.98	10.84	0.20	0.19	0.19	7.11	7.30	7.21	4.63	4.70	4.67	2.36	2.47	2.41
Lucknow-49 (Sardar)	10.48	10.75	10.61	0.24	0.24	0.24	6.96	7.15	7.06	4.52	4.52	4.52	2.32	2.50	2.41
Hisar Safeda	10.85	11.10	10.98	0.19	0.18	0.19	7.22	7.38	7.30	4.81	4.86	4.84	2.28	2.40	2.34
Hisar Surkha	9.85	10.10	9.98	0.24	0.23	0.24	6.55	6.72	6.63	4.33	4.36	4.34	2.11	2.24	2.18
Mean	10.62	10.33	10.48	0.24	0.25	0.25	6.87	7.06	6.97	4.55	4.58	4.57	3.84	2.36	2.28
$CD_{0.05}$	0.24	0.23	0.23	0.04	0.03	0.04	0.16	0.15	0.19	0.10	0.15	0.12	0.20	0.21	0.24

4.1.7.2 Seed weight

Another important parametre is seed weight of guava fruit and data pertaining to this trait is presented in Table 13. Minimum seed weight of 2.97, 2.88 and 3.05 g per fruit during investigation period was observed for 'Lucknow-49' during both years, 2017 and 2018, respectively. 'Allahabad Safeda' recorded maximum seed weight during both the years, 2017 and 2018 with values of 11.65, 11.48 and 11.82 g, respectively. The overall mean seed weight was observed to be 5.55 g during both the years.

4.1.7.3 Seed size

This trait governs fruit quality in guava as small seed size is preferred over bold seeds. Seed size for different guava cultivars and hybrids as shown in Table 13 clearly reveals variation in 'Lalit' with minimum mean value of 3.34 mm being statistically at par with 'CISH-G-1' (3.36 mm), 'CISH-G-4' (3.37 mm), 'Hisar Surkha' (3.39 mm), 'Lucknow-49' (3.48 mm) and 'Allahabad Safeda' (3.50 mm). Maximum seed size was recorded in 'Hisar Safeda' (4.03 mm) which was statistically at par with 'Punjab Hybrid-2' (3.89 mm) and 'Punjab Hybrid-1' (3.82 mm).

4.1.7.4 Seed hardness

As clear from Table 13, fruits were observed to be soft seeded in 'Hisar Surkha', while medium hard seeds in 'CISH-G-1', 'Lalit' and 'Allahabad Safeda' and in rest were hard seeds during both the years.

Significant differences among various fruit characters such as size, weight, colour of peel and flesh were observed in Table 9a, 9c and 10. These fruit characters are detrimental in making any variety acceptable to the end user i.e. the consumer. In general, the domestic market has a likeness toward guava fruits which are large in size, sweet in taste, less acidic and have less number of seeds with soft seeded. Several workers have worked on the physical aspects of guava fruits (Deshmukh *et al.*, 2013; Ghosh *et al.*, 2013; Dolkar *et al.*, 2014; Ajang *et al.*, 2016; Dubey *et al.*, 2016; Gupta *et al.*, 2016 and so on) in the past and have reported considerable variation in fruits of different guava cultivars and hybrids with respect to these important attributes from marketing and consumer point of view.

The fruit length was recorded maximum (71.35 mm) in 'Lucknow-49' and minimum (48.82 mm) in 'CISH-G-1', whereas, fruit width was recorded maximum (69.70 mm) in 'Lalit' and minimum (57.90 mm) in 'Hisar Surkha' (Table 9a) which in accordance with the study of Deshmukh *et al.* (2013) in which mean fruit length and width of different cultivars

Table 13. Seed characters of some guava cultivars and hybrids

Characters / Cultivars/ hybrids	Number of seeds/fruit			Seed weight (g)/fruit			Seed size (mm)			Seed hardness	
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018
Punjab Hybrid-1 (H-1)	134.50	148.50	147.88	5.08	5.37	5.23	3.62	4.02	3.82	Hard	Hard
Punjab Hybrid-2 (H-2)	191.75	217.50	217.25	6.21	6.39	6.30	3.69	4.09	3.89	Hard	Hard
CISH-G-1	127.75	139.50	139.75	2.84	3.16	3.00	3.19	3.52	3.36	Medium	Medium
Lalit (CISH-G-3)	160.25	182.25	182.75	3.55	3.72	3.64	3.16	3.51	3.34	Medium	Medium
Allahabad Safeda	307.25	340.75	337.63	11.48	11.82	11.65	3.34	3.67	3.50	Medium	Medium
CISH-G-4 (Shweta)	255.25	269.50	269.75	6.35	6.53	6.44	3.21	3.54	3.37	Hard	Hard
Lucknow-49 (Sardar)	109.50	124.50	123.50	2.88	3.05	2.97	3.29	3.66	3.48	Hard	Hard
Hisar Safeda	237.75	258.50	257.50	7.11	7.30	7.20	3.85	4.22	4.03	Hard	Hard
Hisar Surkha	147.75	162.25	161.25	3.37	3.57	3.47	3.20	3.57	3.39	Soft	Soft
Mean	185.75	204.81	204.14	5.43	5.66	5.55	3.36	3.70	3.53	-	-
$CD_{0.05}$	10.38	5.75	7.96	0.24	0.12	0.30	0.42	0.45	0.43	-	-

and hybrids varied from 59.8 mm to 65.4 mm and 61.5 mm to 69.9 mm, respectively. The results are also in agreement with the findings of Gupta *et al.* (2016) who also reported maximum fruit length in 'Lucknow-49' under rainfed conditions of Jammu region. Similar results were obtained by Dolkar *et al.* (2014), who recorded maximum length of fruit in 'Lucknow-49' under sub-tropical condition. Kumari *et al*. (2016) also recorded maximum fruit length in 'Lucknow-49' (64.8 mm) under sub-tropical condition of Himachal Pradesh. The maximum fruit weight was observed in 'Lalit' followed by 'Lucknow-49'. Dolkar *et al.* (2014) reported maximum weight in 'Lucknow-49' under subtropical condition. The shape of fruit found to be pomi (round) and ovate while, fruit shape at stalk end varied from broadly rounded to pointed. The shape at stalk end is rounded in 'Allahabad Safeda' as per PPVFRA guidelines (Anonymous, 2016) which was similar to the observations recorded in present study. Fruit shape in guava has also been described by many workers (Daulta *et al.,* 1998; Mahaur, 2010; Sharma *et al.,* 2010; Meena *et al.,* 2013; Ulemale and Tambe, 2015a; Dubey *et al.,* 2016; Kumari *et al.,* 2016; Ran *et al.,* 2017) and similar variations have been reported.

