The reviews relating to different major and minor citrus species and their characters are presented as follows.

According to Cooper and Chapot (1977) the principal species of citrus are as follows:

<table>
<thead>
<tr>
<th>Common name of species</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citron</td>
<td><em>Citrus medica</em> L.</td>
</tr>
<tr>
<td>Sour orange</td>
<td><em>C. aurantium</em> L.</td>
</tr>
<tr>
<td>Sweet Orange</td>
<td><em>C. sinensis</em> Osbeck</td>
</tr>
<tr>
<td>Pummelo</td>
<td><em>C. grandis</em> Osbeck</td>
</tr>
<tr>
<td>Lemon</td>
<td><em>C. limon</em> (L) Burm. f.</td>
</tr>
<tr>
<td>Mandarin</td>
<td><em>C. reticulate</em> Blanco</td>
</tr>
<tr>
<td>Common lime</td>
<td><em>C. aurantifolia</em> Christm.</td>
</tr>
<tr>
<td>Grapefruit</td>
<td><em>C. paradise</em> Macf.</td>
</tr>
<tr>
<td>Tachibana</td>
<td><em>C. tachibana</em> Tan.</td>
</tr>
<tr>
<td>Indian wild orange</td>
<td><em>C. indica</em> Tan.</td>
</tr>
<tr>
<td>Mauritius papeda</td>
<td><em>C. hystrix</em> CD.</td>
</tr>
<tr>
<td>Melanesian Papeda</td>
<td><em>C. macrocarpa</em> Mont.</td>
</tr>
<tr>
<td>Celebes papeda</td>
<td><em>C. celebica</em> Koord.</td>
</tr>
<tr>
<td>Ichang papeda</td>
<td><em>C. ichangensis</em> Swing</td>
</tr>
<tr>
<td>Papeda</td>
<td><em>C. microntha</em> Wester.</td>
</tr>
<tr>
<td>Khasi papeda</td>
<td><em>C. latipes</em> Tan.</td>
</tr>
</tbody>
</table>

2.1 Identification of major and minor citrus species:

Linnaeus (1753) has described the genus *Citrus* as - “Trees or shrubs with sharp spines; leaves I-Foliate, alternate, coriaceous or chartaceous, punctuate with pellucid glands, aromatic, petiole often winged, articulated with leaf blade; flowers solitary or in small cymes or racemes, small to large, bisexual and staminate, sweet scented; calyx cup-shaped, 4-5 lobed; petals 4-8, usually 5, coriaceous, linear, gland dotted, imbricate, white or tinged; stamens 20-60, polyadelphous or free, flattened at the base; deciduous, ovules in two series in each cell; fruit (berry) a hasperidium with segments containing seeds near the ventral side, remaining space of carpel filled with stalked fusiform pulp
vesicles containing sweet or acid juice; rind leathery faceolated with oil glands, turning yellow or orange-red at full maturity; seeds none to many, ovoid to flattened-ovoid, embryos, sometimes two or more in each seed, either white or green”.

Since then, the genus *Citrus* has received continuous attention by many workers from all parts of the world. Consequently more work has been done on the classification and reclassification of the genus than on any other fruit crop. The earlier attempts based upon knowledge of a limited number of plants, over simplified the problem and recognized as few as three or four species and some of the later ones as many as 144, as has been done by Tanaka (1954).

Risso (1813) proposed a new class represented by *Citrus limetta*. With Poieau (Risso, 1818) he established *Citrus bergamia* (the Bargamot) and *Citrus lumina* (the Sweet lemon). In 1826, he further added aurata (Poma Adami), *C. peretta*, *C. mellarosa* and *C. sinesis* (the Chinotto). Unfortunately many of these proposed species are now inaccessible.

Roxburgh (1823) recognized five species namely, *Citrus acida* Roxb., under which he included lemons, limes, sweet limes and Rangpur lime; *C. medica* comprising sweet orange, bitter oranges and loose skinned mandarins; *C. decumana* comprising Shaddock; and *C. inermis* Roxb, comprising of Kumquat which is now placed under the genus *Fortunella*.

