Chapter 2
Review of Literature
Chapter-II

Review of Literature

The eastern plateau and hill region offers suitable climate and edaphic condition for successful cultivation of guava. An effort on characterization of guava genotypes would help in designing crop improvement strategies for achieving desirable plant ediotype having superior qualitative and quantitative attributes. The growth and flowering characters of guava crop, which influence yield, vary with different seasons. In this context morpho-phenological study of guava and yield were important. Hence the work was undertaken to characterize and classify guava genotypes and identify morpho-phenological factors contributing towards yield and quality. In this chapter, the studies done elsewhere by previous workers have been reviewed and authors are fully acknowledged.

2.1 Plant growth:

Bearing behaviour of guava plants is dependant on different vegetative flushes (Salazar et al., 2006). Unlike in mango, flowering in guava takes place on new growth flush. The component of growth habit of guava plants of different genotypes have been studied time to time (Roy and Ahmad, 1951; Kramer and Kozlowaski, 1960; Rathore, 1978 and Subramaniam and Dinesh, 1993). Dubey et al., (2000) observed that there was marked difference in height of plants of different germplasm. The seven years old plants of genotype Allahabad Safeda exhibited the maximum height (2.99 m), the maximum canopy spread (2.79 m) and girth of the main trunk (33.97 cm) under Sabour, Bihar conditions. Athani et al., (2007) reported that there were significant differences in growth attributes among the different genotypes of guava under Karnataka conditions. They also found that the genotype Chittadhar significantly recorded the maximum plant height while plant girth was highest in genotype Seedless. Reddy et al., (1999) reported that under Chhotanagpur plateau (India) conditions, the genotype Allahabad Safeda had the maximum stem girth whereas Red Fleshe had the highest plant height. But plant vigour was heighest in cv. Sardar.

In litchi, the growth behaviour of a genotype may vary in a climate other than it originated. Rai et al., (2001) also reported that genetic variation in 13 litchi genotypes were found under Ranchi condition for various traits including tree spread and volume. Various studies indicated significant differences in height of the litchi genotypes (Miao et al., 1998; Rai et al., 2001).
2.2 Leaf area:
In general leaves are important for photosynthesis, respiration, transpiration and biophysical reaction of the plant. The shape and size of leaf play an important role in the growth of plants. Leaves having less width with more length are important features to control the process of transpiration in case the field having water scarcity (Singh, 2007). The procedure for estimating individual leaf area of mango was reported by Soule and Malcom (1970) in Haden and Turpentine genotypes of mango and commercial varieties of Northern India (Rao et al., 1978). The procedure of estimating total leaf area in apple trees, which was deciduous in nature, was detailed by Holland (1968). The total leaf area can be estimated by multiplying the estimate of the total numbers of leaves with the mean leaf area (Rao et al., 1978). It had been accepted by the earlier workers that the leaf area was a linear function of leaf characters in different fruit crops (Fulger, 1965; Holland, 1968; Kumaran et al., 1964; Soule and Malcom, 1970 and Rao et al., 1978). In litchi leaf size and shape are genetic characters and are of importance in genotype identification (Singh et al., 1999b). Serdar and Demirsoy (2006) carried out multiple regression analysis for the chestnut genotypes for leaf area estimation. The proposed leaf area (LA) estimation model was LA = 3.36 + 0.11L² − 0.26L²/W² + 1.1W², R² = 0.988, where LA is the leaf area, W is the leaf width and L is the leaf length. Singh (2007) reported that leaf area was linear function of leaf characters and four regression equations were developed for guava genotypes viz., Allahabad Safeda, Sardar and Lalit.

2.3 Leaf Characters:
Singh et al., (1976) reported that genotype Surkhaguddi had oblong shaped leaves, thin, apex obtuse, base round margin entire and upper colour of the leaves was deep green while lower was light green and petiole was short (0.7 cm). Mitra and Bose (1996) reported that leaves of Allahabad Safeda were medium elliptical to oblong in shape whereas genotype Sardar had large elliptical to oblong leaves. They also observed that the leaves of Banarasi was oblong in shape with acute apex and base obtuse while lanceolate leaves was found in genotype Harijha with apex acute and base round. Sharma et al., (2010) reported that genotypes Allahabad Safeda and Smooth Green showed green shade of foliage and genotypes Nasik and Apple Colour showed pale green shade, whereas Spear Acid and Lucknow-49 exhibited dark green foliage.
2.4 Phenology:

