CHAPTER – IV

RESULTS & DISCUSSION
RESULTS AND DISCUSSION

The detail of the findings of the present investigation including sketches and plates of the identified types are presented and discussed accordingly

4.1 DESCRIPTION OF CITRUS SPECIES IN ORISSA

4.1.1 Citron (*Citrus medica Linn.*)

Source of collection - Government Farm, Pallahara.

A small tree or a shrub, height 10 ft, tendency to lodge, sagging branches, branching very much low from the trunk, thorny, open foliaged, fruiting season mainly september to december; leaf large, elliptic ovate, leaf not shiny, light green, margin serrated to slightly crenate, petiole wingless, petiole medium length, petiole 2.5 cm long; fruit shape oblong to ellipsoid, medium sized, colour lemon yellow when fully ripe, surface somewhat smooth to sub warty, waxy, pitted, apex broadly mamillate, areole indistinct, rind thick, thickness 4-5 mm, adherence firm to strong, oil gland large, aroma distinct, mesocarp white, texture hard, axis semi hollow or occasionally solid in small fruit; segments 10, pulp vesicle yellowish white, juice medium, taste very sour, seeds many, 25-30 per fruit, cotyledon white, T.S.S 5.0 (Plate-1)

4.1.2 Jamberi (*Citrus Jambhiri* Lush.)

Source of collection – Government Farm, Pallahara.

Plant medium to tall, 15-17 ft, spreading, densely foliaged, few thorn, fruiting season september- february, politic leaves, one crop in a year; leaf medium, elliptical to drooping type, isobilateral, deep green colour, petiole usually wingless or with rudimentary winged, length 2.5 cm long, flower white, solitary or cluster, pedicel short; fruit oval to oblate, large, yellowish colour at ripeness, undulated surface, prominent oil gland, somewhat puffy, not very glossy, fruits
never drop off naturally, apex slightly depressed, rind thickness 2.5 mm, yellowish white, firmness medium, adherence medium, mesocarp thin, spongy, axis hollow, vesicular bundle prominent, yellowish white pulp, juice abundant, yellowish white juice, yellowish white rind, number of segments 10, T.S.S. 7, seed few, 10-12 per fruit. (Plate-1)

4.1.3 Karnakhatta \textit{(Citrus karna} Raf.)

Source of collection – Government Farm, Pallahara.

Medium tall tree, height 12-15 ft well branched and high rate of dropping when loaded with fruits, moderately dense foliage, not compact, thorny, fruiting season December-February, prolific bearer, one crop annually; leaf medium size, petiole very narrowly winged, petiole length 2.5 cm long, dark green, oblong shape margin serrated, flower solitary, fruit shape spherical or ovate, surface slightly undulated, pitted, colour golden yellow, weight 200 g, rind medium thick, thickness 2.5 cm, adherence medium to strong, mesocarp white, soft, spongy, taste sweet, axis solid, oil gland not prominent, number of segments 12, adherence medium, pulp vesicle yellowish orange, texture coarse, vesicle arising from the dorsal side also from lower end of radial wall, juice medium to plenty, juice colour light orange, seed several, 20-25 per fruit, cotyledon white, T.S.S. 6.0 (Plate-1)

4.1.4 Rough Lemon \textit{(Citrus jambhiri} Lush.)

Source of collection – Government Farm, Pallahara.

Tree medium to tall of 12-15 ft height, staggering branches, moderately foliaged, not thorny, fruiting season September- November, heavy bearer; leaf deep green, elliptical shape, petiole wingless, 2.5 cm long articulated; fruit oblong to ovate, gradually tapering towards base, weight 220 g, greenish yellow, undulating surface, ridges and furrow present, oil gland prominent, areole absent,
a broad nipple, rind medium thick, thickness 3-5 mm, firmness firm, adherence with carpel strong, mesocarp white, medium hard, sweet, axis usually hollow or semi hollow, number of segment 11, adherence medium to strong, juice medium, very sour, colour dull white, seeds many, 30-50 per fruit, cotyledon white, T.S.S. 6.0 (Plate-2)

4.1.5 Pummelo (*Citrus grandis* Osbeck.)

Source of collection – Government Farm, Pallahara.

Medium sized plant, height 10-12 ft, very much spreading branches, densely foliaged, thorn few, young shoots angular, fruiting season October-December, one crop in a year; leaf large, with winged, dark green, isobilateral petiole 1.5 cm long, ovate to oblong shape, veins slightly prominent on both sides, flowers white, large, pedicel late; fruit ovate, large size, undulating surface, greenish yellow when ripe, base moderately depressed, basal area slightly ribbed, areole absent, firm, rind thick, thickness 2.5 mm, adherence strong, oil gland conspicuous, mesocarp light pink, vascular bundle prominent, texture soft and spongy, taste slightly sweet with little bitterness, axis hollow, irregular in outline cross section, segment No. 12-13, adherence medium to strong, light orange pulp, pulp vesicle colour not uniform, vesicle irregular in shape and size, flavor medium, juice medium, seed numerous, 30 or more per fruit, cotyledon is greenish with pinkish inner wall, T.S.S. 6.0 (Plate-2)

4.1.6 Mandarin (*Citrus reticulata* Blanco.)

Source of collection – Government Farm, Pallahara.

Medium size plant, height 9-10 ft, upright erect habit, densely foliaged, slightly thorny, young shoots angular, glabrous, fruiting season November-January, one crop annually, prolific bearer; leaf large isobilateral oblong, petiole winged and 4 cm long, dark green; flower white, bisexual, solitary, occasionally in
pairs; fruit depressed globose, large fruit, undulated surface, yellowish-orange colour, glossy base depressed, papilla present, rind thin, thickness 2.5 mm, soft, adherence very slight, slightly puffing oil gland not prominent, mesocarp almost white, axis hollow, number of segments 10, adherence slight, pulp vesicle deep orange colour, seed several, 10-12 per fruit, abundant juice, T.S.S. 8.0 (Plate-2)

4.1.7 Sweet Lime (*Citrus limettioides* Tan.)

Source of collection – Government Farm, Pallahara.

Tree medium tall, 10-12 ft in height, spreading, moderately dense foliaged, medium vigour, thorny, prolific bearer, one crop annually; leaf medium sized, ovate rudimentary wing, petiole length 3 cm, leaf colour very light yellowish green, shiny, veins slightly prominent on upper surface, crushed leaf aroma distinctly different from the sour lime; flower white, flower once annually; fruit almost spherical or slightly globose fruit large, light yellow colour, undulating surface, oil gland prominent distinct aroma, areolar area smooth, insipid sweet, rind thin, 2.5 mm, medium firmness, leathery, adherence medium to strong, mesocarp white, thin, soft, sweet; axis solid or semi solid, segments 10, seed few, 6-10 per fruit, pulp vesicle uniform white, T.S.S. 8.0 (Plate-2)
Plate-1: Karna Khatta, Citron and Jambheri species of Citrus found at Pallahara area of Dhenkanal district of Orissa
Plate 2: Rough lemon, Pummelo, Sweet lime and Mandarin found at Pallaahada block of Dhenkanala district
4.1.8 Rangpur Lime (*Citrus limonia* Osbeck.)

Source of collection – Government Farm, Pallahara.

A small round topped tree with many thorns, height 7-8 ft, new growth coloured; leaf medium size, shape oval, dark green, petiole wingless and 3 cm long; like Mandarin, fruit shape ovate to oblong, colour yellowish green, small to medium size, less compressed with small papilla, rind thickness 2 mm, adherence low to medium, mesocarp white, thin, axis hollow, oil gland not prominent, juice plenty, very acidic with bitter taste, juice colour transparent yellow, number of segment 8-9, seed many, 15-20 per fruit, cotyledon green, T.S.S. 6.0 (Plate-3)

4.1.9 Kagzi Lime (*Citrus aurantifolia* Swingle.)

Source of collection – Government Farm, Pallahara.