Hooker (1875) recognized only four species to accommodate all the citrus varieties of India. They are *C. medica* (citron, lemon, and lime), *C. aurantium* (sweet orange, sour orange, bitter orange and mandarin), *C. decumana* (pummelo) and *C. hystrix*. He eliminated Roxburgh’s *C. inermis* and added *C. hystrix* and also did not accept the specific name *C. acida* of Roxburgh, and combined it along with *C. medica*. Hooker’s mode of grouping distinct botanical units into few broad based species does not seem to be satisfactory.
Watt (1889) compiled with the works of the earlier authors on citrus classification and discussed them elaborately. He has mentioned only four species namely *C. aurantium*, *C. decumana*, *C. medica* and *C. nobills* to cover all the Indian varieties. Under *C. aurantium* he grouped ‘Gajanimma’ and ‘Kichill’ of south India which Tanaka has recognized as separate species *C. pennivesiculate* and *C. maderaspatana*, respectively. Lushington (1910) recorded taxonomical details of *Citrus* and classified nearly all the varieties of citrus which had been collected and studied by Bonovia (1890). He recognized as many as twenty-one species, of which Tanaka (1937) accepted four namely, *C. chrysocarpa* (santara), *C. crenatifolia* (Keonla or Kokni).

Tanaka is most intimately associated with the citrus flora of the East. In 1933, he accepted 15 primary elements or species, for the genera *Poncirus*, *Fortunella* and *Citrus* of which 13 species constituted the genus *Citrus*. Later in 1937 in his further ‘Revision’ of Rutaceae- Aurantioideae of India and Ceylon’, he enumerated as many as twenty-two different new species over his ‘Primary elements’. Up to 1954 he enlarged the number considerably and accepted 144 species in the genus *Citrus* alone. He created 35 species in the mandarin group alone. Many of his new species for example *C. limettioides*, *C. erythorosa*, *C. rugulosa* and *C. Indica* are now well recognized. He had classified the citrus species as follows:

**Subgenus Archicitrus**

**Complex (I) Citraeum**

<table>
<thead>
<tr>
<th>Section 1 Citraeum</th>
<th>representing <em>Citrus hystrix</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 2 Limonellus</td>
<td>representing <em>C. aurantifolia</em> Swing.</td>
</tr>
<tr>
<td>Section 3 Citrophorum</td>
<td>representing <em>C. medica</em> Linn.</td>
</tr>
</tbody>
</table>
Complex (II) Aurantimalum

Section 4 *Cephalocitrus* representing *C. gransis* Osebeck

Section 5 *Aurantium* representing *C. aurantium* Linn.

Section 3 and 5 can be further subdivided -

Section 3a *Citroides* representing *C. medica* Linn.

Section 3b *Limonoides* representing *C. limon* Burm.

Section 5a *Aurantioides* representing *C. aurantium*

Section 5b *Sinensioides* representing *C. sinensis* Osbeck

Subgenus Metacitrus -

Section 6 *Osmocitrus* representing *C. junos* Siebex Tan.

Section 7 *Acrumen* representing *C. deliciosa* Tan.

Section 8 *Pseudofortunella* representing *C. madurensis* Lour.

Two sub-sections of the section Acrumen are -

(a) *Euacrumen* comprising *C. nobills*

(b) *Microacrumen* comprising *C. techibana* Tan.