The colour of fruit (flesh and peel), relief of fruit surface and presence of longitudinal ridges and grooves are also important indices to differentiate between various guava cultivars and hybrids and to some extent the fruit colour is considered as indices of fruit maturity. However, in the present study the guava cultivars and hybrids exhibited no significant variation in fruit peel colour except the slight variation was observed in the shade of colour but the flesh colour varied from yellow-white to greyed-red and several studies conducted elsewhere has also reported so (Mahaur, 2010; Sharma *et al.,* 2010; Meena *et al.,* 2013; Ulemale and Tambe, 2015a; Dubey *et al.,* 2016; Kumari *et al.,* 2016; Singh *et al.,* 2016a; Ran *et al.,* 2017) Although flesh colour is a varietal character, slight variation in the intensity may be attributed to the climatic factor and soil type. Relief of fruit surface was found to be smooth to rough Table 9c. Singh (2013) reported rough fruit surface in 'CISH-G-1' and 'Lucknow-49'. UPOV (Anonymous, 1987) indicated similar categorization in guava cultivars and hybrids. The longitudinal ridges and grooves were categorized as present or absent in nine guava cultivars and hybrids. UPOV (Anonymous, 1987) indicated similar characterization in guava cultivars and hybrids. Thickness of outer flesh ranged from 9.75 mm to 16.88 mm and core diameter from 46.01mm to 56.43 mm in all guava cultivars and hybrids. Similar reports were observed by Singh (2013) with 10.17 mm to 17.48 mm and 31.11 mm to 42.35 mm, respectively.

The maximum (16.45 kg/tree) value of fruit yield was recorded in ‘Lalit’ and minimum (12.09 kg/tree) in ‘Hisar Surkha’ (Table 11) which is similar to the study of Meena *et al.* (2013) who reported fruit yield ranging between 5.93 kg/plant to 14.91 kg/plant. Significant variation in yield characters has been observed earlier also ((Jana *et al.,* 2009; Deshmukh *et al.,* 2013; Meena *et al.,* 2013; Jana *et al.,* 2015; Ulemale and Tambe, 2015a; Dubey *et al.,* 2016; Gupta *et al.,* 2016; Kumari *et al.,* 2016; Sahoo *et al.,* 2017 etc).

The TSS content in fruits was found to be ranging between 9.89 ^{o}B in ‘Allahabad Safeda’ to 10.98 ^{o}B in ‘Hisar Safeda’ (Table 12). However, according to Kumari *et al*. (2016), TSS ranged from 9.66 ^{o}B to 11.40 ^{o}B in sub-tropical condition of Himachal Pradesh. The total sugars ranged from 6.57 per cent to 7.30 per cent, reducing sugars from 4.30 per cent to 4.84 per cent and non-reducing sugars from 1.70 per cent to 2.57 per cent in all guava cultivars and hybrids (Table 12). Similar reports were observed by Kumari *et al*. (2016) with 6.28 to 7.46 per cent, 4.08 to 4.85 per cent and 2.09 to 2.48 per cent, respectively. Lot of work has been done on the physico-chemical characteristics of guava cultivars and hybrids. These parametres may vary from place to place depending on climatic factors and management practices. In the present investigations on the physico-chemical characteristics of different guava cultivars and hybrids, the results are within the range but shows slight variation compared with the findings of other workers. Similar variations for physical and chemical characters like TSS, acidity, sugars etc have also been reported by Deshmukh *et al.* (2013); Ghosh *et al.* (2013); Meena *et al.* (2013); Singh *et al.* (2013); Ajang *et al.* (2016); Dubey *et al.* (2016); Gupta *et al.* (2016); Kumari *et al.* (2016); Bhalekar and Chalak (2017) and so on.

The number of seeds per fruit varied from cultivar to cultivar being maximum (337.63) in ‘Allahabad Safeda’ and minimum (123.50) in ‘Lucknow-49’. Although variations in the presence of less number of seeds per fruit is a desirable character. Kumari *et al.* (2016) also recorded low (127) seed number in ‘Lucknow-49’ under sub-tropical condition of Himachal Pradesh. The observations on seed hardness in guava cultivars and hybrids are presented in Table 13. Seed texture is an important character in the identification of guava cultivars and hybrids and also from market point of view. The three categories of seed hardness are soft, medium and hard. The results of present findings are in accordance with the findings of Daulta *et al.* (1998); Kumari *et al.* (2016); Bhalekar and Chalak (2017) who reported that the seed texture of guava is in range of soft, medium and low. UPOV

(Anonymous, 1987) indicated similar characterization of seed hardness in guava cultivars and hybrids.

4.2 POMOLOGICAL DESCRIPTION OF GUAVA CULTIVARS AND HYBRIDS

Based upon the observations recorded on various characters as per UPOV (1987) guidelines, nine guava cultivars and hybrids studied are described below (Plate 7 to 15).

'Punjab Hybrid-1' (H-1)

(Plate 7)

Tree characters

Drooping attitude of branches; green colour of young twigs; yield 13.18 kg/tree; yield efficiency 8.64 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf present with medium intensity; leaf colour Green-Group; green colour of leaf Green-group 137 C; medium degree of undulation of leaf margins present; relief of surface on upper side smooth; medium pubescence on lower side of fully developed leaf; obtrullate shape of mature leaf; rounded leaf base shape; apiculate leaf apex shape

Flower characters

Staminoid petals present; 1-3 predominant number of flowers in inflorescence; 5-7 number of fully developed petals.

Fruit characters

Terminal and lateral fruiting habit; fruit length long; medium width; medium length/width ratio; uniform fruit size; ovate fruit shape; pointed fruit shape at stalk end; yellow-green colour of peel; smooth fruit surface; greyed-red colour of flesh; even colour of flesh; discolouration of flesh after cutting absent; longitudinal ridges absent; longitudinal grooves absent; inconspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

Hard seeded; medium number of seeds per fruit.

PLATE 7

TREE

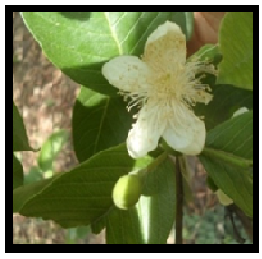
YOUNG LEAVES

YOUNG TWIG

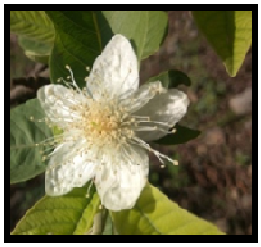
LEAF SHAPE

LEAF APEX

LEAF BASE



FLOWER



STAMINOID PETALS

FRUIT SHAPE AT STALK END (POINTED)

RIDGED COLLAR AROUND CALYX CAVITY (INCONSPICUOUS)

FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'PUNJAB HYBRID-1' GUAVA

‘Punjab Hybrid-2’ (H-2)

(Plate 8)

Growth characters

Drooping attitude of branches; green colour of young twigs; yield 12.52 kg/tree; yield efficiency 9.68 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf absent; leaf colour Green-Group; green colour of leaf Green-group 137 B; weak degree of undulation of leaf margins present; relief of surface on upper side medium; medium pubescence on lower side of fully developed leaf; obtrullate shape of mature leaf; rounded leaf base shape; apiculate leaf apex shape

Flower characters

Staminoid petals present; 1-3 predominant number of flowers in inflorescence; 6-8 number of fully developed petals.