As most of the tree species, guava tree (*Psidium guajava* L.) shows different stages throughout its vegetative period in response to environmental conditions (Salazar *et al*., 2006). The growth of vegetative and reproductive organs and the phenological behaviour of guava trees were studied to assess their adaptability to different location where climate is hot and dry (Damian-Nava *et al*., 2004). In their study they observed that temperature fluctuated between 23°C to 30 °C with 1050 mm rain accumulated from June to September and irrigation was applied from 30th November up to the next rainy season were ideal conditions for guava crop. In a different experiment, Marin *et al*., (2000) found that all the genotype exhibited vegetative flushes of 65-100% and reproductive branches of 0-35% except on genotype ‘Mohtalban’. They also reported that the flower bud to fruit period lasted 15 days for all genotypes. Flower buds, flowers and fruits were observed 15 to 45 days, 15 to 30 days and entire period, respectively. Normand and Habib (2001) reported that in strawberry guava the intervals between shoot emergence and flowering and fruit maturity were strongly related to temperature, with base temperatures 5.5 and 2.6 degrees and heat unit requirements of 675 and 2552 degree days respectively. Singh (2003b) found that the highest average number of flowers per tree (7 years old) was 593.00 and obtained during 1997/98 wet season, while the highest terminal shoot growth was 14.87cm and yield was 92.00 kg/tree during 1998/99 wet season. Menzel and Paxton (1986) reported that fruit took 14 weeks to reach maturity and last fruit was harvested in mid June under varieties grown in subtropical coastal southern Queensland, Australia. In another experiment, Singh *et al*., (1999a) reported that fruit bud differentiation (FBD) pattern varied in guava genotype ‘Sardar’, ‘Allahabad Safeda’ and ‘Thailand’ in experiment at Lucknow, India. In their study shoot morphology indicated that FBD took place in the growing vegetative buds throughout the shoot growing season. Shoot emergence in October, November, December, February and March produced the rainy season crop while August and September shoot produced the spring season crop. Fruit growth showed a trimodal or double sigmoid growth pattern (Mercado-Silva *et al*., 1998 and Padilla-Ramirez *et al*., 2002). Spring summer fruits required 130 days from flowering to harvest, while autumn-winter (October-December) fruits required 190 days to reach the right stage. The highest sprout elongation rates occurred in September (0.32 cm per day) and from December to February, with 0.28 cm per day and each sprout grow 1.2 cm on average during one year. Damian-Nava *et al*., (2004) reported that in one year a tree yielded 9 kg leaf biomass which corresponded to a 60 m² of leaf area. In the same period, the stem accumulated 52% of the total biomass, 39 % of leaves and 9% of reproductive organs from
which 8% corresponded to fruit of all sizes. In another study in mango, Chacko (1991) reported that the growth in mango occurs in terminal flushes after a period of quiescence. Quiescence is essential to ensure flowering and fruiting (Popenoe, 1939; Chacko, 1985). Physiological maturity appeared directly related to flower bud differentiation. Most of the vegetative growth was produced from non-flowering shoots (Sen and Malik, 1946 and Singh 1978).

2.5 Flowering and Fruit set:

Flowering is a very complex physiological phenomenon of plants. The guava bears flower, solitary or cymes of two to six flowers on the current season’s growth in the axil of the leaves.