According to this classification *C. medica*, *C. aurantifolia* and members of Papeda group have an association, which is not brought out by the work of Swingle, is reported below:

Swingle (1948) simplified the citrus classification. He separated *Fortunella* and *Poncirus* from the genus *Citrus*, under which he recognized two subgenera, 16 species and 8 botanical varieties. The notable change of botanical nomenclature accepted by him is *C. reticulata* Blanco for the mandarin, therefore, designated as *C.*
C. chrysocarpa, C. deliciosa, etc. It is to be noted that under this species he included all mandarins coming under the section Acrumen of Tanaka. He also accepted the species C. limon Burm, for lemon instead of C. limonial Osbeck. Similarly, he considered C. grandis Osbeck as the correct name for Pummelo which has also been called as C. maxima and C. decumana. The confusion in limes which had been variously named as C. acida, C. limonellus, Limonic acidissima and Limonic aurantifolia, was cleared by Swingle and he gave it the name C. aurantifolia Swingle. It is apparent that gradually the citrus classification has become more comprehensive and elaborate. This was undoubtedly due to the fact that the earlier workers in Europe were familiar with limited citrus plant material found in that part of the world. Gradually more and more material from the Eastern homes of citrus come to light and the classification had to be broadened to accommodate these diverse taxons. However, even among the modern authorities a great deal of divergence of opinion with regard to the number of valid species continues. One extreme view accepting only a limited number of species is represented by Swingle (1948) and the other extreme by Tanaka (1954), who has accepted over 144 species. Both of them are renowned workers and their different approaches to the problem are caused firstly by the differences in the concept of a valid species and secondly by the different characters employed by each for the delineation of these species.

Reuther et al. (1968) distinguished between various members of the Citrus spp by the differences in fruit anatomy as follows:

A.) C. medica [Citron] has fruit which is lemon yellow in color, large, 6-9 inches (15-23 cm) long, oblong, rough or warty, sometimes ridged, apex blunt pointed; rind thick, white except for the outer colored rim; pulp sparse; juice scant, acid, and somewhat bitter, or sweetish; juice sacs small, slender; seeds oval, plump, light colored, smooth.
B.) *C. limon* [Lemon] has fruit which ripen at all seasons; ovoid or oblong and pointed at both apex and base, about 3 inches (7.6 cm) long, either smooth or rough, light yellow in color; rind thin; flesh light colored; pulp acid, juice sacs long and pointed; seed oval, pointed at micropylar end, quite smooth.

C.) *C. aurantifolia* [Lime] has fruit which is rounded or oblong, frequently mammillate, light yellow to green; maturing irregularly throughout the year; rind thin; pulp greenish, acid; juice sacs small, slender, pointed; seeds small, oval, pointed.

D.) *C. grandis* [Pummelo] has very large fruit, globose or pyriform, light lemon to orange in color; rind very thick, white, spongy, smooth, dotted on surface with large conspicuous oil glands; segments large, commonly 10 to 14 in number, covered with thick, leathery tissue; juice vesicles large, long tapering, only loosely adhering; pulp light colored or pink, tough; flavor acid and bitter with scant sweetness; seeds monoembryonic, numerous, large, flattened or wedge-shaped.

E.) *C. paradisi* [Grapefruit] has large fruit, oblate, globose, pyriform, from out of season bloom, light lemon or orange colored; flesh grayish or pink; juice sacs large, spindle shaped, closely packed together; flavor a mingling of acid, bitterness, and sweetness or subacid; seeds polyembryonic, large, light-colored, wedge-shaped or irregular, ridged; cotyledons white.

F.) *C. aurantium* [Sour Orange] has orange or reddish fruit, rough, slightly aromatic, bitter; pulp acid; juice sacs spindle-shaped, rather small; core hollow when fully ripe; seed flattened and wedged toward micropylar end, marked with ridge lines.

G.) *C. sinensis* [Sweet Orange] has fruit globose or oblate, light orange to reddish; rind smooth; pulp juicy, subacid; juice sacs spindle-shaped; seeds few or
many, oblong-ovoid, plano-convex, generally broad, wedged or pointed at micropylar end, marked with oblique ridges.

H.) C. reticulata [Mandarin] has fruit flattened or depressed globose, yellow to reddish orange; segments 10-14, separating readily from one another; rind loosely attached, easily removed; seeds small, beaked; cotyledons green.