Fruit characters

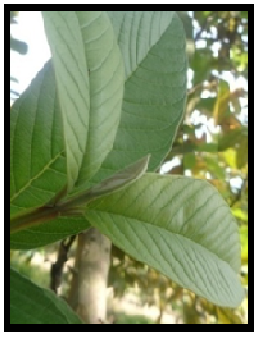
Terminal and lateral fruiting habit; fruit length medium; medium width; narrow length/width ratio, uniform fruit size; pomi (round) fruit shape; broadly rounded fruit shape at stalk end; yellow-green colour of peel; rough fruit surface; greyed-red colour of flesh; even colour of flesh; discolouration of flesh after cutting absent; longitudinal ridges absent; longitudinal grooves absent; inconspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

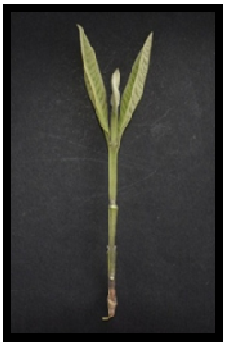
Hard seeded; medium number of seeds per fruit.

PLATE 8

TREE



YOUNG LEAVES

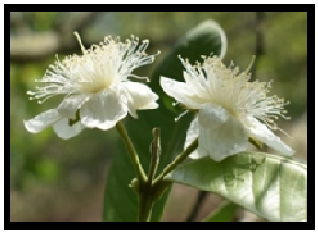


YOUNG TWIG

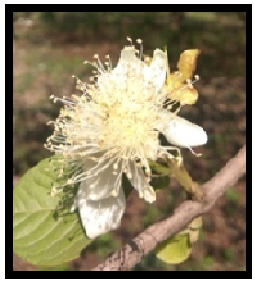
LEAF SHAPE

LEAF APEX

LEAF BASE

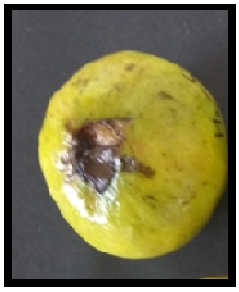


FLOWER



STAMINOID PETALS

LEAF SHAPE AT STALK END (BROADLY ROUNDED)



RIDGED COLLAR AROUND CALYX CAVITY (INCONSPICUOUS)

FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'PUNJAB HYBRID-2' GUAVA

‘CISH-G-1’

(Plate 9)

Growth characters

Erect attitude of branches; green colour of young twigs; yield 10.98 kg/tree; yield efficiency 7.66 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf present with medium intensity; leaf colour Green-Group; green colour of leaf Green-group 138 A; weak degree of undulation of leaf margins present; relief of surface on upper side wrinkled; dense pubescence on lower side of fully developed leaf; oblong shape of mature leaf; rounded leaf base shape; obtuse leaf apex shape

Flower characters

Staminoid petals absent; 1-2 predominant number of flowers in inflorescence; 5-6 number of fully developed petals.

Fruit characters

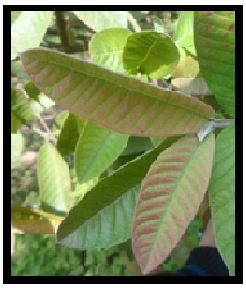
Terminal and lateral fruiting habit; fruit length medium; broad width; narrow length/width ratio; uniform fruit size; pomi (round) fruit shape; broadly rounded fruit shape at stalk end; yellow-green colour of peel; rough fruit surface; yellow-white colour of flesh; even colour of flesh; discolouration of flesh after cutting absent; longitudinal ridges absent; longitudinal grooves present; inconspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

Medium hard seeded; medium number of seeds per fruit.

PLATE 9

TREE



YOUNG LEAVES

YOUNG TWIG

LEAF SHAPE

LEAF APEX

LEAF BASE

FLOWER

FRUIT SHAPE AT STALK END (BROADLY ROUNDED) WITH LONGITUDINAL GROOVES

RIDGED COLLAR AROUND CALYX CAVITY (INCONSPICUOUS)

FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'CISH-G-1' GUAVA

‘Lalit’ (CISH-G-3)

(Plate 10)

Growth characters

Erect attitude of branches; green with red streaks in young twigs; yield 16.45 kg/tree; yield efficiency 7.43 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf present with weak intensity; leaf colour Green-Group; green colour of leaf Green-group 137 C; weak degree of undulation of leaf margins present; relief of surface on upper side smooth; sparse pubescence on lower side of fully developed leaf; oblong shape of mature leaf; rounded leaf base shape; obtuse leaf apex shape

Flower characters

Staminoid petals absent; 1-2 predominant number of flowers in inflorescence; 5-7 number of fully developed petals.

Fruit characters

Terminal and lateral fruiting habit; fruit length long; broad width; narrow length/width ratio; uniform fruit size; pomi (roumd) fruit shape; broadly rounded fruit shape at stalk end; yellow-green colour of peel; rough fruit surface; greyed-red colour of flesh; even colour of flesh; discolouration of flesh after cutting absent; longitudinal ridges absent; longitudinal grooves present; inconspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

Medium hard seeded; medium number of seeds per fruit.

PLATE 10

TREE

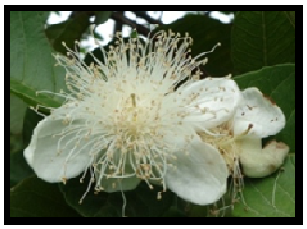
YOUNG LEAVES

YOUNG TWIG

LEAF SHAPE

LEAF APEX

LEAF BASE

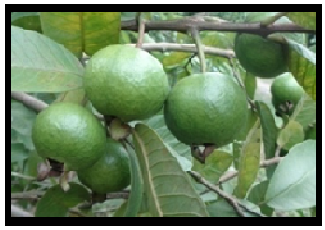


FLOWER

RIDGED COLLAR AROUND CALYX CAVITY (INCONSPICUOUS)

LONGITUDINAL GROOVES

FRUIT SHAPE AT STALK END (BROADLY ROUNDED)



FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'LALIT' (CISH-G-3) GUAVA

‘Allahabad Safeda’

(Plate 11)

Growth characters

Spreading attitude of branches; green with red streaks in young twigs; yield 14.77 kg/tree; yield efficiency 9.86 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf present with medium intensity; leaf colour Green-Group; green colour of leaf Green-group 137 C; weak degree of undulation of leaf margins present; relief of surface on upper side medium; sparse pubescence on lower side of fully developed leaf; oblong shape of mature leaf; rounded leaf base shape; obtuse leaf apex shape

Flower characters

Staminoid petals absent; 2-3 predominant number of flowers in inflorescence; 5-7 number of fully developed petals.

Fruit characters

Terminal and lateral fruiting habit; fruit length long; broad width; narrow length/width ratio; uniform fruit size; pomi (round) fruit shape; rounded fruit shape at stalk end; yellow-green colour of peel; smooth fruit surface; orange-white colour of flesh; even colour of flesh; discolouration of flesh after cutting absent; longitudinal ridges absent; longitudinal grooves present; inconspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

Medium hard seeded; many number of seeds per fruit.