In northern India, three distinct flowering seasons i.e. summer, rainy and autumn with corresponding harvesting periods in rainy, winter and spring have been observed by Rathore(1972) and Singh (2000). Ojha et al.,(1985) observed that the flowering behaviour of genotypes Allahabad Safeda and Sardar was same during all the seasons of flowering. The flowers were borne on newly emerged shoots in the axil of leaves singly or in cymes of two or three on the lateral as well as terminal shoots. The bearing shoots were normally 1-2 months old before they produced flower (Sehgal and Singh, 1965 and Shigeura et al., 1975). Duration of flowering was more during rainy season (39 days) than spring season (31-32 days) (Ojha et al., 1985). Teotia et al., (1970) also found that variation in duration of flowering but number of days of flowering differed due to climatic variations. Under Sabour, Bihar (India) conditions Singh (2000) observed that the highest percentage of fruit set was recorded from summer crop (69 and 71 %) followed by autumn flowering (61 and 63 %) and rainy season flowering (58 and 53 %) in both the years. Singh (2003b) observed that the highest percentage of fruit set was recorded from summer crop (66 to 68%) followed by winter crop (58.10 to 60.13 %) and rainy season crop (50 to 54.3 %) in Safed Jam genotype under Sabour condition. Kundu and Mitra (1994) observed that duration of flowering was little longer in autumn (31-43 days) than in summer (27-38 days). The different genotypes showed 42.4 to 80.8 per cent fruit set in summer for rainy season crop and 39.2 to 74.4 per cent in winter season crop. The period for maturity was longer in winter. The genotype Apple Colour and Harijha performed well in winter under laterite tract of West Bengal. Under Tripura condition for rainy season crop flowering started in the last week of March and fruit set in April (Singh, 2003 a). The highest percentage of fruit set was recorded in autumn flowering (winter crop) followed by rainy and summer season flowering (Rathore
and Singh, 1974). Kundu (2007) reported that high density planting delayed emergence of flowering, shortened flowering period and reduced fruit set.

2.6 Correlation and Regression studies:

From phenology of wild strand of strawberry guava, Normand and Habib (2001) correlated that flowering (Y) was related to shoot production per branch (X), log (y)\(=1+1.33\log (x)\), \(r^2=0.78\), whereas fruit set rate was highly variable between trees (26 to 100%). In another study, Padilla-Ramirez et al., (2002) reported that a negative relationship was found between total soluble solids content and fruit size. Thaipong and Boonprakob (2006) observed that most of the physical traits (fruit weight, flesh thickness, flesh weight and seed cavity weight) had weak negative correlations (-0.25<=r<=0.38) with chemical traits (T.S.S., titratable acidity and ascorbic acid). There were strong positive correlations between fruit weight and flesh thickness \(r=0.81\), flesh weight \(r=0.99\) and seed cavity weight\(r=0.88\). Therefore, fruit weight could be used in indirect selection for flesh thickness, flesh weight and seed cavity weight. Padilla-Ramirez et al., (2007) carried out simple regression analysis between fruit number vs fruit yield and fruit number vs fruit weight. Regression analysis showed a strong positive relationship \(r= 0.91^{**}\) between fruit number vs fruit yield. In contrast, the relationship between fruit number vs average fruit weight \(r=-0.56^{**}\) showed a tendency to decrease fruit weight as fruit number increased. Raghava and Tiwari (2008) reported that the fruit yield/tree was positively and significantly correlated with fruit weight and fruit length. Pandey et al., (2002) reported that the correlation among fruit weight, fruit diameter, fruit length, fruit width, pulp thickness and pulp percentage were positively and significantly correlated. Regression analysis showed that fruit length, pulp thickness and pulp percentage were important factors for predicting fruit weight and seed percentage. Rajan et al., (2008) found that at genotypic and phenotypic levels, number of seed per fruit was significantly and positively associated with seed weight per fruit (SWPF), number of seeds 100 g\(^{-1}\) pulp (NSPHP) and fruit weight (FW). Correlation and path coefficient analysis revealed that SWPF, NSPHP and 100-seed weight (100SW) were deciding factors for realizing improvement for number of seed per fruit (NSPF).

In another study in cashew nut, Rao et al., (2002) reported that nut yield had a highly positive correlation with stem girth (+0.686), mean canopy spread (+0.667), leaf area (+0.831), number of flowering laterals/m\(^2\) (+0.782), number of bisexual flowers per panicle (+0.759), fruit set percentage (+0.906), number of nuts per panicle (+0.666), and panicle length (+0.622). The mean canopy spread showed a highly significant positive correlation with yield (+0.667), leaf area (+0.811), number of bisexual flowers (+0.870), panicle length
(+0.672) and fruit set percentage (+0.819). Genetic variance and correlation coefficient for yield components and fruit quality and growth characters were measured in a study of 40 varieties of mango by Prasad (1987). A high genotypic coefficient of variation was found for fruit weight, fruit volume and contents of ascorbic acid and reducing sugars with respect to yield (Prasad, 1987). In apricot, Kecskemeti and M Nyuito (1986) found a very close correlation between leaf N and K with yield and direct correlation was also observed between N and trunk girth. George et al., (1986) in their study with custard apple genotype African Pride and Pink’s Mammoth, found positive linear relations between tree yield and tree girth, cross-sectional areas, canopy volumes and numbers of laterals, while fruit weight was negatively related to fruit number per tree (r = -0.69). In their study on yield prediction in Coorg mandarin, Shamasundran et al., (1983) found significant correlations between morphological characters and total yield, the index of crown weight and the number of branches had a significant correlation with the total number of fruits. They also suggested that by using girth measurements and the yield of some branches a satisfactory yield prediction could be made.