Barrett and Rhodes (1976) studied the affinity relationships of 43 biotypes of cultivated citrus-close relatives, interspecific and intergeneric hybrids, and clones of unknown origin. Among the citrus species and relatives, the affinity pattern showed two main groups in citrus and a third group consisting of *Eremocitrus glauca* and *Microcitrus* species. The larger citrus group included five species (*C. aurantium*, *C. grandis*, *C. paradisi*, *C. reticulata*, and *C. sinensis*) and a smaller group of three (*C. aurantifolia*, *C. limon*, and *C. medica*). The characteristics of *C. grandis* were dominant in interspecific hybrids. In hybrids of cultivated citrus species and wild relatives the characteristics of the latter were strongly dominant with one exception. The affinities of clones of unknown origin indicated probable hybrid origins of diverse genetic backgrounds. Comparisons of the data on the study of clones were made with the major authoritative speculations on their derivations. *Citrus grandis, C. medica, and C. reticulata* are proposed as true biological species. *Citrus aurantifolia, C. aurantium, C. limon, C. paradisi,* and *C. sinensis* are proposed as unique, apomictically perpetuated biotypes of probable hybrid origin. A nonmetric multidimensional scaling solution is presented to support, in part, the proposed systematic relationships. Inadequate sampling of the variation present in populations and a lack of appreciation of the effects of facultative apomixis on population samples and its relationship to genetic heterozygosity in citrus have been the major obstacles in past efforts to produce an objective citrus taxonomy.
Mabberley (1997) classified edible citrus into three species and four hybrid groups taking in to account recent chemotaxonomic advances.

Runkel et al. (1997) reported that ripe fruits of Citrus paradisi and their juices contain high concentration of scopolin (β-glucopyranoside of 7-hydroxy-6-methoxycoumarin). The naturally occurring glycoside was identified as the glucoside of scopoletin comparing it with authentic scopolin. Mass spectra revealed that scopoletin releases one methyl- and two carbonyl-groups. The molecule finally breaks into fragments of 51 and 69 atomic mass units.

According to Wellmer et al. (2004) spatially limited expression of several genes may be part of Citrus flower development and metabolism for model plants.

Yamamoto et al. (2006) determined self and cross incompatibility of 65 citrus accessions in Japan by pollen tube growth in style. Lemon was self-compatible, whereas the six pummelos and seven out of 11 of its relatives were self-incompatible. Furthermore, among sour oranges and their relatives, two out of six accessions were, likewise, self-incompatible as were one out of five sweet orange and their relatives. Every Yuzu and its relatives, except hyuga-natsu, were self-compatible. Of the mandarin and its relatives, 14 out of 28 accessions were self-incompatible, whereas calamondin, a kumquat relative, and Hedzuka daidai of diverse origin were self-compatible. Thirty-one out of 65 accessions used in this study were self-incompatible. Of the self-incompatible accessions, clementine and ‘Ariake’, a hybrid of navel orange and clementine, were cross-incompatible. Thus, the incompatible genotypes of those two accessions were considered to be identical.

Mbagwu et al. (2007) studied on the leaf epidermal characteristics of four species of Citrus namely: C. sinensis, C. limon, C. aurantifolia, and C. paradisi to investigate and compare the leaf epidermal features and possibly to establish the taxonomic relationships among these taxa. The results showed that at the lower
leaf epidermis, the epidermal cells of *C. sinensis* and *C. aurantifolia* are irregular but vary from pentagonal to hexagonal in *C. limon*, and rectangular to pentagonal in *C. paradisi*. Also at the upper leaf epidermis, the epidermal cells of *C. sinensis* and *C. paradisi* are irregular, pentagonal in *C. aurantifolia* but vary from rectangular to pentagonal in *C. limon*. Both taxa showed inter species similarities in anomocytic stomata, absence of stomata at the upper leaf epidermis, absence of trichomes, absence of subsidiary cells and thick walled cells that characterized all the species. The similarities in structures are strong reasons for the four taxa to be in the same genus while the differences suggest reasons for the existence of each as a separate species and thus strengthen the reliability of leaf epidermal features as taxonomic tools.