PLATE 11

TREE

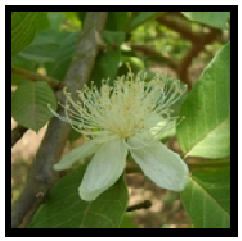
YOUNG LEAVES

YOUNG TWIG

LEAF SHAPE

LEAF APEX

LEAF BASE



FLOWER

RIDGED COLLAR AROUND CALYX CAVITY (INCONSPICUOUS)

LONGITUDINAL GROOVES

FRUIT SHAPE AT STALK END (ROUNDED)

FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'ALLAHABAD SAFEDA' GUAVA

‘CISH-G-4’ (Shweta)

(Plate 12)

Growth characters

Spreading attitude of branches; green with red streaks in young twigs; yield 13.84 kg/tree; yield efficiency 10.41 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf present with medium intensity; leaf colour Green-Group; green colour of leaf Green-group 137 D; weak degree of undulation of leaf margins present; relief of surface on upper side smooth; sparse pubescence on lower side of fully developed leaf; ovate shape of mature leaf; obtuse leaf base shape; apiculate leaf apex shape

Flower characters

Staminoid petals present; 1-2 predominant number of flowers in inflorescence; 6-8 number of fully developed petals.

Fruit characters

Terminal and lateral fruiting habit; fruit length long; broad width; medium length/width ratio; uniform fruit size; ovate fruit shape; pointed fruit shape at stalk end; yellow-green colour of peel; rough fruit surface; greyed-yellow colour of flesh; even colour of flesh; discolouration of flesh after cutting absent; longitudinal ridges present with weak prominence; longitudinal grooves absent; inconspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

Hard seeded; many number of seeds per fruit.

PLATE 12

TREE

YOUNG LEAVES

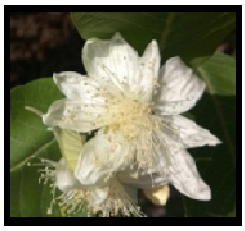
YOUNG TWIG

LEAF SHAPE

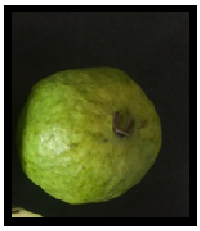
LEAF APEX

LEAF BASE

FLOWER



STAMINOID PETALS



RIDGED COLLAR AROUND CALYX CAVITY (INCONSPICUOUS)

STAMINOID PETALS

FRUIT SHAPE AT STALK END (POINTED)

FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'CISH-G-4' (SHWETA) GUAVA

‘Lucknow-49’ (Sardar)

(Plate 13)

Growth characters

Spreading attitude of branches; green with red streaks in young twigs; yield 15.48 kg/tree; yield efficiency 7.85 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf absent; leaf colour Green-Group; green colour of leaf Green-group 137 C; medium degree of undulation of leaf margins present; relief of surface on upper side smooth; medium pubescence on lower side of fully developed leaf; oblong shape of mature leaf; obtuse leaf base shape; apiculate leaf apex shape

Flower characters

Staminoid petals absent; 1-2 predominant number of flowers in inflorescence; 6-8 number of fully developed petals.

Fruit characters

Terminal and lateral fruiting habit; fruit length long; broad width; medium length/width ratio; uniform fruit size; ovate fruit shape; pointed fruit shape at stalk end; yellow-green colour of peel; rough fruit surface; orange-white colour of flesh; even colour of flesh; discolouration of flesh after cutting absent; longitudinal ridges present with medium prominence; longitudinal grooves absent; inconspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

Hard seeded; medium number of seeds per fruit.

PLATE 13

TREE

YOUNG LEAVES

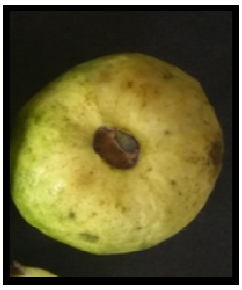
YOUNG TWIG

LEAF SHAPE

LEAF APEX

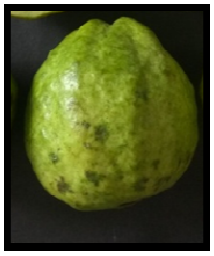
LEAF BASE

FLOWER



RIDGED COLLAR AROUND CALYX CAVITY (INCONSPICUOUS)

LONGITUDINAL RIDGES



FRUIT SHAPE AT STALK END (POINTED)

FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'LUCKNOW-49' (SARDAR) GUAVA

‘Hisar Safeda’

(Plate 14)

Growth characters

Spreading attitude of branches; green with red streaks in young twigs; yield 14.39 kg/tree; yield efficiency 9.41 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf absent; leaf colour Green-Group; green colour of leaf Green-group 137 C; medium degree of undulation of leaf margins present; relief of surface on upper side smooth; dense pubescence on lower side of fully developed leaf; oblong shape of mature leaf; rounded leaf base shape; apiculate leaf apex shape

Flower characters

Staminoid petals absent; 1-2 predominant number of flowers in inflorescence; 5-7 number of fully developed petals.

Fruit characters

Terminal and lateral fruiting habit; fruit length long; broad width; narrow length/width ratio, uniform fruit size; pomi (round) fruit shape; rounded fruit shape at stalk end; yellow-green colour of peel; rough fruit surface; greyed-yellow colour of flesh; even colour of flesh; discolouration of flesh after cutting present; longitudinal ridges present with weak prominence; longitudinal grooves absent; conspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

Hard seeded; many number of seeds per fruit.

PLATE 14

TREE

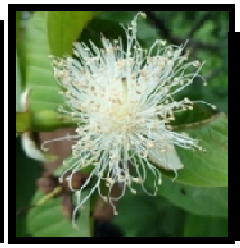
YOUNG LEAVES

YOUNG TWIG

LEAF SHAPE

LEAF APEX

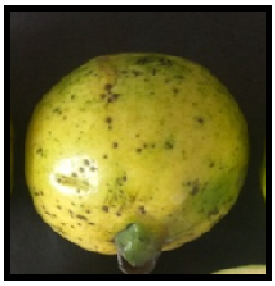
LEAF BASE



FLOWER

DISCOLOURATION OF FLESH AFTER CUTTING

LONGITUDINAL RIDGES WITH CONSPICUOUS RIDGED COLLAR AROUND CALYX CAVITY



FRUIT SHAPE AT STALK END (ROUNDED)

FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'HISAR SAFEDA' GUAVA

‘Hisar Surkha’

(Plate 15)

Growth characters

Drooping attitude of branches; green colour of young twigs; yield 12.09 kg/tree; yield efficiency 8.14 g/cm^2 TCSA.

Foliage characters

Anthocyanin colouration of young leaf present with medium intensity; leaf colour Green-Group; green colour of leaf Green-group 138 B; weak degree of undulation of leaf margins present; relief of surface on upper side wrinkled; medium pubescence on lower side of fully developed leaf; ovate shape of mature leaf; cordate leaf base shape; obtuse leaf apex shape

Flower characters

Staminoid petals present; 1-3 predominant number of flowers in inflorescence; 5-7 number of fully developed petals.