A small tree or a shrub, bushy habit, height 8 ft, spreading, slender branch, densely foliaged, thorns, heavy yielder, pick season August-October, periodical low crops almost all the year around; leaf small and prominently winged, oval shape, deep green, dorsiventral petiole 2-5 cm long, young bud light green with coppery tinged; flower small and white, flowers round the year, mainly during February- March; fruit oval to spherical, small colour greenish yellow, surface undulating, dotted with prominent oil gland, glossy areole with irregular circular depression, areolar adherence strong, aroma distinctly of the lime, pleasant, mesocarp white thin, axis solid, no of segment 10, adherence strong, pulp vesicle slender, juice abundant, sour, excellent flavour, seed few, 7 per fruit, cotyledon light greenish white, T.S.S. 7.0 (Plate-3)
10. Kagzi Lime (*Citrus aurantifolia* Swingle.)

Source of collection- Hidisingh, Angul.

A small tree or a shrub, upright habit, height 8 ft, slender branch, densely foliaged, thorny, heavy yielder, pick season August to October, periodical low crops almost all the year round; leaf small and not prominently winged, oval shape, deep green, dorsiventral, petiole 2.5 cm long, young bud light green with coppery tinged; flower small, white, flowers round the year, mainly during February- March, fruit oval to spherical, small to medium, colour greenish yellow, surface undulated, dotted with prominent oil gland, glossy, areole with irregular circular depression, areolar area ribbed, rind thin, thickness 2 mm, firmness medium, adherence strong, aroma distinctly of lime, pleasant, mesocarp white thin, axis solid, segment 10, adherence strong, pulp vesicle slender, juice abundant, sour, excellent flavor, seeds few, 7 per fruit, cotyledon light greenish white, T.S.S. 6.0 (Plate-3)

4.1.11 Nagpur Orange (*Citrus reticulata* Blanco.)

Source of collection- Hidisingh, Angul.

Medium size plant, height 8-10 ft, spreading habit, sparsely foliaged, slightly thorny, young shoots angular, glabrous, fruiting season November-January, one crop annually, prolific bearer, leaf medium isobilateral, elliptical shape, petiole wingless, petiole 3 cm long, dark green; flower white, bisexual, solitary, occasionally in pairs; fruit depressed globose, large fruit, undulated surface, yellowish orange colour, glossy, base depressed, papilla present, rind thin, 2.5 mm thick soft, adherence very slight, slightly puffing, oil gland prominent, mesocarp almost white, axis hollow, number of segment 10, adherence slight, pulp vesicle deep orange colour, seed several, 10-15 per fruit, abundant juice, T.S.S. 9.0 (Plate-4)
4.1.12 Jamberi (*Citrus Jambhiri* Lush.)

Source of collection- Tumuni, Angul.

Plant small to medium 10 ft upright, moderately dense foliage, thorny; fruiting season September- February, prolific bearer, one crop in a year, leaf medium, elliptical, dorsiventral, deep green colour, petiole, usually winged, petiole length 2 cm, flower white, solitary or cluster, pedicel short; fruit oval to oblate, large, yellowish green at ripeness, undulated surface, prominent oil gland, some what puffy, not very glossy, fruits never drop off naturally, apex slightly depressed, rind thickness 2.5 mm, firmness medium, adherence medium, mesocarp thin, spongy, axis hollow, vesicular bundle prominent yellowish white pulp, juice abundant, yellowish white juice, yellowish green rind, number of segment 10, seeds few, 10 per fruit, T.S.S.  5.0 (Plate-4)

4.1.13 Gangakulia Lime (*Citrus aurantifolia* Swingle.)

Source of collection- Tumuni, Angul.

A small tree or shrub, bushy habit, height 6.5 ft, upright habit, slender branch, densely foliaged, not thorny, medium yielder, pick season August-October, periodical low crops almost all the year round; leaf small and prominently winged, oval shape, deep green, dorsiventral, petiole 3 cm long, young bud, light green with croppy tinged; flower small, white, main flowering season February- March, also all the year round; fruit oval to spherical, small to medium, colour greenish yellow, surface very smooth, dotted with prominent oil gland, glossy, areole with irregular circular depression, rind medium thick, thickness 3 mm, firmness strong adherence strong, aroma distinctly of lime, pleasant, mesocarp white thin, axis solid, number of segment 10, adherence strong, pulp vesicle slender, juice scanty, sour, excellent flavor, seeds few, 6 per fruits, cotyledon light greenish white, T.S.S.  5.0 (Plate-4)
Plate-3: Rangpur lime and Kagzi lime of Pallahara and Kagzi lime found in the Hidisingi of Anugul district of Orissa.
Plate-4: Jambheri, Gangakulia and Nagpur orange found in the Anugul district of Orissa.
4.1.14 **Grape Fruit** (*Citrus paradise* Macf.)

Source of collection- Tumuni, Angul.

Medium to tall plant, height 9-12 ft, spreading medium vigour, densely foliaged, thorny; leaf small to medium, oval, isobilateral leaf, petiole slightly winged, petiole length 3 cm, shiny leaf; flower white in cluster; fruit oblong to globose, large, oil gland not prominent, evenly rounded base, greenish yellow colour smooth surface, basal area depressed, apex evenly rounded, rind medium thick, 3 mm thickness, firm, number of segment 12-15, seeds numerous, 20-30 per fruit, juice sacs closely packed, juice abundant, moderate flavour, whitish yellow pulp, T.S.S. 5.0 (Plate-5)

4.1.15 **Jamberi** (*Citrus Jambhiri* Lush.)

Source of collection- Dimiripal, Angul.

Plant medium to tall, 12-15 ft height, upright, moderately dense foliaged, thorny; fruiting season September- February, prolific bearer, one crop in a year; leaf medium, elliptical oblong, isobilateral, deep green colour petiole with wings, petiole length 2 cm; flower, white, solitary or cluster, pedicel short; fruit ovate to oblate, medium, yellowish green colour at ripeness, undulated surface, prominent oil gland, some what puffy, not very glossy, fruits never drop off naturally, apex slightly depressed, rind thickness 3 mm, medium firmness, adherence medium, mesocarp thin, spongy, axis hollow, vesicular bundle prominent, yellowish white pulp, juice abundant, yellowish white juice, yellowish green rind, number of segments 10, seeds few, 10 per fruit, T.S.S. 4.0 (Plate-5)

4.1.16 **Sarbati Lemon** (*Citrus limettioides* Tan.)

Source of collection- Tumuni, Angul.

Tree medium height (10 ft), erect habit, medium vigour, slightly thorny, prolific bearer, one crop annually; leaf medium size, elliptical shape, isobilateral, petiole wingless, petiole length 9.5 cm long, not shiny, distinctly different from the sour lime; flower white, flowers once annually; fruit almost spherical or slightly globose, yellowish green colour at ripeness, smooth surface, oil gland not prominent, distinct aroma,
mesocarp, white, soft, sweet, number of segments 11, seed few, 6-10 per fruit, pulp white colour. (Plate-5)

4.1.17 **Mosambi** (*Citrus sinensis* Osbeck.)

Source of collection- Loba, R.Udaygiri.

Small to medium plant, height 7-10 ft, upright, trunk straight, spreading branches, densely foliaged, thorn less, fruiting season December- January, prolific bearer, one crop annually, leaf medium size, oval shape, deep green, isobilateral, petiole winged and 3 cm long; flower white, solitary, bisexual, fruit spherical, large, slightly wavy surface, yellowish green colour fruit, calyx areole area smooth, rind medium thick, thickness 3 mm, medium soft, distinct aroma, mesocarp white, spongy, axis usually solid, number of segments 10, pulp vesicle yellow to light orange, texture coarse, melting, flavor good, medium juice, dull white colour, sweetness and acidity blended, seed several, 12-15 per fruit, cotyledon white, T.S.S. 8.0 (Plate-5)

4.1.18 **Mandarin** (*Citrus reticulata* Blanco.)

Source of collection- Aingarsingh, R.Udaygiri.