Yamamoto et al. (2007) studied the CMA banding patterns of chromosomes in major citrus species. Fluorochrome staining with chromomycin A3 (CMA) was used to characterize and compare the CMA banding patterns of chromosomes in 14 accessions of 12 species of major Citrus species. All accessions had 2n = 18 chromosomes. These chromosomes were classified into seven types based on the number and position of CMA positive bands: A: two telomeric and one proximal band, B: one telomeric and one proximal band, C: two telomeric bands, D: one telomeric band, E: without bands, F: one proximal band, and Dst: type D with a satellite chromosome. Each accession possessed two to six types of chromosomes and unique CMA banding patterns.

Nishikawa et al. (2009) obtained a peel-specific promoter useful for citrus transgenic research, the flanking region of a citrus d-limonene synthase gene (*CitMTSE2*), which showed a high degree of expression in the peel of mature fruits, was isolated from the Satsuma mandarin (*Citrus unshiu* Marc.).
2.2 Evaluation of identified genotypes based on the morphological characters:

A perusal of the morphological characters actually employed earlier in the various works in citrus taxonomy brings out the fact that the difference in grouping of different species adopted by the various workers is governed by the different primary or secondary characters. It is well recognized principle that the morphological characters employed in classification should be least subjected to the influence of environment and should fall under clear cut and easy to recognize categories. Flower characters are eminently suited for this purpose and have been generally employed. It is surprising that in spite of the plethora of work on the taxonomy of the citrus as reviewed earlier; there is hardly any work on the importance of the different characters of the plant for its classification. The only schedule giving the characters for classification is at the cultivar level. Hooker (1875) used morphological characters of fruits like hair development and colour of young shoots, sex type in flower, surface and aroma of rind, amount of juice in pulp vesicles, shape of juice vesicles etc.

Lushingoton (1910) in grouping the different species used the number of leaflets, petiole length, degree of serration of leaflet margin, aroma of leaves, core development, nature of coherence of segments to each other, colour of the pulp and shape of leaflets.

Swingle (1948) considered the development of acrid oil droplets in pulp vesicles, development of wing on petioles, size and fragrance of flower and nature of coherence of stamens as the important characters in his mode of grouping the species. The other characters used by him are the number of segments of the fruit, taste of juice vesicles, degree of articulation between leaf-blade and petiole, number of stamens, nature of the adherence of skin to the pulp ball, colour of the fruit at maturity, size, shape and embryo colour of seed etc.

Tanaka (1954) in his system of classification adopted the growth habit of the tree, spine development, shape of young shoots in transverse section, development of
inflorescence, nature of calyx lobes, pigmentation of petals, coherence for grouping the different species. The other characters employed by him are size and shape of flower bud, number of petals, growth habit of the ovary, mamilla development, taste and length of pulp vesicles etc.

Grieve (1983) confirmed that most salt tolerant rootstock were Cleopatra mandarin, Rangpur lime, Sweet lime, Carrizo citrange and Troyer citrange. Salt tolerance was the lowest with Poncirus trifoliate root stock.

According to Rao et al. (1987) Rangpur lime showed highest tolerance to drought followed by Nasanaram (C.amblycarpa), Poncirus trifoliate, and Troyer citrange while C.jambhiri was the most susceptible root stock.

Valderrama et al. (1987) found that citrus fruits ripened earliest on trees of Frost Valencia grafted on trifoliate orange and Ruby orange (No. 1437) and latest on Frost Valencia grafted on Garcia Valencia. Use of these two rootstock could extend the harvesting season to 5 months.

Husak et al. (1988) conducted a root stock trial in Cuba and observed that growth, development and bearing potential of Washington Navel orange, Marsh grape fruit and Orlando tangelo trees were best on C.volkameriana and C.macrophylla rootstock.