Fruit characters

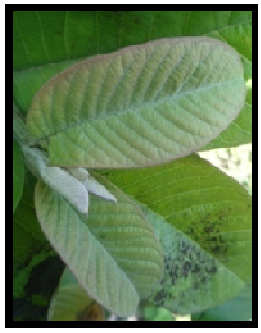
Terminal and lateral fruiting habit; fruit length medium; medium width; medium length/width ratio; uniform fruit size; pomi (round) fruit shape; rounded fruit shape at stalk end; yellow-green colour of peel; smooth fruit surface; greyed-red colour of flesh; even colour of flesh; discolouration of flesh after cutting absent; longitudinal ridges absent; longitudinal grooves absent; inconspicuous ridged collar around calyx cavity; puffiness absent; muskiness present; mild flavour.

Seed characters

Hard seeded; medium number of seeds per fruit.

PLATE 15

TREE



YOUNG LEAVES

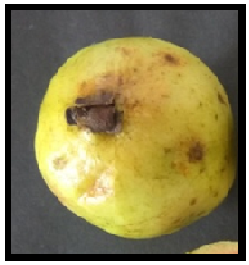
YOUNG TWIG

LEAF SHAPE

LEAF APEX

LEAF BASE

STAMINOID PETALS



RIDGED COLLAR AROUND CALYX CAVITY (INCONSPICUOUS)

FRUIT SHAPE AT STALK END (ROUNDED)

FRUITS AT BEARING STAGE

FRUITS

DESCRIPTOR FOR 'HISAR SURKHA' GUAVA

Chapter-5

SUMMARY AND CONCLUSION

The present investigation entitled **"Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids"** was conducted during the year 2016-17 and 2017-18 in the Regional Horticultural Research and Training Station, Dhaulakuan, Sirmour. The results obtained during present course of study are summarized as under:

5.1 Tree characters

- The tree height (5.57 m) was recorded maximum in Allahabad Safeda. However, the minimum tree height (3.80 m) was noticed in Hisar Safeda.
- The maximum trunk girth (53.27 cm) was found in Allahabad Safeda and the minimum (41.10 cm) in Punjab Hybrid-2.
- The maximum tree spread in N-S direction and E-W direction was observed in CISH-G-4 (4.78 m and 5.69 m, respectively), whereas, minimum in Hisar Safeda (3.65 m and 3.98 m, respectively).
- The tree volume was maximum in Allahabad Safeda (73.66 m^3) and minimum tree volume of 28.40 m^3 was recorded in Hisar Safeda.
- Plants in majority of cultivars and hybrids were found to be of spreading growth habit in Allahabad Safeda, CISH-G-4, Lucknow-49 and Hisar Safeda, whereas, drooping growth habit was observed in Punjab Hybrid-1, Punjab Hybrid-2 and Hisar Surkha and erect in CISH-G-1 and Lalit.
- Maximum inter-nodal length of twigs was observed in CISH-G-4 (5.31 cm) and minimum was observed in Allahabad Safeda (3.37 cm).
- The maximum stem thickness was recorded in Allahabad Safeda (7.14 cm), whereas, minimum was observed in Hisar Safeda (5.16 cm).
- The maximum (22.97 cm) extension growth of twigs was recorded in Allahabad Safeda which was statistically higher among all the cultivars and hybrids, whereas, minimum (12.01cm) was found in Hisar Surkha.

- The twig diametre during both the years was maximum (6.77 mm) in Lucknow-49 and it was followed by Lalit, Allahabad Safeda, CISH-G-4 and Hisar Safeda, which recorded 6.49 mm, 6.41 mm, 6.27 mm and 6.22 mm of twig diametre, respectively. The minimum twig diametre (5.72 mm) was found in Hisar Surkha.
- Colour of young twigs was found to be green in Punjab Hybrid-1, Punjab Hybrid-2, CISH-G-1 and Hisar Surkha, whereas, green with red streaks were present in Lalit, Allahabad Safeda, CISH-G-4, Lucknow-49 and Hisar Safeda.

5.2 Foliage characters

- The leaf blade length was maximum (15.03 cm) in Lalit, whereas, minimum in Hisar Safeda (11.07 cm).
- A variation in leaf blade width was observed among different guava cultivars and hybrids ranging from 4.44 cm in CISH-G-1 to 5.60 cm in Hisar Surkha which were statistically different from each other.
- The maximum (2.81) length/width ratio was recorded in Lalit, whereas, minimum (2.13) in Hisar Surkha.
- The value of spacing of secondary veins ranged from 6.19 mm in CISH-G-4 to 8.29 mm in CISH-G-1.
- The maximum mean leaf area was found in Lalit (74.70 cm^2) and the minimum leaf area was recorded in CISH-G-1 (45.10 cm^2).
- The anthocyanin colouration was present in young leaves among all the cultivars and hybrids except Punjab Hybrid-2, Lucknow-49 and Hisar Safeda with green coloured young leaves without anthocyanin colouration.
- The medium intensity of anthocyanin colouration of young leaf was found in all the cultivars except Lalit with weak intensity of anthocyanin content.
- Variation in leaf shape was found to be obtrullate in Punjab Hybrid-1 and Punjab Hybrid-2; ovate in Hisar Surkha and CISH-G-4; oblong in rest of the cultivars and hybrids.
- Leaf base shape was observed as rounded in Punjab Hybrid-1, Punjab Hybrid-2, CISH-G-1, Allahabad Safeda, Lalit and Hisar safeda, whereas, obtuse in CISH-G-4, Lucknow-49 and cordate in Hisar Surkha.

- Leaf apex shape was found to be apiculate in Punjab Hybrid-1, Punjab Hybrid-2, CISH-G-4, Lucknow-49 and Hisar Safeda, whereas, rest were observed to be obtuse in leaf apex shape.
- Leaf colour in all the cultivars and hybrids fell in Green Group (137 &138).
- Most of the cultivars showed smooth surfaced leaves whereas, Punjab Hybrid-2 and Allahabad Safeda had medium rough leaf surface. On the other hand, in CISH-G-1 and Hisar Surkha wrinkled upper leaf surface was observed.
- Pubescence on the lower side of fully developed leaf was found to be sparse in Lalit, Allahabad Safeda and CISH-G-4 whereas, medium in Punjab Hybrid-1, Punjab Hybrid-2, Lucknow-49, Hisar Surkha and dense in CISH-G-1 and Hisar Safeda.
- Leaf margin undulation to a medium extent was observed in Punjab Hybrid-1, Lucknow-49 and Hisar Safeda whereas, weak degree of undulation of leaf margins were present in rest of the cultivars and hybrids.