Medium size plant, height 10-12 ft, spreading habit, sparsely foliaged, thorny, young shoots angular, glabrous, fruiting season November-January, one crop annually, poor bearer; leaf medium, dorsiventral, oblong, petiole wingless, 2.5 cm long, dark green; flower white, bisexual, solitary, occasionally in pairs, fruit depressed, globes, medium fruit undulated surface, yellowish orange colour at ripeness, glossy, base depressed, papilla present, rind thin, oil gland prominent, mesocarp almost white, axis hollow, number segments 10, adherence slight, pulp vesicle yellowish orange colour, seed several, 10-15 per fruit, medium juice, T.S.S.  6.0 (Plate-6)

4.1.19 **Mandarin** (*Citrus reticulate* Blanco.)

Source of collection- Loba, R.Udaygiri.

Medium size plant, height 9-12 ft, upright and erect habit, densely foliaged, slightly thorny, young shoots angular, glabrous, fruiting season November- January, one
crop annually, prolific bearer; leaf medium, isobilateral, elliptical, petiole wingless, 2 cm long, dark green; flower white, bisexual, solitary, occasionally in pairs; fruit depressed globose, medium fruit, slightly smooth depressed, papilla present, rind thin, thickness 2 mm, soft, adherence very slight, slightly puffing, oil gland prominent, mesocarp almost white, axis hollow, number of segments 10, adherence slight, pulp vesicle yellowish orange colour, seed several, 10-15 per fruit, medium juice, T.S.S. 6.0 (Plate-6)

4.1.20 Grape Fruit (Tava) (*Citrus paradise* Macf.)

Source of collection - Aingarsingh, R.Udaygiri.

Medium to tall plant, height 10-15 ft, spreading, medium vigour, densely foliaged, slightly thorny; leaf medium, oval, isobilateral leaf, petiole winged, 3 cm long, not shiny; flower white in cluster; fruit oblate to globose, large, oil gland not prominent, evenly rounded base, orange green colour at ripeness, basal area depressed, apex evenly rounded, rind medium thick, 2.5 mm thickness, firm, number of segments 10, seed numerous, 15-20 per fruit, juice sacs closely packed, juice abundant, moderate flavor, orange colour pulp, T.S.S. 6.0 (Plate-6)

4.1.21 Lemon (*Citrus limon* Tan.)

Source of collection - Raising, Ganjam.

A small tree or shrub, 6-8 ft height, well branched, moderately dense foliage, thorny, small, slender, prolific bearer; leaf medium size, elliptical, pale green, dorsivetral slightly winged petiole, petiole 0.8-1 cm long; flower small, white; fruit round shape, smooth surface, oil gland prominent, rind thin, areole present, orange colour pulp, orange colour fruit, segment 10, seeds few, 10-12 per fruit. (Plate-6)
Plate-5: Mandarin orange, Grape fruit and Lemon species of Citrus found in the R.Udyagiri block of Gajapati district of Orissa.
Plate-6: Jambheri and Mosambi cv. of Sweet orange found at the Gajapti district of Orissa.
4.1.22 Kagzi Lime (*Citrus aurantifolia* Swingle.)

Source collection- Mandibisi, Kasipur, Koraput.

A medium sized tree, height 10 ft, spreading, slender branch, densely foliaged, thorny, medium yielding plant; leaf small and not prominently winged, lanceolate shape, deep green leaf, isobilateral, petiole 2 cm long; flower small, white, main flowering season February- March, also all the year round; fruit oval, small to medium, smooth surface, colour, greenish yellow, pulp colour-less, juice medium, yellowish white colour juice, firm pulp, oil gland prominent, rind thin, thickness 2 mm, yellowish green rind, excellent flavor, sour taste, seeds few, 6-8 per fruit, cotyledon light greenish white, number of segments 11, T.S.S.- 6.0 (Plate-7)

4.1.23 Pummelo (*Citrus grandis* Osbeck.)

Source of collection- Mandibisi, Kasipur, Koraput.

A medium sized plant, height 8-10 ft, very much spreading branches, not densely foliaged, thorny; leaf lanceolate, obilateral leaf, leaves are very thick and large, petiole slightly winged and 2 cm long, deep green; small white flowers, flowering season February- March, one picking during a year; fruit ovate to oblong, large size, undulating surface, greenish yellow when ripe, base moderately depressed, base area slightly ribbed, areole absent, juice medium, yellowish colour juice, pulp rind very thick, thickness 2 mm, firm pulp, oil gland prominent, texture soft and spongy, taste slightly sweet with little bitterness, axis solid, segment no. 11-12, light orange pulp, seeds numerous 30 per fruit, T.S.S. - 6.0 (Plate-7)

4.1.24 Gaja Lemon (*Citrus limon* Tan.)

A medium sized plant, height 8-10 ft, somewhat staggering habit, branches spreading, somewhat moderately foliaged, thorny, crop peak season July-September; leaf moderately large, pale green, shiny, shape oblong, margin serrate to slightly crenate, petiole wingless, short, 1.5 cm long; fruit shape ovate to
oblong, gradually tapering towards base and apex, lemon yellow colour, surface slightly rough, basal area narrowed, protuted surface into somewhat broad pointed nipple, rind medium thick, thickness 1-2 mm, firmness firm, adherence strong, oil gland conspicuous, shape, ovate with long beak, mesocarp white, texture hard, axis semi hollow, segments 7-8, not extended towards beak, adherence strong, pulp vesicle colour-less, texture medium coarse, juice medium, very sour, seeds many, about 15-30 per fruit, cotyledon white. (Plate-7)

4.1.25 Pummelo (*Citrus grandis* Osbeck.)

Source of collection- Kendugada, Chinudiijhar, Kasipur, Koraput.

Small sized plant, height 6-8 ft, very much spreading branches, densely foliaged, large and strong thorns on stem and leaf axil; leaf ovate oblong, dorsiventral, leaves very thick and large, petiole slightly winged, petiole 1 cm long, deep green; flower white, flowering season July- August; fruit ovate, large size, undulating surface, greenish yellow when ripe, base moderately depressed, base area slightly ribbed, areole absent, firm, rind very thick, oil gland prominent, texture soft and spongy, taste slightly sweet with little bitterness, axis hollow, segment no. 13-15, light orange pulp, juice medium, seeds numerous, 30 or more per fruit. (Plate-7)

4.1.26 Kagzi Lime (*Citrus aurantifolia* Swingle.)

Source of collection- Laxmipur, Rayagada, Koraput.

A small tree or a shrub, bushy habit, height 10 ft, spreading, densely foliaged, thorny, heavy yielder, leaf small, elliptical, isobilateral leaf, light green colour; leaf not prominently winged, petiole 3 cm long, flowers small, white, main flowering season February- March, with round the year flowering; fruit oval to spherical, small to medium, colour greenish yellow, surface smooth, oil gland prominent, rind thin, thickness 2 mm, firmness medium, adherence strong, aroma distinctly of lime, pleasant, mesocarp white, thin, axis solid, number of segment
11-13, adherence strong, juice plenty, sour, seeds few, 8 per fruit, cotyledon light greenish white, T.S.S. 7.0 (Plate-3)

4.1.27 Mandarin (Citrus reticualta Blanco.)

Source collection: Chattikona, Koraput.

A medium to tall plant, height 20-25 ft, upright and erect habit, slightly thorny, young shoots angular, glabrous, fruiting season November-January, one crop annually, prolific bearer; leaf medium, dorsiventral, lanceolate shape, petiole wingless, petiole 1.5-2 cm long, dark green, flower depressed, globose, medium fruit, undulated surface, light orange colour, glossy, base depressed, papilla present, oil gland prominent, mesocarp almost white, axis hollow, number of segments 12, pulp vesicle light orange colour, seeds several, 15-20 per fruit. (Plate-5)

4.1.28 Citron (Citrus medica Linn.)

Source collection: Chattikona, Koraput.

A tall tree, height 15 ft, medium spreading habit, branching very much low from the trunk, thorny, fruiting season mainly September-December; leaf large, not shiny, round yellow; fruit greenish orange colour at ripeness, surface somewhat smooth, pitted, oil gland prominent, number of segment 10, pulp vesicle yellowish white, taste very sour, seeds many, 10-15 per fruit. T.S.S.-4.0 (Plate-4)

4.1.29 Kagzi Lime (Citrus aurantifolia Swingle.)

Source of collection: Khajuri, Chattikona, Koraput.