Levy (1989) opined that Villafranca lemon on Volkameriana was the best rootstock-scion combination during the 1st thirteen years of experiment.

Chohan et al. (1991) studied the effect of root stock on tree survival, vigour, health, yield and fruit quality in Jaffa cultivar of sweet orange and found that Jatti Jaffa sweet orange budded on Jatti Khatti root stock showed cent per cent survival and significantly produced better stock and scion girth than that given by Karna Khatta and Pectinifer root stock. Jatti Khatti root stock also produced more yield (396 fruits / tree and 74.8 kg fruit).
After 7 years of observation, Xiao et al. (1992) concluded that trifoliate orange should be a good dwarfing rootstock for Liangpingyou (C. grandis); 1/3 rd of trees on trifoliate orange came into bloom in the 2nd year after planting, earlier than for all other rootstocks like C.junos, C.ichangensis, and Severenia buxifolia.

The tree growth, yield and fruit quality of Grape fruit cv. Frost Marsh Seedless on 15 rootstocks were evaluated under Cyprus condition by Economides and Gregoriou (1993). Over the 9 year production period, trees on Palestine sweet lime, 3 rough lemon root stock and C.volkameriana were more productive and their cumulative yields were significantly higher than those on sour orange, which was standard root stock in Cyprus.

Iwata et al. (2002) examined variations of leaf form, i.e., differences in shape and size, among citrus varieties and the genotype × environment (GE) interactions influencing the variations and suggested that the genotype was the main source of variation in leaf shape, but not in size, and that the contribution of GE interaction was minor to both shape and size, although statistically significant at the 1 % probability level.

Gogorcena and Ortiz (2006) studied 21 cultivars of sour orange and relatives in Spain. Morphological determinations were carried out both in leaves and in fruits, including leaf size and area, number of oil glands, petiole length, fruit weight, number of seeds and others. Biochemical analysis included electrophoresis separations of proteins from leaves and fruit rind as well as peroxidases and esterases from some of the organs. Also chromatographic separations of rind oils were carried out in mature fruits. Quantitative and qualitative differences were detected for some of the cultivars. Enzyme differences were found to be adequate for distinction at the specific level. Two of the cultivars, ‘Bergamot’ and ‘Amargo clementino’, segregated from the main group, which indicates their belonging to a different species or to a hybrid.
Hamilton et al. (2008) studied the comparative morphology of seeds of 3 Australian citrus species viz., *C.australisca*, *C.inodora* and *C. garrawayi*. Their seed characteristics were broadly similar to those of the cultivated species of the genus when observed under light and scanning electron microscopy. *C. garrawayi* differed in seed shape (rounded to triangular) and seed coat morphology (i.e. thicker with longer epidermal protrusions) from *C.australisca* and *C.inodora* (rounded surface with flat underside in shape). Surface topography of *C.australisca* and *C.inodora* seeds was more like that of cultivated species of *C. aurantifolia* and *C. limon*. Seed morphology especially surface topography was found to be a useful tool for taxonomic identification in Australian wild citrus.

The foregoing review brings out that in the systems of classification of citrus followed by the various workers, stresses have been laid on different characters. This had led to differences in the grouping of different species. Furthermore, no attempt has been made to show, which one is the important character for the descriptions of *Citrus* species.

2.3 Recommendation of the identified types for commercial cultivation or use as rootstock

2.3.1 Commercial cultivation

As a result of systematic varietal trial, Pine apple, Mosambi, Jaffa, Valencia Late and Excellencies were recommended for cultivation in Punjab (Tharpar, 1945). In different parts of India, Valencia was found to be better in Punjab (Bajwa et al., 1972); Malta Common, Washington Navel, Mosambi and Blood Red in Garhwal hills (Singh and Mishra, 1981) and Sathgudi at Bhatinda (Anon, 1984-85). A new clonal selection made from Blood Red at Ganganagar has been named Yuvaraj Blood Red which was seedless and early maturing (Singh, 1964). Singh (1962) found Italian -76 to be compatible with Hill mandarin and imparted vigour and high vitamin-C content to this Cultivar in Uttar Pradesh. For Emperor
Cultivar, Jambheri rootstock was found to give maximum yield (Dhuria et al., 1983; Bhullar and Khokhar, 1977). Among 9 varieties of lemon evaluated at Tamil Nadu, Malta was found to be the best with respect to yield and fruit quality (Irulappan et al., 1973).