5.3 Flower characters

- Lalit and Allahabad Safeda were earliest in 2017 and 2018 (26th April and 2nd May) to start flowering, whereas, CISH-G-1 and Hisar Safeda were last in initiation of flowering on 7th May and 14th May, respectively.
- The end of flowering during 2017 was observed on 4th June till 14th June and 9th June to 25th June during 2018 for different guava cultivars and hybrids. Cultivars and hybrids viz. Punjab Hybrid-1, Lalit, CISH-G-4, Lucknow-49, Punjab Hybrid-2, Allahabad Safeda and Hisar Surkha were first to complete flowering during 2017 and Lalit, Lucknow-49, Punjab Hybrid-1 and CISH-G-4 during 2018, Whereas, Hisar Safeda and CISH-G-1 were last to end flowering during both the years.
- The longest duration of flowering (43.38 days) was recorded in Allahabad Safeda and the shortest flowering duration (36.50 days) was recorded in Lucknow-49.
- The maximum (2.50) number of flowers was recorded in Allahabad Safeda while lowest (1.19) was found in Lucknow-49.

- The flower size (46.90 mm) was recorded highest in Lucknow-49. However, the least value (36.12 mm) of flower size was recorded in Lalit.
- Maximum (7.47) number of fully developed petals was found in Lucknow-49, whereas, lower number of fully developed petals were recorded in CISH-G-1 (5.44) followed by Hisar Surkha (5.50), Lalit (5.59) and Allahabad Safeda (5.84).
- The staminoid petals were found to be present in Punjab Hybrid-1, Punjab Hybrid-2, CISH-G-4 and Hisar Surkha during both the years (2017 and 2018), whereas, absent in rest of the cultivars and hybrids.

5.4 Fruit (morpho-physical) characters

- Punjab Hybrid-1 was observed to be earliest to harvest the fruits on 22nd August and 5th September during 2017 and 2018, respectively. Whereas, Allahabad Safeda and Hisar Safeda were found to be the last to harvest the fruits during 2017 (30th August, each) and 2018 (10th September, each).
- The days from initiation of flowering to first harvesting ranged from 116.75 days in CISH-G-1 to 129.50 days in Allahabad Safeda.
- The maximum fruit length was recorded in Lucknow-49 (71.35 mm) and width was found maximum in Lalit (69.70 mm). Whereas, minimum length and width was observed in CISH-G-1 (48.82 mm) and Hisar Surkha (57.90 mm), respectively with maximum fruit length/width ratio in CISH-G-4 and minimum in CISH-G-1. All the cultivars and hybrids were uniform in fruit size.
- The maximum fruit weight was observed in Lalit (171.71 g) followed by Lucknow-49, Allahabad Safeda and Hisar Safeda which recorded 164.44 g, 161.91 g and 157.90 g of fruit weight, respectively and least fruit weight was recorded in CISH-G-1 (103.59 g).
- CISH-G-1 possessed shortest stalk of 21.61 mm, whereas, longest stalk (36.57 mm) was recorded in Lucknow-49. The size of sepals ranged from 7.61 mm in CISH-G-1 to 12.66 mm in Hisar Safeda.
- The least calyx cavity diametre was recorded in CISH-G-4 (11.12 mm). However, maximum value for the trait was observed in Hisar Safeda with a mean calyx cavity diametre of 16.57 mm.

- Prominence of neck was absent in all the cultivars and hybrids.
- Terminal and lateral type of fruiting habit were observed in all the cultivars and hybrids.
- All the cultivars and hybrids were observed pomi (round) in fruit shape except Punjab Hybrid-1, CISH-G-4 and Lucknow-49. Whereas, Allahabad Safeda, Hisar Safeda and Hisar Surkha showed rounded fruit shape at stalk end and pointed fruit shape at stalk end was found in Punjab Hybrid-1, Lucknow-49 and CISH-G-4, while, remaining cultivars were broadly rounded in shape at stalk end.
- Yellow-Green colour of fruit peel was observed in all the cultivars with slight variation in shade of colour. While, flesh colour was found to be Yellow-White in CISH-G-1, Greyed-Red in Punjab Hybrid-1, Punjab Hybrid-2, Lalit and Hisar Surkha. Orange-White was found in Lucknow-49 and Allahabad Safeda. Greyed-Yellow was found in CISH-G-4 and Hisar Safeda with even colour of flesh in all the cultivars. Discolouration after cutting of flesh was recorded in Hisar Safeda.
- Fruit surface was found rough in Punjab Hybrid-2, CISH-G-1, Lalit, CISH-G-4, Lucknow-49 and Hisar Safeda, whereas, smooth surface was observed in Punjab Hybrid-1, Allahabad Safeda and Hisar Surkha.
- Ridged collar around calyx cavity was found to be inconspicuous in all the cultivars and hybrids except in Hisar Safeda, it was conspicuous. Longitudinal ridges were observed in CISH-G-4, Lucknow-49 and Hisar Safeda, while, that longitudinal grooves were present in CISH-G-1, Lalit and Allahabad Safeda.
- Least seed core diametre was observed in Hisar Surkha (46.01 mm) and maximum was observed in Lalit (56.43 mm). The thickness of flesh in relation to core diametre ranged from 9.75 mm (CISH-G-4) to 16.88 (Lucknow-49) mm.
- Puffiness was absent in all the cultivars and hybrids, while muskiness was present with mild flavour of fruits.

5.5 Yield characters

- The maximum fruit yield (16.45 kg/tree) with minimum yield efficiency (7.43 g/cm^2 TCSA) was observed in Lalit and minimum fruit yield of 12.09 kg/tree

was recorded in Hisar Surkha with minimum yield efficiency in CISH-G-4 (10.41 g/ cm^2 TCSA).

5.6 Fruit (biochemical) characters

- The maximum TSS (10.98 °B) was recorded in Hisar Safeda followed by CISH-G-4 (10.84 °B), Lalit (10.70 °B), Punjab Hybrid-2 (10.64 °B) and lower soluble solid content was recorded in Lucknow-49 (10.61 °B), Punjab Hybrid-1 (10.36 °B), CISH-G-1(10.29 °B), Hisar Surkha (9.98 °B) and least TSS (9.89 °B) was recorded in Allahabad Safeda. The maximum acidity (0.32 %) was observed in Punjab Hybrid and minimum (0.19 %) was recorded in Hisar Safeda and CISH-G-4.
- Hisar Safeda recorded maximum per cent of total sugars (7.30 %) and reducing sugars (4.84 %), while non-reducing sugars were maximum in Lalit (2.57 %).

5.7 Seed characters

- The seed number per fruit varied from 123.50 in Lucknow-49 with minimum seed weight per fruit (2.97 g) to 337.63 in Allahabad Safeda with maximum seed weight per fruit (11.65 g). The large size of seed was observed in Hisar Safeda (4.03 mm), whereas, Lalit (3.34 mm) was found to be small in size. Fruits were observed to be soft seeded in Hisar Surkha, while medium hard seeded in CISH-G-1, Lalit and Allahabad Safeda and rest were hard seeded during both the years.