A small tree or shrub, bushy habit, height 9 ft, spreading slender branch, densely foliaged, thorny, small oval, deep green, dorsiventral, narrowly winged petiole, small to medium, colour greenish yellow, surface very smooth, oil gland absent, areole slightly raised, rind thin to medium, aroma distinctly of lime, pleasant, mesocarp white thin, axis solid, segment 11, seeds few, 7-8 per fruit, sour taste. T.S.S.-5.0 (Plate-3)
Plate-7: Pummelo, Lime & Gajja Lemon found in Koraput district of Orissa.
4.1.30 Mandarin (*Citrus reticulata* Blanco.)

Source of collection- Basalai, Deogarh.

Small to Medium size plant, height 7-10 ft, upright and erect habit, densely foliaged, thorny, young shoots angular, glabrous, fruiting season November-January, one crop annually, prolific bearer, leaf medium, dorsiventral, oblong, petiole wingless, petiole 3 cm long, dark green, flower white, bisexual, solitary, occasionally in pairs, fruit depressed, oblong, large fruit, undulated surface, deep orange colour at ripeness, glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft, adherence very slight, slightly puffy, oil gland not prominent, mesocarp almost white, axis hollow, number of segment 10, adherence slight, pulp vesicle deep orange colour, seeds several, 15-20 per fruit, abundant juice, T.S.S. – 8.0 (Plate-5)

4.1.31 Narangi (*Citrus reticulata* Blanco.)

Source of collection- Basalai, Deogarh.

Small to medium size plant, height 8-10 ft, upright habit, vigorous, densely foliaged, thorny, fruiting season all the year round; leaf small to medium, oval shape, dorsiventral, petiole almost wingless, petiole length 2.5 cm long, shiny leaf, flower white, bisexual usually solitary, rarely in pairs, pedicel distinct, 2-3 mm long, flowering throughout the year, fruit globose, deep orange at ripeness, depressed at the blossom end, undulated surface, slightly prominent oil gland, orange yellow pulp colour, axis hollow, juice abundant, slightly sweet, adherence of segment slight to medium, rind thin, thickness 2 mm, fruit roughness not very marked, number of segments 10, seeds few, 7-10 per fruit, T.S.S. 8.0 (Plate-8)
4.1.32 **Sweet Lime** (*Citrus limettioides* Tan.)

Source of collection- Basalai, Deogarh.

Tree medium, 8-10 ft height, spreading, moderately dense foliage, medium vigour, thorny, prolific bearer, one crop annually, leaf medium size, ovate to oblong, dorsi ventral leaf, apex broad, petiole winged, petiole length 2.5 cm long, leaf colour very light yellowish green, shiny, veins slightly prominent on upper surface, crush leaf aroma distinctly different from the sour lime, flower white, flower once annually, fruit oblong shape, small, yellowish green colour, smooth surface, oil gland prominent, areolar area smooth, insipid sweet, rind thin, 2 mm, medium firmness, leathery, adherence medium to strong, mesocarp white, thin, soft, sweet, axis solid or semi-solid, segments 11, seed several, 15-20 per fruit, pulp vesicle uniform white, T.S.S. 6.0 *(Plate-8)*

4.1.33 **Mandarin** (*Citrus reticulata* Blanco.)

Source of collection- Brajamohinipur, Deogarh.

Medium size plant, height 10-12 ft, upright erect habit, sparsely foliaged, slightly thorny, young shoots angular, glabrous, fruiting season November-January, one crop annually, prolific bearer, leaf medium, isobilateral, oblong, petiole wingless, petiole 3 cm long, dark green, flower white, bisexual, solitary, occasionally in pairs, fruit depressed, papilla present, rind thin, thickness 2.5 mm, soft, adherence very slight, slightly puffy, oil gland not prominent, mesocarp almost white, axis hollow, number of segment 10, adherence slight, pulp vesicle deep orange colour, seeds several, 15-20 per fruit, abundant juice, T.S.S. 8.0 *(Plate-8)*
4.1.34 Mandarin (*Citrus reticulata* Blanco.)

Source of collection- Brajamohinipur, Deogarh.

Small to medium size plant, height 7-10 ft, spreading habit, densely foliaged, thorny, young shoots angular, glabrous, fruiting season November-January, one crop annually, medium bearer, leaf medium, isobilateral, oblong shape, petiole wingless, petiole 3 cm long, dark green, flower white, bisexual, solitary, occasionally in pairs, fruit depressed, oval, large fruit, smooth surface, greenish orange colour, glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft, adherence very slight, slightly puffy, number of segment 10, adherence slight, pulp vesicle deep orange colour, seed several, 12-15 per fruit, abundant juice, T.S.S. 10.0 (Plate-8)

4.1.35 Mandarin (*Citrus reticulata* Blanco.)

Source of collection- Brajamohinipur, Deogarh.

Small size plant, height 5-7 ft, upright and erect habit, densely foliaged, thorny, young shoots angular, glabrous, fruiting seasons November-January, one crop annually, prolific bearer; leaf medium dorsiventral, ovate shape, petiole winged, petiole 2.5 cm long dark green, flower white, bisexual, solitary, occasionally in pairs, fruit depressed, oval shape, medium fruit, undulated surface, yellowish orange colour at ripeness, glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft, adherence very slight, slightly puffy, oil gland not prominent, mesocarp almost white, axis hollow, number of segments 10, adherence slight, pulp vesicle deep orange colour, seeds several, 15-17 per fruit, abundant juice, T.S.S. 8.0 (Plate-9)
4.1.36 Kagzi Lime (*Citrus aurantifolia* Swingle.)

Source collection- Rajamunda, Deogarh.

A small tree or shrub, bushy habit, height 8 ft, spreading, slender branch, densely foliaged, thorny, heavy yielder, pick season August- October, periodical low crops almost all the year round, leaf small and not prominently winged, oval shape, deep green, dorsi ventral, petiole 3 cm long, young bud light green with coppery tinge, flower small, white, main flowering season February-March, also all the year round; fruit oval to spherical, small to medium, color greenish yellow, surface very smooth, dotted with prominent oil gland, glossy, areole with irregular circular depression, areolar area ribbed, rind thin, thickness 2 mm, firmness medium, adherence strong, aroma distinctly of lime, pleasant, mesocarp white, thin, axis solid, segment 11, adherence strong, pulp vesicle slender, juice plenty, sour, excellent flavor, seeds few, 6 per fruit, cotyledon light greenish white, T.S.S. 7.0 (Plate-3)

4.1.37 Sweet Orange, Mosambi (*Citrus sinensis* Osbeck.)

Source of collection- Mithapalli, Deogarh.

A medium to tall plant, height 15-20 ft, upright, trunk straight, densely foliaged, thorny, fruiting season December- January, prolific bearer, one crop annually, leaf medium size, oval shape, deep green, isobilateral, petiole winged, petiole 2.5 cm long, flower white, solitary, bisexual, fruit ovate, small, slightly wavy surface, bright yellow to orange colour fruit, calyx slightly depressed, oil gland prominent, areole absent, areole area smooth, rind medium thick, thickness 2.5 mm, medium, soft, distinct aroma, mesocarp white, spongy, axis usually solid, number segments 10, pulp vesicle yellow to light orange, texture coarse, melting, flavor good, medium juice, colour transparent white, sweetness and acidity blended, seeds several, 12-15 per fruit, cotyledon white, T.S.S. 9.0 (Plate-9)
4.1.38 Mandarin (*Citrus reticulata* Blanco.)

Source of collection- Kundheigola, Deogarh.

Medium size plant, height 10-12 ft, spreading habit, sparsely foliaged, slightly thorny, young shoots, angular, glabrous, fruiting season November-January, one crop annually, prolific bearer; leaf medium, isobilateral leaf, oblong, petiole wingless, petiole 3 cm long, dark green, flower white, bisexual, solitary, occasionally in pairs, fruit depressed, ovate, small fruit, smooth surface, lemon orange colour, glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft adherence very slight, slightly puffy, oil gland not prominent, mesocarp almost white, axis hollow, number of segments 10, adherence slight pulp vesicle light orange colour, seed several, 10-15 per fruit, medium juice, T.S.S. 6.0 (Plate-9)

4.1.39 Sweet Orange, Mosambi (*Citrus sinensis* Osbeck.)

Source of collection – Government Farm, Barkote, Deogarh.