In strawberry, Lacy (1973) reported that vegetative characters associated with yield were found to fall into two main categories: those associated with fruit number (e.g. the number of leaves during the preceding autumn and winter); and those associated with fruit size (e.g. plant size during the preceding seasons). He also reported that late flowering was found to be correlated with heavier yields. In litchi, fruits of 9 genotypes were measured for a number of physical characters and simple correlation coefficients were computed in all possible combinations for all the characters. A large amount of variation among genotypes was attributed to a high level of genetic variability as well as environmental influences. Regression analysis indicated that fruit weight and volume and pulp weight can be predicted from either fruit breadth or thickness (Bandyopadhyay et al., 1990). In banana, Swennen and Langhe (1985) reported a significant regression between different yield parameters. It appeared that taller pseudostems produce leaves at a faster rate, flower earlier and produce higher infructescences which need more time to mature. Correlation and regression analysis were also performed by Flavio et al., (2006) in apple in order to determine the relationships among fruit quality parameters. In genotypes, fruit size and fruit weight were lower with heavy cropping trees than with standard cropping trees. Hence fruit size and fruit weight had negative correlation with number of fruits/tree. While studying of root stock and scion growth in apple, Devyatov and Statskevich (1977) reported that irrespective of the rootstock the
most significant correlation was between total yield and trunk girth or trunk cross sectional area. They also observed a similar correlation between yield and the total cross sectional area of the primary branches. Positive correlations were observed between all the growth indices, especially trunk girth, and yield in different apple genotypes (Devyatov and Statskevich (1971). Silva et al., (1980) reported that in one young orchard of apple (Golden Delicious), yield became increasingly a function of trunk girth during first 3 cropping years.