CONCLUSION

- On the basis of characterization studies based on DUS test guidelines, nine guava cultivars and hybrids studied can be divided into the following broad categories:
    - Tree growth habit: Erect, spreading and drooping
    - Colour of young twigs: Green and green with red streaks
    - Leaf shape: Obtrullate, oblong and ovate
    - Anthocyanin colouration of young leaf: Present and absent
    - Staminoid petals: Present and absent
    - Fruit shape: Pomi (Round) and pyriform or ovate

- Relief of fruit surface: Smooth and rough
- Flesh colour: Greyed-Red, Yellow-White, Orange-White and Greyed-Yellow
- Longitudinal ridges: Present and absent
- Longitudinal grooves: Present and absent
- Seed hardness: Soft, medium and hard

- From the above categorization, it can be concluded that the development of descriptors will facilitate true identification and DUS testing of guava genotypes.

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APPENDIX-I

ANOVA for Growth Characters

Tree height

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.19	0.062312	0.432582
Factor A	1	5.08	5.082735	35.28506
Factor B	8	27.89	3.48647	24.20356
Interaction A X B	8	0.10	0.012541	0.087061
Error	51	7.35	0.144048	
Total	71	40.61		

Trunk Girth

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	88.22	29.40685	1.819224
Factor A	1	554.44	554.445	34.30017
Factor B	8	992.50	124.0624	7.674994
Intraction A X B	8	6.79	0.848125	0.052468
Error	51	824.39	16.1645	
Total	71	2466.34		

Tree spread (North-South)

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.51	0.168333	5.961806
Factor A	1	2.14	2.135556	75.63426
Factor B	8	7.18	0.8975	31.78646
Interaction A X B	8	0.19	0.024306	0.860822
Error	51	1.44	0.028235	
Total	71	11.45		

Tree spread (East-West)

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.07	0.024815	0.693244
Factor A	1	9.39	9.388889	262.2946
Factor B	8	15.40	1.925625	53.79561
Interaction A X B	8	0.73	0.090764	2.535644
Error	51	1.83	0.035795	
Total	71	27.42		

Tree volume

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	73.60	24.53216	0.351799
Factor A	1	5778.69	5778.693	82.86835
Factor B	8	11292.23	1411.529	20.24179
Intraction A X B	8	300.46	37.55803	0.538594
Error	51	3556.40	69.73341	
Total	71	21001.39		

Inter-nodal length of twigs

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.19	0.064107	1.496504
Factor A	1	0.00	0.00185	0.043194
Factor B	8	26.92	3.365101	78.55387
Intraction A X B	8	0.21	0.026598	0.620887
Error	51	2.18	0.042838	
Total	71	29.51		

Stem thickness

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.99	0.329836	2.961658
Factor A	1	2.37	2.366219	21.24669
Factor B	8	37.13	4.641622	41.67792
Intraction A X B	8	0.07	0.008357	0.075042
Error	51	5.68	0.111369	
Total	71	46.24		

Extension growth of twigs

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	73.97	24.65753	10.26077
Factor A	1	207.73	207.7316	86.44367
Factor B	8	332.59	41.5739	17.30021
Intraction A X B	8	240.88	30.1097	12.52959
Error	51	122.56	2.403087	
Total	71	977.73		

Twig diameter

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.06	0.019694	0.907603
Factor A	1	0.04	0.037812	1.742601
Factor B	8	7.94	0.99293	45.75947
Intraction A X B	8	0.30	0.037653	1.735256
Error	51	1.11	0.021699	
Total	71	9.45		

ANOVA for Floral Characters

Flowering duration

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	6.00	2	0.435897
Factor A	1	2.72	2.722222	0.593305
Factor B	8	233.44	29.18056	6.359865
Intraction A X B	8	42.28	5.284722	1.151798
Error	51	234.00	4.588235	
Total	71	518.44		

Flower size

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.89	0.298079	1.075003
Factor A	1	5.93	5.933295	21.39802
Factor B	8	655.41	81.92574	295.4595
Intraction A X B	8	44.18	5.522951	19.91814
Error	51	14.14	0.277282	
Total	71	720.56		

Predominant number of flowers in inflorescence

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.15	0.049479	1.066007
Factor A	1	0.20	0.195313	4.207921
Factor B	8	13.89	1.735894	37.39906
Intraction A X B	8	0.48	0.060547	1.304455
Error	51	2.37	0.046415	
Total	71	17.08		

Number of fully developed petals

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	1.36	0.454572	4.64066
Factor A	1	0.73	0.730035	7.452824
Factor B	8	42.25	5.28125	53.91555
Intraction A X B	8	0.40	0.050347	0.513988
Error	51	5.00	0.097954	
Total	71	49.74		

ANOVA for Foliage Characters

Leaf blade length

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.61	0.204531	0.692322
Factor A	1	0.03	0.027222	0.092145
Factor B	8	84.96	10.61972	35.94702
Intraction A X B	8	1.00	0.1249	0.422777
Error	51	15.07	0.295427	
Total	71	101.66		

Leaf blade width

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.04	0.014684	0.300304
Factor A	1	0.16	0.163878	3.351503
Factor B	8	6.66	0.832566	17.02697
Intraction A X B	8	0.31	0.038187	0.78098
Error	51	2.49	0.048897	
Total	71	9.67		

Leaf length/width ratio

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.02	0.005328	0.272244
Factor A	1	0.05	0.049828	2.546268
Factor B	8	2.80	0.350053	17.88812
Intraction A X B	8	0.10	0.011893	0.607758
Error	51	1.00	0.019569	
Total	71	3.96		

Spacing of secondary veins

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.40	0.133367	0.786351
Factor A	1	0.10	0.098272	0.579429
Factor B	8	48.15	6.018862	35.48817
Intraction A X B	8	0.76	0.094628	0.557944
Error	51	8.65	0.169602	
Total	71	58.06		

Leaf area

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	5.39	1.797663	0.17773
Factor A	1	37.49	37.49058	3.706585
Factor B	8	4461.20	557.6501	55.13324
Intraction A X B	8	131.72	16.46507	1.627854
Error	51	515.84	10.11459	
Total	71	5151.65		

ANOVA for Fruit Characters

Period from initiation of flowering to first harvesting

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	175.71	58.56944	54.76623
Factor A	1	642.01	642.0139	600.3247
Factor B	8	1053.19	131.6493	123.1006
Intraction A X B	8	45.86	5.732639	5.36039
Error	51	54.54	1.069444	
Total	71	1971.32		

Fruit length

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	41.84	13.94606	0.852384
Factor A	1	138.00	138.0014	8.434653
Factor B	8	3635.84	454.4803	27.77786
Intraction A X B	8	10.59	1.323938	0.080919
Error	51	834.42	16.36124	
Total	71	4660.70		

Fruit width

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	64.62	21.54121	1.898521
Factor A	1	99.62	99.61661	8.779648
Factor B	8	1350.06	168.7576	14.87334
Intraction A X B	8	4.48	0.559869	0.049344
Error	51	578.66	11.34631	
Total	71	2097.44		

Fruit length/width ratio

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.01	0.001911	0.811376
Factor A	1	0.00	0.002342	0.994331
Factor B	8	0.66	0.082514	35.032
Intraction A X B	8	0.00	0.000513	0.217952
Error	51	0.12	0.002355	
Total	71	0.79		