A tall plant, height 15-20 ft, upright, trunk straight, spreading branches, densely foliaged, thornless, fruiting season December-January, prolific bearer, one crop annually; leaf medium size, elliptical shape, deep green, isobilateral, petiole narrowly winged, petiole 2 cm long, flower white, solitary, bisexual, fruit spherical, medium, slightly wavy surface, bright yellow to orange colour fruit, calyx slightly depressed, oil gland prominent, areole absent, areole area smooth, rind medium thick, thickness 2.5 mm, medium soft, distinct aroma, mesocarp white, spongy, axis usually solid, number of segments 11, pulp vesicle yellow to light orange, texture coarse, melting, flavor good, medium juice, colour transparent white, sweetness and acidity blended, seed several, 15-20 per fruit, cotyledon white, T.S.S. 6.0. (Plate-9)
4.1.40 Mosambi (*Citrus sinensis* Osbeck.)

Source of collection – Paikamal, Padampur.

A tall plant, height 15-20 ft, trunk upright straight, spreading branches, densely foliaged, thorny, fruiting season December – January, prolific bearer, one crop annually; leaf medium size, oval shape, deep green, dorsiventral, petiole winged, petiole 2.5 cm long, flower white, solitary, bisexual, fruit ovate, medium, slightly wavy surface, bright yellow to orange colour fruit, calyx slightly depressed, oil gland not prominent, areole absent, areole area smooth, rind medium thick, thickness 2.5 mm, medium soft, distinct aroma, mesocarp white, spongy, axis usually solid, number of segments 10, pulp vesicle yellow to light orange, texture coarse, melting, flavour good, abundant juice, colour transparent white, sweetness and acidity blended, seeds several, 12-15 per fruit, cotyledon white, T.S.S. 6.0 (Plate-9)

4.1.41 Mosambi (*Citrus sinensis* Osbeck.)


A medium plant, height 8-10 ft, upright, trunk straight, spreading branches, densely foliaged, thorny, fruiting season December – January, prolific bearer, one crop annually; leaf medium size, oval shape, deep green, dorsiventral, petiole winged, petiole 2.5 cm long, flower white, solitary, bisexual, fruit oval, medium, slightly, wavy surface, bright yellow to orange colour fruit, calyx slightly depressed, oil gland not promintnt, areole absent, areole area smooth, rind thick, thickness 3 mm, medium, soft, distinct aroma, mesocarp white, spongy, axis usually solid, number of segments 10, pulp vesicle yellowish white, texture coarse, melting, flavor good, medium juice, colour transparent yellow, sweetness and acidity blended, seeds several, 10-15 per fruit, cotyledon white. T.S.S. 6.0 (Plate-9)
Plate 8: Narangi, Sweet lime & Mandarin found at Deogarh district of Orissa
Plate 9: Mandarin & Mosambi cv. of sweet orange found at Deogarh and Baragarh district of Orissa
4.1.42 Mandarin (*Citrus reticulata*)


Medium size plant, height 12-15 ft, upright and erect habit, sparsely foliaged, slightly thorny, young shoots angular, glabrous, fruiting season November – January, one crop annually, poor bearer; leaf medium, isobilateral, elliptical shape, petiole wingless, petiole 2.5 cm long, dark green, flower white, bisexual, solitary, occasionally in pairs, fruit depressed, ovate, medium fruits, smooth surface, yellowish orange colour, glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft, adherence very slight, slightly puffy, oil gland prominent, mesocarp almost white, axis hollow, number of segments 11, adherence slight, pulp vesicle greenish yellow colour, seeds several, 10-12 per fruit, abundant juice, T.S.S. 7.0 (Plate-10)

4.1.43 Mandarin (*Citrus reticulata*)


Medium size plant, height 10 ft, spreading habit, sparsely foliaged, slightly thorny, young shoot angular, glabrous, fruiting season November – January, one crop annually, prolific bearer; leaf medium, dorsi ventral, elliptical, petiole wingless, petiole 2.5 cm long, dark green, flower white, bisexual, solitary, occasionally in pairs, fruit depressed, oblone, large fruit, undulated surface, deep orange colour, glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft, adherence very slight, slightly puffy, oil gland not prominent, mesocarp almost white, axis hollow, number of segments 10, adherence slight, pulp vesicle deep orange colour, seeds few, 8 per fruit, abundant juice, T.S.S. 8.0 (Plate-10)

4.1.44 Mandarin (*Citrus reticulata*)


Medium size plant, height 10-12 ft, spreading habit, sparsely foliaged, slightly thorny, young shoot angular, glabrous, fruiting season November –
January, one crop annually, prolific bearer; leaf medium, isobilateral, oblong, petiole wingless, petiole 2.5 cm long, dark green, flower white, bisexual, solitary, occasionally in pairs, fruit depressed globose, medium fruit, undulated surface, yellowish orange colour, glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft, adherence very slight, slightly puffy, oil gland not prominent, mesocarp almost white, axis hollow, number of segments 10, adherence slight, pulp vesicle deep orange colour, seed several, 12-15 per fruit, abundant juice. (Plate-10)

4.1.45 Jamberi (*Citrus jambhiri* Lush.)


Plant medium to tall, height 15-18 ft, spreading moderately dense foliage, few thorn, fruiting season September – February, prolific bearer, one crop in a year; leaf medium, elliptical to oblong, isobilateral, deep green colour, petiole usually wingless or rudimentary winged, petiole length 2 cm, flower white, solitary or cluster, pedicel short, fruit oval to oblong, large, yellowish colour at ripeness, undulated surface, prominent oil gland, somewhat puffy, not very glossy, fruits never drop off naturally, apex slightly depressed, rind thickness 2-3 mm, firmness medium, adherence medium prominent, yellowish white pulp, juice plenty, transparent white juice, yellowish white rind, number of segments 10, seeds few, 10 per fruit, T.S.S. 7.0 (Plate-11)

4.1.46 Grape Fruit (*Citrus paradise* Macf.)


Plant medium to tall, height 9-12 ft, upright habit, medium vigor, densely foliaged, thorny, leaf small to medium, elliptical shape, petiole length 2.5 cm, not shiny, flower white, in cluster, fruit ovate to globose, medium, oil gland prominent, evenly rounded base, greenish yellow surface, undulated surface, basal
area depressed, apex evenly rounded, rind medium thick, 3 mm thickness, firm,  
number of segments 10, seeds numerous, 20-25 per fruit, juice sac closely packed,  
juice abundant, moderate flavour, whitish yellow pulp, T.S.S. 4.0 (Plate-11)

4.1.47 Mandarin (Citrus reticulata Blanco.)

Source of collection – Kuliposh, Lahunipada.

Medium size plant, height 10 ft, upright and erect habit, densely foliaged,  
thorny, young shoots angular, glabrous, fruiting season November – January, one  
crop annually, prolific bearer; leaf medium, dorsi ventral, oblong, petiole winged  
and 2.5 cm long, dark green, flower white, bisexual solitary, occasionally in pairs,  
fruit depressed, globes, medium fruit, slightly smooth surface, orange green  
colour, glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft,  
adherence very slight, slightly puffy, oil gland not prominent, mesocarp almost  
white, axis hollow, number of segment 10, adherence slight, pulp vesicle orange  
colour, seed several, 10-12 per fruit, abundant juice, T.S.S. 6.0 (Plate-11)

4.1.48 Mandarin (Citrus reticulata Blanco.)

Source of collection – Kuliposh, Lahunipada.

Medium size plant, height 10 ft, spreading habit, densely foliaged, vigorous  
thorny, young shoots angular, glabrous, fruiting season November – January, one  
crop annually, medium bearer; leaf medium, isobilateral, oblong, petiole winged  
and 3 cm long, dark green, flower white, bisexual, solitary, occasionally in pairs,  
fruit depressed, globose, large fruit, undulated surface, greenish yellow colour,  
glossy, base depressed, papilla present, rind thin, thickness 2.5 mm, soft,  
adherence slight, pulp vesicle deep orange, seed several, 10-12 per fruit, abundant  
juice, T.S.S. 7.0 (Plate-10)
4.1.49 **Pummelo** *(Citrus grandis* Osbeck.)*

Source of collection – Kuliposh, Lahunipada.