2.7 Fruit quality attributes:

TSS, acidity, reducing sugars, total sugars and ascorbic acid are important constituent of fruit quality. Singh et al., (1995) reported that they observed three crops of guava under Lucknow condition. Wide variation in these fruit constituents were observed during rainy, winter and spring seasons. Development of the chemical of fruits of winter crop was better than those other two seasons. Kundu et al., (1995) reported that Allahabad Safeda, Harijha, Apple Colour, Kerala, Baruipur, Sardar, Chittidar and Kerala showed better fruit quality in winter. Fruits of Allahabad Safeda, Sardar and Behat Coconut contained higher T.S.S. and total sugar considering the average fruit weight, yield as well as fruit quality. The genotypes Allahabad Safeda, Sardar, Baruipur and Chittidar were suggested for cultivation in the laterite tract of West Bengal. Chemical composition of fruits showed remarkable variation in TSS, acidity and ascorbic acid which may be due to environmental factors and cultural practices adopted (Subramanyam and Iyer, 1993). Regarding fruit quality attributes, Singh (2003b) reported that the highest fruit width (6.2 cm), acidity (3.93%) and content of total sugar (18.15%) and ascorbic acid (280.19mg/100g fruit pulp) were obtained during 1997/1998 winter season. Tandon et al.,(1983) found that genotype Gunees gave the largest fruit (220.9 g), genotype White Fleshed had the highest titratable acidity (0.45%) and genotypes Lucknow-49 and Behat Coconut had the highest contents of soluble sugars and ascorbic acid, respectively. The highest fruit weight (180.00 g /fruit) and total soluble solid contents (20.27%) were obtained during the 1998/99 winter season. Jana et al., (2009) reported that the genotype Allahabad Safeda accounted for the maximum fruit weight of 242.1 g during winter season under Ranchi (Jharkhand) condition. Babu et al., (2007a) reported that the fruit weight was highest in Selection-11(144.20 g ) outscoring Sardar guava (140.50 g ). TSS content in guava genotypes varied from 9.59°B in Chittidar to 12.27°B in Seedless evaluate under Meghalayan condition (Chandra and Gupta, 1991). The highest TSS content of 11.5°B and ascorbic acid content of 258.5 mg/100 g pulp were recorded in genotype Hybrid-7 and Hybrid-3, respectively under ICAR Reseach Complex for North
Eastern Hilly Region during October (Babu and Yadav, 2002). Under Arabhati, Karnataka condition the highest TSS of 11.6 °B was recorded in genotype Chittidhar (Athani et al., 2007). Gohil et al., (2006) reported that the genotype Apple Colour contained the maximum T.S.S (16.9°B) followed by genotype Pear Shaped. They also found that genotype Behat Coconut accounted for the maximum total sugar content of 15.67 per cent and acid content was minimum (1.08 per cent) in genotype Chittidar. Singh and Jain (2007) reported that the genotype Allahabad Safeda grown in Chhattisgarh (India) showed the maximum T.S.S. and ascorbic acid content of 14.93 °B and 270.8 mg/100g pulp at 150 days of maturity of fruits, respectively. Under Rewa (M.P.) condition, Patel et al., (2005) reported that Allahabad Safeda fruits had the highest T.S.S., total sugar (11.80 %) and ascorbic acid (250.80 mg/100g of pulp) contents, as well as the lowest level of acidity (0.25%). Patel et al., (2007) observed that the genotype Hybrid-1 was excellent in quality with high sweetness, less seed content and soft flesh texture as compared to other genotypes/hybrids under mid hill of Meghalaya, India. Under same situation and in rainy season Babu et al., (2007b) found that the vitamin-C content was highest in Hybrid-3 (258.5mg/100g pulp) followed by Hybrid-1(240.00 mg/100g pulp). Under sub-arid zone of Maharashtra, (India) the guava genotypes like Apple Colour, Nagpur Seedless and Allahabad Safeda were soft seeded (Gohil et al., 2006). Chundawat et al., (1976) reported that higher reducing sugar was found in genotype Lucknow-49 as compare to other genotypes. Aulakh (2004) reported that fruit quality characteristics were higher during winter season as compared to the rainy season. The maximum fruit weight, fruit size, total soluble solid content, ascorbic acid content and total sugar content were recorded in Lucknow-49 followed by Behat Coconut, while the minimum values for these characters were obtained from Pear Shaped. The highest fruit weight (180.00 g) and total soluble solid content (20.27 per cent) was found during winter season under Sabour, Bihar climatic condition (Singh, 2003b). The genotype Allahabad Safeda and Safed Jam exhibited superior fruit quality characteristics (Singh et al., 2002). In another study in litchi, Menzel and Simpson (1990) reported that a large numbers of genotypes were grown around the world. The shape of skin segments and protuberances were the reliable and stable genetic characteristics, white fruit size, shape and taste were some other variables. In guava Sharma et al., (2010) reported that fruit of cv. Spear Acid was pear shaped with rough surface whereas fruit of Apple Colour was oblate with smooth surface. Similarity in the fruit characters of ‘Hisar Safeda’ with ‘Allahabad Safeda’ may be due to ‘Allahabad Safeda’ is one of the parents of ‘Hisar Safeda’. The similar variations in the fruit characters were also observed by Singh (1988) and Dinesh and Reddy (2001).
2.8 Estimation of genetic divergence:

To provide orientation and get efficiency of guava breeding programmes study of genetic divergence in this crop has immense importance. The genetic divergence is a basis for parent selection in hybridization programmes. The genetic divergence in seed characteristics of guava was studied by Rajan et al., (2007) through Mahalanobis $D^2$ statistics and Ward’s minimum variance methods. Sixty eight guava accessions were grouped into five distinct clusters. The cluster-V had the minimum number of seeds fruit$^{-1}$, seed weight fruit$^{-1}$, 100-seed weight, number of seeds 100 g$^{-1}$ fruit and seed content, and cluster I had high number of seeds fruit and seed weight fruit$^{-1}$. Mean number of seeds 100 g$^{-1}$ fruit and seed content was highest in cluster-III whereas, cluster- IV had the maximum value of 100-seed weight.