The Cultivar Nagpur Mandarin was found superior to others at Delhi (Anand and Leisram, 1963); Seminole Tangelo in the plains of North India (Shankar, 1973); Kinnow and Kara gave maximum yield of quality fruits in Garhwal region (Singh and Mishra, 1981). A promising seedless bud mutant of Nagpur Mandarin, named as Mudkhed Seedless has been isolated by Chakrawar and Rane (1977).

In another trial, Foster Pink, Duncan and Marsh Seedless were found better on the basis of overall performance (Arora and Daulta, 1982). Sulladmath and Iyer (1982) found Seville lemon to be superior to Eureka, Lisbon, Villafranca, Nepali Oblong, Hill Lemon, Italian, Nepali Round and Tahiti lime with regard to fruit yield.

Two cluster bearing Kagzilime varieties named Pramalini and Vikram have been developed at Marathawada Agricultural University, Prabhani which gave 30-35 % more yield than existing Cultivar (Anon, 1985-86). Bagde and Patil (1989) selected a thornless and seedless Chakradhar from Kagzilime which has round fruits with thin papery rind and 60-66% juice content, higher yield and vitamin-C content.

At Bhatinda, Dabwali Baramasi and PAU selection produced heaviest crop (Anon, 1987). Similarly, the Cultivar Kadayam showed best growth and yield at Periyakulam (Anon, 1987) while Seedless was found better in Himachal Pradesh which is late maturing, having oblong fruits, thin skin and 1.5 to 2 times more yield (Badiyala et al., 1990).
A large variability was observed in different germplasms of Sweet orange at Fruit Research Station, Abhor by Josan and Kaur (2004). The variability in fruit yield (32 – 157 fruits / tree), tree height (3.10-5.13 m), tree volume (13.69 -103.37 m³), fruit weight (134 – 213 g / fruit), juice content (45.7-51.0 %) , TSS (8.1-9.4%), acid content (0.54-1.01 %) and ascorbic acid content (28.52 – 31.09 mg / 100 ml juice) have been observed. Few introductions viz. Vainiglia Sanguigno, Queen, Campbell Valencia and Olinda Valencia were found to be most promising than others.

Ram and Singh (2004) studied the physico-chemical performance of Kagzi lime, Pramalini, Vikram and Saisarbati acid lime cultivars in processing laboratory at NRC for citrus, Nagpur. They found that the cultivar Kagzi lime fruit was larger than that of Saisarbati, Vikram and Pramalini. However, juice per cent and juice pH of Saisarbati fruits was found to be significantly higher than others. The TSS, Fructose, Glucose, Sucrose and limonoids content were on par to each other. The juice of Pramalini and Saisarbati fruits had higher citric acid (8.9 and 8.5 %) than that of Kagzi lime and Vikram. Peel oil of Saisarbati and Pramalini fruit showed higher optical rotation (96.0 and 91.2 + ve degree) than those of Kagzi lime and Vikram. However, Saisarbati fruit juice accumulated significantly higher flavonoids and hesperdin content followed by those in Vikram and Kagzi lime.

Liu and Deng (2007) opined that selections of seedless and early or late ripening varieties are two important breeding goals in citrus

2.3.2 Rootstock purpose

Rootstocks are known to have a tremendous effect on the tree growth, fruit yield, quality and longevity of a particular scion cultivar grafted on them. There is no single rootstock available that can be regarded as ideal for all the citrus species under varying soil and climatic conditions.
Panijamir was found to be vigorous for Khasi mandarin in North East India in nursery stage (Nandi et al., 1943). Bhattacharya and Dutta (1952) however, found Sohmyndong and Katajamir to be compatible and these imparted the highest vigour.