Medium size plant, height 10-12 ft, upright habit, densely foliaged, few thorn, young shoots angular, fruiting season October – December, one crop in a year; leaf large with broad wing, dark green, isobilateral, petiole 3 cm long, ovate oblong shape, veins slightly prominent on both sides, flowers white, large, pedicellate, fruit ovate to oblong, large size, smooth surface, greenish yellow when ripe, base moderately depressed, basal area slightly ribbed, areole absent, firm rind thick, thickness 2.5 mm, adherence strong, very prominent oil gland present, mesocarp light pink, vascular bundle prominent, texture soft and spongy, taste slightly sweet with little bitterness, axis hollow, irregular outline in cross section, number of segment 11, adherence medium strong, brilliant pink red colour pulp, pulp vesicle colour not uniform, vesicle irregular in shape and size, flavor medium, juice medium, seed numerous, 30 or more per fruit, cotyledon greenish with pinkish inner wall, T.S.S. 9.0 (*Plate-7*)
Plate-10: Mandarin & Mosambi cv. of sweet orange found at Baragarh & Sambalpur district of Orissa
Plate 11: Mandarin, Jambheri & Grape fruit found at Jharsuguda & Sundergarh district of Orissa
4.1.50 Sarbati Lemon (*Citrus limeticides* Tan.)

Source collection – Government farm, Kuliposh.

Tree medium, height 9 ft, spreading habit, moderately dense foliage, medium vigour, slightly thorny, poor bearer, one crop annually; leaf medium size, ovate to oblong, isobilateral leaf, apex broad, petiole winged, petiole length 3 cm, leaf colour very light yellowish green, not shiny, veins slightly prominent on upper surface, crushed leaf aroma distinctly different from the sour lime, flower white, flower once annually, fruit almost spherical or slightly globes, fruit large, yellowish green at ripeness, slightly smooth surface, oil gland prominent, distinct aroma, areolar area smooth, insipid, sweet, rind thin 2 mm, medium firmness, leathery, adherence medium to strong, mesocarp white thin, soft, sweet, axis solid or semi solid, segments 10, seeds few, 6-10 per fruit, pulp vesicle uniform white, T.S.S. 6.0.

4.1.51 Grape Fruit (*Citrus paradise* Macf.)

Source of collection – Biswakanan, Sundergarh.

Medium to tall plant, height 14-16 ft, spreading habit, sparsely foliaged, slightly thorny, leaf small to medium, oval, isobilateral leaf, petiole with winged, petiole length 3 cm, not shiny, flower white, in cluster, fruit oblate to globose, large, oil gland not prominent, evenly rounded base, greenish yellow surface, smooth surface, basal area depressed, apex evenly rounded, rind medium thick, 2.5 mm thickness, firm, number of segments 12, seed numerous, 15-20 per fruit, juice abundant, juice sac closely packed, moderate flavor, greenish white pulp, T.S.S. 6.0 (Plate-12)
4.1.52 Pummelo (*Citrus grandis* Osbeck.)

Source of collection – Kuliposh, Lahunipada.

Medium size plant, height 10-12 ft, upright habit, densely foliaged, not thorny, young shoots angular, fruiting season October – December, one crop in a year; leaf large, with broad wing, dark green, isobilateral leaf, petiole 3 cm long, elliptical shape, veins slightly prominent on both sides, flower white, large, pedicellate, fruit ovate to oblong, large size, undulated surface, greenish yellow when ripe, base moderately depressed, basal area slightly ribbed, areole absent, firm, rind thick, thickness 2.5 mm, adherence strong, oil gland very prominent, mesocarp light pink, vascular bundle prominent, texture soft and spongy, taste slightly sweet with little bitterness, axis hollow, irregular in outline in cross section, number of segment 10, adherence medium strong, brilliant pink red colour pulp, pulp vesicle colour not uniform, vesicle irregular in shape and size, flavor medium, juice medium, seeds numerous, 25 per fruit, cotyledon is greenish with pink inner wall, T.S.S. 6.0(Plate-12)
Plate 12: Grape fruit & Pummelo found at Sundergarh district of Orissa
4.2 EVALUATION OF IDENTIFIED GENOTYPES BASED ON MORPHOLOGICAL CHARACTER.

The following morphological descriptions of the fifty two specimens studied were recorded according to the proforma prepared for this purpose.

**Pummelo** (*C. grandis* Osbeck.)

**cv.: Large Red Fleshe**

**Vegetative characters**

The medium sized, hardy, vigorous; crown rounded open; foliage density medium, colour of emerging leaves light green; trunk robust, medium in height; bark thick, rough; branches robust, spreading; young shoots angular, deeply furrowed in cross section, densely hairy, spinach green (0960/1), oil glands on the young shoots few and ovalish; thorns numerous, straight, short, slender dark tan coloured.

Leaf lamina very large (average length 13.5 cm, breadth 8.0 cm), thick, glossy, slightly brittle, oblong- elliptic, upper surface spinach green (0960/1), lower surface lettuce green (861); margin undulated; apex acute; base obtuse; articulation with the petiole prominent; lower surface of lamina, midrib on lower surface and leaf margin thinly pubescent; glands on lower surface of lamina few, glands on lower surface of wing and petiole visible; veins not very distinct, slightly raised on lower surface, even on upper surface; petiole long, circular in cross section broadly winged, wing cordata, overlapping the base of lamina; scent of the leaves distinct and strong.

**Flower characters**

Flowering late; inflorescence spuriously terminal as well as of mixed type, cymose, size medium; flowers – bisexual only, scent mild and not agreeable; flower buds long and thick, obovoid, applanate quadrangular, furrowed towards base, white, pedicel thick, long, angular and grooved toward base, light green, hairy, glands few and sunken; calyx large, cup shaped, segments 3-4 (mostly 4), tapered, light green,
pubescent along the margin and outer surface, densely pubescent on the tips, glands sunken; petals 4, long, thick, fleshy, oblong, strongly reflexed, apex obtuse to rounded, glands large, moderately dotted towards apex, very few to absent at the base; stamens many (33), shorter than pistil (2/3rd of the length), filaments polyadelphous, united all along the length, medium long, flattened, thick, glabrous; anthers medium sized, oblong, apex sharply pointed, cream coloured, pollen moderately abundant; style thick, medium long, tapering, slightly curved, very thinly pubescent towards base; stigma very thick, strongly compressed, greenish yellow, secretion milky white; ovary large, obovate, clearly set off from the style; disc not prominent, broad, radially furrowed, greenish white.

**Fruit characters**

Fruit large (average diameter 11.6 cm, length 10.1 cm) oblate, golden yellow; surface finely pitted, faintly rugose; apex depressed, smooth; base slightly depressed, faintly and irregularly furrowed; calyx raised, thick, large, lobes persistent, long and sharply pointed; stem medium long, thick; nipple and areole absent; stalar scar medium sized, raised; style deciduous; oil glands large, moderate, primary glands prominently raised, oil abundant, sweetly aromatic and distinct.

Rind very thick, leathery, spongy, adherence medium; puffiness note; glandular layer thin; albedo pinkish white, bitter, spongy, thick; central axis large, solid, split after maturity, irregularly rounded; pith pinkish, striated; segments numerous (16-20, average 18), some burst, adherence medium strong, septa thick and tough; pulp unevenly water melon-pink, deeper towards periphery, texture coarse, vesicles medium long, fusiform, arising from dorsal wall only, oil droplets absent, stalk short (a few long); juice scanty, sugar medium, acidity medium, flavor sub acid, aroma distinctive, bitterness note; seeds numerous (51-104, average perfect seeds 43, imperfect seeds 36), large, arranged all along the central axis from apex to base, fresh seeds straw coloured with faint brownish tinge, irregularly D-shaped, very rough, veins prominent; cotyledons white; chalazas spot faintly brown. (Fig.8)
Fig. 8
LARGE RED FLESHED (C. grandis Osbeck)

1  2  3

NATURAL SIZE

4  5  6  7

1/2 NATURAL SIZE

8  9

10  11
Grape fruit (*C. Paradisi* Macf.)
cv. : Marsh seedless

Vegetative characters

Tree medium sized, hardy, vigor medium; crown rounded, medium compact; foliage density medium, colour of emerging leaves light green; trunk medium thick, long, bark thick, smooth; branches medium thick, spreading; young shoots angular and deeply furrowed in cross section, finely pubescent, more towards the tip, lettuce green (861), oil glands on the young shoots moderate and ovalish; rather thorny, thorns straight, short, slender, dull green with brownish tips.