Sixty-nine Psidium accessions collected in six Brazilian states were analyzed by two non-hierarchical clustering methods (Santos et al., 2011). They studied genetic divergence of genus Psidium based on biochemical and agronomic variables. The variables were ascorbic acid, lycopene, total phenol, total flavonoids, anti-oxidant activity, acidity, T.S.S., diameter of fruit, fruit pulp and seed weight, and plant fruit number and weight. There was no specific grouping in terms of States of origin, indicating the absence of barriers in the guava propagation accessions. The analyses suggested that the collection of a greater number of guava germplasm samples from smaller number of regions and divergent accessions with high nutritional compound levels to develop new cultivars.

Lima et al., (1999) analyzed the different fruit characters like internal and external colour, weight, longitudinal and transversal diameters, shape, peel roughness, flavour, yield, pericarp-thickness, content of T.S.S., acidity and vitamin C. The results were statistically evaluated by means of cluster analysis and four similarity groups were formed. Genotypes ‘8502-1’, ‘8502-18’ and ‘8502-38’ resembled to cv. ‘Paluma’ with respect to high yield, thickness of pericarp and pink colouration in the fruit pulp.

Shyamalamma et al., (2008) reported that they grouped all fifty jack fruit accessions into three clusters based on amplified fragment length polymorphism markers. Cluster-I included the genotypes grown in dry region of Karnataka, Cluster-II contained the genotypes collected from location having medium to heavy rain fall; Cluster-III grouped the genotypes in distant locations with different environment. Saran et al., (2006) grouped thirty five ber genotypes into seven Clusters based on ten morphological traits by using Mahalanobis $D^2$ statistic and Tocher method. In their study Cluster-VI and VII were the most divergent with an inter cluster distant 5.162. They suggested that hybridization could be made especially for
powdery mildew resistance and small stone size. Rai et al., (2002) grouped seventeen bael germplasm in to three clusters by using Mahalanobis D² statistics. They found that ascorbic acid content, fruit weight, fruit length, number and weight of seed per fruit, fibre content and petiole length contributed maximum in genetic divergence.

Cluster analysis was done also in blue berry germplasm using Ward’s minimum variance by Panda et al., (2009). Principal component bands of multispectralor quick bird image were classified in to different clusters using an unsupervised ISO DATA classification technique and wards minimum variance method (Panda et al., 2009). Meghala et al., (2005) worked with twenty sapota germplasm from different parts of India. Cluster analysis based on Ward’s minimum variance algorithm showed two major groups. Both cluster analysis and principal component analysis of the RAPD data indicated wide genetic diversity among genotypes. Ravishankar et al., (2004) studied with ten mango germplasm of polyembryonic and monoembryonic origin and clustered them into two distinct groups through RAPD markers.

Rajan et al., (2009) grouped 42 important mango genotypes into three clusters using D² statistics and Tocher Method. Genotypes with higher mean value for weight of fruit and peel, fruit length, width and thickness of fruit and stone, fruit length and width ratio and pulp : stone ratio were grouped in Cluster-III and high pulp weight and per cent acidity, TSS, weight, length and width of the stone were grouped in Cluster-II. Highest inter cluster distance was between Cluster-I and II. The highest intra-cluster distance was observed in Cluster-I.

Based on morphological characters, Sharma, et al., (2010) grouped twenty two guava genotypes into two clusters. Cluster I comprised of ‘Spear Acid’ which merged with ‘Super Max Ruby’ at a similarity coefficient of 0.25 and these two further joined with ‘Chakaiya Rehmannagar’ and ‘Gutaniwala’ at a similarity coefficient value of 0.37. Cluster II consisted of the remaining 18 genotypes. In another study, eleven litchi genotypes were grouped in four clusters on the basis of the Tocher's method. Cluster I was the largest with five genotypes and all other clusters had two genotypes each. The inter cluster D² values varied from 213.9 (between Clusters II and III) to 1373.4 (between Clusters I and IV); the intra cluster D² values varied from 79.7 (Cluster I) to 138.8 (Cluster IV). Crossing between genotypes belonging to Cluster I with those of Cluster IV is expected to give maximum extent of heterosis (Dwivedi and Mitra, 1996).
2.9 Yield:

Mitra *et al.*, (1983) reported that the number of fruits in rainy season was more than that of winter season. In case of eight years plant, the highest productivity was recorded by Allahabad Safeda (20.40 kg/tree) followed by Sardar (19.25 kg/tree) under ICAR Research Complex for North Eastern Hill Region (Babu *et al.*, 2007a). But in a different study, Patel *et al.*, (2007) observed that in Lucknow 49, five years old guava plants produced 18.50 kg fruits/tree. In another study, Singh *et al.*, (2002) reported that the genotype Allahabad Safeda and Safed Jam exhibited superior yield under Sабour, Bihar (India) conditions. Reddy *et al.*, (1999) reported that under Chhotanagpur plateau (India) conditions the genotype Allahabad Safeda and Sardar were best yielders whereas Red Fleshe the least. Kumar (1998) observed that among six genotypes of guava evaluated under Ranchi condition, the yield was maximum in cv. Allahabad Safeda and cv. Lucknow-49. Singh (2000) reported that under Bhagalpur, Bihar condition genotype Allahabad Safeda produced three crops in a year and the highest yield per plant was obtained in rainy season followed by winter and spring season. But under Tripura codition, Lucknow-49 was the highest yielder (Singh 2003a).

2.10 External feature of the fruit:

Rodriquez *et al.*, (1971) observed difference in the shape of the fruit among different guava genotypes. Most of them were having roundish appearance. Yellowish ground colour with straw yellow skin at maturity was usual feature. However, blush colour seemed to be a genuine marker imparting significant change in skin colour to genotype. Kumar *et al.*, (2006) reported that red skin of Apple Colour and red dots on Chittidar were valuable identifying characters. The presence of red dots on fruits of Chittidar and Safeda was reported by Sehgal and Singh (1965). Mitra and Bose (1996) referred that the genotypes Chittidar and Behat Coconut had small dots present on the fruit surface whereas Pear Shaped had large dots on the fruit surface. Sharma *et al.*, (2010) reported that the genotype ‘Chakaiya Rehmnnagar’ had an ovate fruit shape while ‘Patillo’, ‘Gutaniwala’, ‘Tehsildar’ and ‘Chinese Guava’ had obovate fruits. Oblate fruits were a character of ‘Super Max Ruby’ and ‘Apple Colour’, whereas oval fruits were found in ‘Hafsi’ and ‘Dharwar’. ‘Spear Acid’ had pear shaped fruits, whereas in the remaining 10 genotypes, a round fruits. A rough surface of fruits was noted in ‘Chakaiya Rehnmannagar’, ‘Super Max Ruby’, ‘Spear Acid’, ‘Gutaniwala’ and ‘Chinese Guava’, whereas rough fruit surface along the ridges was a character of ‘SP 6550’, ‘Barafkhana’, ‘White Flesh Sour’, ‘Dharwar’, ‘Tehsildar’, ‘Lucknow-49’ and ‘Banarsi
Surkha’. ‘Patillo’ and ‘Supreme’ had a smooth and ridged fruit surface, while the rest of the genotypes had a smooth surface. Fruits of Sardar was elliptic ovate to oblong and Pear Shaped genotypes was pyriform whereas round fruited genotypes were Allahabad Safeda, Banarasi, Harijha, Apple Colour and Behat Coconut (Mitra and Bose, 1996). Singh et al., (1976) reported that fruits were medium in case of genotype Surkhaguddi and fruit had rounded apex, rounded base, medium basal cavity, and sub-epidermal layer greenish, soft textured thick light red pulp. They also reported that the seeds of genotype Surkhaguddi was large, 135 seeds/fruit and test weight of seed was 1.65 g. Kundu et al., (1995) reported that the fruits of Allahabad Safeda, Harijha and Apple Colour were round shaped, pyriform in Kerala and elliptical in Baruipur. The genotype Allahabad Safeda had soft textured seed while Lucknow -49 seed was medium hardy (Babu et al., 2002). In another study Dubey et al., (2009) reported that among high yielding genotypes the highest number of seed (398.0) was found in genotype Safed Jam and genotype Allahabad Safeda had least number of seeds (302.1).