Rootstock trial on grapefruit has been mostly confined to Punjab. Grapefruit plants raised on rootstocks performed better than seedling plants (Singh and Nagpal, 1947; Bajwa and Nagpal, 1955). Karna Khatta imparted maximum vigour and the highest yield to common grapefruit and Marsh Seedless (Singh and Singh, 1942; Singh and Nagpal, 1947; Bajwa and Nagpal, 1955). In Assam, Sohmyndong imparted dwarfing to Duncan grapefruit (Bhattacharya and Dutta, 1952).

For Mosambi, out of Sohmyndong, Katajamir and Khasi mandarin, Bhattacharya and Dutta (1956) found Sohmyndong and Katajamir rootstocks to be compatible and to give prolific yield. In Uttar Pradesh, Sweet lime was found to be better rootstock for Mosambi with regard to yield, quality and precociousness as compared to Jambiri, Florida Rough Lemon, Seville orange, Sweet lime, Italian-76, Lime Sylhet and Karna Khatta (Singh, 1961).

Jatti Khatti rootstock imparted the highest vigour to Valencia in Punjab (Ahmed, 1960; Jawanda and Mehrotra, 1974; Sharma et al., 1978). However, Troyer and Carrizo citranges gave highest TSS:acid ratio and Karna Khatta the maximum juice content. In Assam, Sohmyndong and Katajamir rootstocks were found compatible with Valencia and imparted prolific yields. Katajamir induced precociousness (Bhattacharya and Dutta, 1952). Italian-76 rootstock was found to impart the highest vigour and yield to Vanille in Uttar Pradesh but the TSS / acid ratio was low (Prasad, 1967).

Acid lime budded on Jambheri, Gajanima and acid lime showed better performance than unworked trees (Naik, 1948). Among rootstocks, Jambheri
imparted maximum vigour to acid lime scions (Rao et al., 1970) and Gajanima the highest yield (Naik, 1948; Rao et al., 1970). However, no significant differences were observed in different rootstocks with regard to fruit quality. Singh and Singh (1983) found Pummelo to be the compatible rootstock for Kagzi lime in west Uttar Pradesh.

In Punjab, Jawanda and Mehrotra (1974) found Jatti Khatti, Karna Khatta and Jambhiri to impart highest vigour to Mosambi in prebearing stage.

For Kinnow, a number of trials have been conducted throughout the country. In Delhi, Sohsarkar was found vigourous and Karna Khatta gave maximum yield (Singh et al., 1978). Sevile Kinb, however, imparted the highest fruit quality. In Punjab, Jatti Khatti was found to be the most vigourous.

In Maharashtra and Himachal Pradesh, Jambheri and Jatti Khatti rootstocks have been found to give maximum vigour and yield to Nagpur Mandarin scion. Galgal and Sevile Kimb imparted dwarfing (Dhuria et al., 1983; Bhullar and Khokhar, 1977; Despande et al., 1977).

Singh and Singh (1983) found that in western UP, Galgal was the most compatible rootstock for Mosambi.

In Himachal Pradesh, Jambheri was found to be the best rootstock with regard to vigour and yield. Dwarfing was observed when budded on Galgal and Sevile Kimb rootstocks (Dhuria et al., 1983; Bhullar and Khokhar, 1977). In Uttar Pradesh, Karna Khatta was found compatible and gave good fruit quality (Shanker, 1978). In South India, particularly in districts of Coorg, Hassan and Chikmaglur in Karnataka; Wynad and Palghat in Kerla; and Ootacamund and Madurai in Tamil Nadu, rough lemon performed well.

Josan and Thatai (2004) conducted an experiment on influence of rootstocks on tree girth, fruit yield and quality of Kinnow mandarin at Fruit Research Station Abhor and observed Jatti Khatti to be the best root stock on the