Leaf lamina large (average length 10.6 cm, breadth 6.5 cm) moderately thick, firm, glabrous, elliptic, upper surface spinach green (0906/1), lower surface spinach green (9060/2); margin crenate; apex subacute; base rounded; reticulation with petiole distinct; glands on lower surface abundant; glands on the midrib on lower surface visible; veins fairly prominent, slightly raised on lower surface, even on the upper surface; petiole long, almost circular in cross section, broadly winged, wing chordate, slightly overlapping the base of lamina; scent of leaves mild.

Flower characters

Flowering mid season; inflorescence spuriously terminal and occasionally solitary axillary, medium sized, cymose; flowers bisexual as well as staminate, scent strong and pleasant; flower bud long, obovoid, furrowed towards apex, white; pedicel medium thick, long, obconical, ridged at the apex, light green, pubescence very sparse to absent, glands sparse and sunken; calyx medium size, copulated, 5-segments irregularly divided, greenish white, finely pubescent along the margin and outer surface, glands moderately dotted and slightly depressed; petals 5, long, ovate-lanceolate, strongly reflexed, apex obtuse, glands medium sized, thinly dotted; stamens moderate (27), equal to pistil length, filaments polyadelphous, united all along the length, flattened long, thin, glabrous; anthers small, oblong, yellow, apex notched,
pollen abundant; style medium thick, medium long, terete, slightly curved, hairy
towards the base, glands absent; stigma medium in diameter, strongly compressed,
yellow, secretion milky white; ovary medium sized, obovate, clearly set off from the
style; disc prominent, broad, cushion like, light cream coloured.

Fruit characters

Fruit large (average diameter 9.3 cm, length 8.5 cm) subglobose, golden yellow;
surface smooth but pitted; apex truncated to slightly depressed, smooth; calyx slightly
raised, medium to large lobes persistent, short and blunt; stem medium long, medium
thick; nipple and areole absent; styalr scar large, slightly depressed; style deciduous; oil
glands medium sized, ovate, abundant, primary glands depressed, oil abundant, aroma
distinct and mild.

Rind very thick, leathery, slightly spongy, adherence medium; puffiness none;
glandular layer thin; albedo white, bitter, soft, thick; central axis large, solid, irregularly
rounded; segments numerous (11-14, average 13) closed at the center, adherence
medium strong, septa medium thick; pulp straw coloured, texture medium, vesicles
medium long, fusiform, arising from dorsal and 1/4th of the radial walls, oil droplets
absent, stalk short to long; juice abundant, sugar medium, acidity medium, flavor
sprightly, aroma medium, bitterness in vesicles none; seeds numerous (46-73, average
perfect seeds 46, imperfect seeds 15), large arranged all along the central axis from
apex to base, fresh seeds off white, winged, slightly rugose, veins not prominent;
cotyledons white; chalazal spot tan coloured.(Fig.9)
Fig. 9

MARSH SEEDLESS (C. paradisi Macf.)

NATURAL SIZE
Amilbed (*C. megaloxycarps* Lush.)

**Vegetative characters**

Tree tall, hardy, vigorous; crown irregularly rounded, compact; foliage density medium, colour of emerging leaves light green; trunk medium thick, long; moderately rough; branch robust, spreading; young shoots angular in cross section, densely and finely pubescent, spinach green (0960/1), oil glands on the young shoots few and roundish; thorns numerous, straight, sharp, medium long, medium thick, green with brownish tips.

Leaf lamina large (average length 11.5 cm, breadth 0.6 cm.) thick, leathery, sparsely pubescent towards the base of lamina and along the midrib on lower surface, obovateelliptic, upper surface spinach green (9060/1), lower surface spinach green (0960/2); margin crenulate; apex obtuse; base rounded; articulation with the petiole obscure; glands on lower surface moderate; veins moderately prominent, slightly raised on lower surface, even on upper surface; petiole medium long, almost circular in cross section, narrowly winged, wing cordate; scent of the leaves suggestive of pummel.

**Flower characters**

Flowering early; inflorescence spuriously terminal, medium sized, cymose; flower bisexual only, early in the season, late in the season, staminate flowers also found, scent weak and not agreeable; flower bud long; obovoid- oblong, faintly ridged towards base, white with faintly purple pedicel medium thick, long, obconical, faintly ridged towards the distal end, light green, glands sparse and sunken, finely pubescent; calyx large, cup shaped, segments 5, (rarely 4), deltoid light green with very light purple patches, finely pubescent (more towards the apex), glands moderate and prominent; petals 5 (rarely 4), long, obovate- oblong, boat shaped, strongly reflexed, apex obtuse, glands dense; stamens many (40), slightly shorter than pistil, filaments polyadelphous, united all along the length, medium long flattened, thin, glabrous; anthers medium sized, ovate- oblong, bright yellow, apex obtuse, pollen abundant; style
medium thick, long, terete, sparsely pubescent towards base; stigma thick, obliquely knobbled, light yellow, secretion milky white; ovary medium sized, fusiform, moderately merging with style; disc prominent, broad, cushion like, radially ridged, light green.

**Fruit characters**

Fruit large (average diameter 10.7 cm, length 13.8 cm) ovate, lemon yellow; surface smooth, glossy, sparsely pitted; apex truncated, smooth base narrowed faintly and irregularly, furrowed; calyx even, large, lobes persistent, long, curved up and very blunt; stem long, medium thick, areole very faint and nipple absent; stylar scar medium sized, raised; style deciduous; oil glands large, few, primary glands depressed, oil medium, aroma strong, lemon like.

Rind very thick, leathery, adherence medium; puffiness none; glandular layer thin; albedo white, soft, slightly spongy, thick, slightly bitter, central axis large, semi-hollow, in some cases completely solid, irregularly rounded; segments numerous (12-14, average 13), slightly burst, adherence slight, septa thick to medium; pulp greenish yellow, texture medium, vesicles long, fusiform arising from dorsal wall only, croplets absent, stalk short to long; juice medium sugar little, acidity much, flavor poor, aroma weak, bitterness none, seeds medium (7-37, average perfect seeds 13, imperfect seeds 2), large, arranged all along the central axis mostly towards apicel end fresh seeds cream coloured, oval-oblong, slightly rough, veins prominent; cotyledons white; chalazal spot light brownish purple. *(Fig.10)*
Fig. 10
AMILBED (C. megaloxycarpa Lush)

NATURAL SIZE
**Keem (C. megaloxycarpa Lush.)**

**Vegetative characters**

A dwarf tree, semi hardy, vigour medium, slight attack of canker on fruits; crown rounded, moderately compact, foliage density thin, colour of emerging leaves light green; trunk robust, medium in height; bark thick, moderately smooth; branches slender, spreading; young shoots angular in cross section, finely and moderately pubescent, lettuce green (861), oil glands on the young shoots, few, slightly depressed, ovalish; thorns numerous, straight, sharp, short, slender, green with tan coloured tips.

Leaf lamina large (average length 10.2 cm, breadth 6.0 cm), thick, firm, oval-oblong, upper surface spinach green (0960/1), lower surface spinach green (0960/2); margin crenate; apex rounded and emerginated; base rounded; articulation with petiole prominent; finely pubescent along midrib on lower surface; leaf and wing margin very sparsely pubescent; glands on lower surface of lamina moderate, glands on the midrib on lower surface; leaf wing margin very sparsely pubescent; glands on the lower surface of lamina moderate, glands on the midrib on lower surface visible; veins prominent, slightly raised on upper surface, even on lower surface; petiole medium long, semi circular to circular in cross section, broadly winged, wing cordate, margin faintly crenulated, slightly overlapping the base of lamina; scent of leaves distinct and mild.