Weight

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	2416.35	805.4494	1.857125
Factor A	1	113.25	113.2513	0.261123
Factor B	8	54475.67	6809.458	15.70057
Intraction A X B	8	11.54	1.4425	0.003326
Error	51	22119.09	433.7077	
Total	71	79135.90		

Stalk length

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	25.15	8.382257	1.496777
Factor A	1	109.74	109.7359	19.59498
Factor B	8	1651.44	206.4298	36.8611
Intraction A X B	8	49.83	6.229072	1.112293
Error	51	285.61	5.600205	
Total	71	2121.76		

Size of sepals

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	3.95	1.315345	0.895769
Factor A	1	28.13	28.13469	19.16012
Factor B	8	130.96	16.37058	11.1486
Intraction A X B	8	18.36	2.295116	1.563007
Error	51	74.89	1.468398	
Total	71	256.29		

Diameter of calyx cavity

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	9.48	3.158666	1.114484
Factor A	1	59.24	59.24161	20.90244
Factor B	8	243.94	30.49252	10.75879
Intraction A X B	8	1.40	0.174545	0.061585
Error	51	144.54	2.834196	
Total	71	458.60		

Thickness of outer flesh in relation to core diameter

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	1.44	0.478943	0.506591
Factor A	1	44.02	44.02347	46.56489
Factor B	8	290.56	36.32014	38.41686
Intraction A X B	8	3.35	0.419063	0.443255
Error	51	48.22	0.945422	
Total	71	387.59		

Core diameter

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	90.77	30.25649	2.769465
Factor A	1	123.98	123.9788	11.34814
Factor B	8	880.78	110.0969	10.07749
Intraction A X B	8	8.26	1.032481	0.094506
Error	51	557.18	10.92503	
Total	71	1660.96		

ANOVA for Yield Characters

Fruit yield

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	4.25	1.417301	2.858907
Factor A	1	42.52	42.51957	85.76826
Factor B	8	191.82	23.97768	48.36653
Intraction A X B	8	2.43	0.303731	0.61267
Error	51	25.28	0.495749	
Total	71	266.31		

Yield efficiency

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	31.76	10.58816	2.582515
Factor A	1	32.04	32.04081	7.814944
Factor B	8	75.19	9.39903	2.292479
Intraction A X B	8	7.51	0.938842	0.228989
Error	51	209.10	4.099941	
Total	71	355.61		

ANOVA for Biochemical Characters

Total soluble solids

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.06	0.018759	0.696295
Factor A	1	1.56	1.560556	57.92356
Factor B	8	8.96	1.120063	41.57366
Intraction A X B	8	0.02	0.002743	0.101815
Error	51	1.37	0.026942	
Total	71	11.97		

Acidity

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.00	0.001038	1.578074
Factor A	1	0.00	0.002113	3.210322
Factor B	8	0.12	0.01549	23.53972
Intraction A X B	8	0.00	7.81E-05	0.118725
Error	51	0.03	0.000658	
Total	71	0.16		

Reducing sugars

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.05	0.016154	2.295207
Factor A	1	0.02	0.015022	2.134439
Factor B	8	2.47	0.309153	43.92622
Intraction A X B	8	0.02	0.00216	0.306865
Error	51	0.36	0.007038	
Total	71	2.91		

Total sugars

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.35	0.117227	6.476718
Factor A	1	0.69	0.69051	38.15035
Factor B	8	3.96	0.494555	27.32393
Intraction A X B	8	0.01	0.001227	0.067798
Error	51	0.92	0.0181	
Total	71	5.93		

Non-reducing sugars

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.27	0.090266	3.263705
Factor A	1	0.45	0.452908	16.3755
Factor B	8	3.96	0.495217	17.90528
Intraction A X B	8	0.03	0.003423	0.123775
Error	51	1.41	0.027658	
Total	71	6.12		

ANOVA for Seed Characters

Seed size

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	0.35	0.118204	1.268378
Factor A	1	1.89	1.894756	20.33149
Factor B	8	4.15	0.518502	5.56374
Intraction A X B	8	0.25	0.031038	0.333046
Error	51	4.75	0.093193	
Total	71	11.40		

Seed weight

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	1.22	0.406172	9.199978
Factor A	1	0.93	0.931613	21.10145
Factor B	8	500.38	62.54742	1416.728
Intraction A X B	8	0.08	0.010491	0.237618
Error	51	2.25	0.044149	
Total	71	504.86		

Number of seeds per fruit

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Replication	3	127.00	42.33333	1.345591
Factor A	1	6536.06	6536.056	207.7525
Factor B	8	311774.44	38971.81	1238.742
Intraction A X B	8	808.44	101.0556	3.212112
Error	51	1604.50	31.46078	
Total	71	320850.44		

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Title of Thesis	:	**"Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids"**
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Admission Number	:	H-2016-46-M
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ABSTRACT

The present investigation entitled "Characterizing some guava (*Psidium guajava* L.) cultivars and hybrids" was carried out on eight years old stool layered nine guava cultivars and hybrids namely Punjab Hybrid-1, Punjab Hybrid-2, CISH-G-1, Lalit, Allahabad Safeda, CISH-G-4, Lucknow-49, Hisar Safeda and Hisar Surkha during the year 2016-17 and 2017-18 in RHR&TS, Dhaulakuan, Sirmour (H.P.), India. The experiment was laid out in a Randomized Block Design. These cultivars and hybrids were evaluated for their growth, foliage, floral, fruit, yield, biochemical and seed characters. The attitude of branches was observed to vary from erect to spreading to drooping. The anthocyanin colouration of young leaf was absent in Punjab Hybrid-2, Lucknow-49 and Hisar Safeda and present in rest of the cultivars and hybrids. Variation in leaf shape i.e. obtrullate, oblong and ovate; leaf apex shape i.e. apiculate and obtuse; leaf base shape i.e. rounded, obtuse and cordate were also observed. The flower initiation was found to be earliest in Lalit and Allahabad Safeda during both the years, whereas, CISH-G-1 and Hisar Safeda were the last. Fruit size and weight were observed maximum in Lalit which recorded highest fruit yield per tree but lowest yield efficiency. The fruit shape was observed to be ovate with pointed shape at stalk end in Punjab Hybrid-1, CISH-G-4 and Lucknow-49, whereas in others were round in shape. The smooth fruit surface was observed in Punjab Hybrid-1, Allahabad Safeda and Hisar Surkha with longitudinal ridges in Lucknow-49, CISH-G-4 and Allahabad Safeda; longitudinal grooves in CISH-G-1, Lalit and Allahabad Safeda; conspicuous ridged collar around calyx cavity in Hisar Safeda. Flesh colour varied from yellow-white to greyed-yellow to orange-white to greyed-red. Maximum TSS, total sugars and reducing sugars were recorded in Hisar Safeda with minimum acidity. Lucknow-49 was observed to have minimum number of seeds. Fruits were found to be soft seeded in Hisar Surkha, CISH-G-1, Lalit and Allahabada Safeda were medium seeded and rest were hard seeded. From the present study it can be concluded that the development of descriptors will facilitate true identification and DUS testing of guava genotypes.

Signature of Major Advisor
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