**Flower characters**

Flowering mid season; inflorescence spuriously terminal, medium sized, cymose; flower bisexual only, scent not agreeable, scent of young shoots suggestive of guava; flower bud long, obovate, broadened towards apex, white; pedicel thick, long tapering towards base, green, densely pubescent, glands sparse and slightly sunken; calyx large, cup shaped segments mostly 4 (rarely 5), abruptly tapered, green, minutely and densely pubescent along the margin and outer surface, glands prominent; petals 4-5, long, obovate-oblong, slightly shorter than pistil, filament polyadelphous, united all
along the length, medium long, flattened, thick, glabrous; anthers medium sized, oblong, yellow, apex obtuse, pollen abundant; syle medium thick, medium long, clavate, moderately pubescent, glands densely dotted and raised; stigma thick, strongly compressed, light yellow on light green background, secretion milk white; ovary large, ovate, somewhat merging with style; disc prominent, broad, cushion like, green.

**Fruit characters**

Fruit large (average diameter 13.6 cm. length 13.0 cm) subglobose, light russet yellow (straw yellow (604/1); surface uneven and sparsely pitted; apex depressed, slightly rugose; base rounded, irregularly and deeply furrowed; calyx depressed, large, lobes persistent, blunt; stem long, medium thick; nipple and areole absent; stylar scar medium sized, raised; style deciduous; oil glands large drop-shaped, few, primary glands depressed, oil abundant, aroma suggestive to citron.

Rind very thick, somewhat spongy, firm, sweetish, adherence strong; puffiness none; glandular layer thin; albedo white, slightly spongy, thick, sweetish; central axis large, hollow to semi hollow, irregular; segments numerous (13-15, average 14), burst at the center, adherence strong, septa thick; pulp straw coloured with pinkish patches, texture medium, vesicles long, medium thick, fusi-from, arising from dorsal wall only, oil droplets absent, stalk short to long; juice abundant, sugar little, acidity medium, flavor poor, aroma weak like pummel, bitterness none; seeds numerous (24-57, average perfect seeds 44, imperfect seeds 2), large, arranged at the central axis from apex to base, fresh seeds cream coloured with brownish patches, D-shaped to elliptic-oblong, rough, veins prominent; cotyledons white; chalazal spot brownish purple. *(Fig.11)*
Fig. 11
KEEM(C. megaloxycarpa Lush.)

(NATURAL SIZE)

1/2 NATURAL SIZE)
**Gajanimma** (*C. pennivesiculata* Tan.)

**Vegetative characters**

Tree medium sized, hardy, vigorous; crown rounded, compact; foliage density medium, colour of emerging leaves purple; trunk robust, long; bark thick, branches, medium thick, spreading; young shoots angular in cross section, glabrous, spinach green (0960), oil glands, young shoots few, ellipsoid; thorns numerous, straight, long, thick, green with russetted patches and dull brown tips.

Leaf lamina large (average length 10.8 cm, breadth 5.7 cm), thick, leathery, extremely glossy, slightly cupped and characteristically twisted, glabrous, oval-oblimg, upper surface spinach green (0960), lower surface lettuce green (861); margin crenate; apex obtuse with slight emergination; base obtuse; articulation with the petiole distinct; glands on lower surface abundant; veins fairly prominent; slightly raised on lower surface, even on upper surface, petiole long, semicircular in cross section, narrowly winged, wing club shaped; scent of leaves distinct and strong.

**Flower characters**

Flowering early; inflorescence spuriously terminal, medium sized, cymose; flowers mostly staminate, rarely bisexual, scent weak and not agreeable; flower bud short, obovoid with depressed apex, light purple; pedicel slender, medium long, obconical, irregularly ridged towards apex, green glands absent to very sparse and sunken, glabrous; calyx small, cup shaped, segments irregularly divided, faint purple, more deeper towards apex, finely pubescednt along the margin, glands moderately prominent, even, petals mostly 4, also 5, medium long, elliptic, slightly reflexed, apex obtuse to rounded, glands dense towards the upper half, very few at the base; stamens moderate (28), slightly longer than pistil, filaments free, short, proportionate to the size of anthers, acicular, thin; anthers large, ovate yellow, apex sharply pointed, pollen abundant; style thick, medium long, dumb bell shaped, glabrous, light purplish, glands prominent, dense and raised; stigma thick, flattened (disc like), merging with style,
cavernous, light yellow, no secretion; ovary large, obovate and necked, merging with style; disc prominent, broad, cushion like, radially ridged, yellowish white.

**Fruit characters**

Fruit large (average diameter 9.2 cm, length 8.8 cm), ovate-globose, golden yellow; surface smooth, glossy, sparsely and deeply pitted; apex rounded, irregularly furrowed; base rounded; deeply and irregularly furrowed; calyx depressed, lobes persistent, short, medium thick; stem long, medium sized, depressed; style deciduous; oil glands small, ovate, moderate, primary glands slightly depressed; style scar medium sized, depressed; style deciduous; oil glands small, ovate, moderate, primary glands slightly depressed, oil abundant, aroma distinct and strong.

Rind medium thick, leathery, adherence strong; puffiness none; glandular layer thick; albedo white, soft, thin, tasteless; central axis medium sized, solid, irregularly rounded; segments numerous (14-16, average 14), closed at center, adherence strong, septa thin, pulp greenish white, texture fine, vesicles short, thin, fusiform, arising from dorsal and ½ of radial walls, arranged in herring bone fashion, oil droplets present, stalk long; juice abundant, sugar little, acidity much, flavor poor, aroma medium, bitterness none; seeds numerous (89-97, average perfect seeds 65, imperfect seeds 29), medium sized, arranged all along the central axis from apex to base, fresh seeds cream coloured with tan patches towards the middle, ovate, ellipsoid, smooth, veins not prominent; cotyledons white; chalazal spot brownish purple. *(Fig.12)*
Fig. 12
GAJANIMMA (C.pennivesiculata Tan)

NATURAL SIZE
Citron (C. medica Linn.)
cv. – Sour Citron

Vegetative characters

A dwarf tree or a shrub, hardy, slow growing; crown irregularly shaped, open; foliage density thin, colour of emerging leaves reddish purple; trunk medium thick, short; bark thick, moderately smooth; branches medium thick, moderately smooth; branches medium thick, drooping to slightly straggling; young shoots rounded in cross section, glabrous, lettuce green (861), oil glands on the young shoots few and ovalish; thorns numerous, straight, sharp, long, medium thick with yellowish brown tips.

Leaf lamina medium sized (average 1.0 cm. breadth 5.0 cm.), medium thick, smooth but rumpled, glabrous, obovate-oblong, upper surface spinach green (0960/1), lower surface lettuce green (861); margin serrulate; apex rounded; base obtuse to rounded; articulation with the petiole obscure, sometimes absent; glands on lower surface of lamina moderate; veins prominent, slightly depressed on upper surface; petiole short, almost circular in cross section, wingless or barely margined; scent of the leaves feeble.

Flower characters

Flowering mid season; inflorescence spuriously terminal, large, cymose; flowers bisexual as well as staminate, scent weak and not agreeable; flower bud long, elliptic-oblong, faintly furrowed, unevenly purplish; pedicel thick, medium long, obconical, smooth, light green, glands slightly sunken, glabrous; calyx medium sized, cupulate, segments 4-5 (mostly 5), thick and fleshly, segments irregularly divided, light green with light purple patches, sparsely pubescent along the tips only, glands sparse, slightly raised; petals 5, long, elliptic oblong, slightly reflexed, apex acute, slightly recurved, glands dense towards apex and moderate at the base; stamens many (40), uneven, shorter than the pistil (3/4th of the length), filaments polyadelphous, united all long the length, medium sized, filiform, bright yellow, apex sharply pointed; pollen abundant;
style thick, medium long, clavate finely pubescent, sometimes purplish patches present, glands prominent and slightly raised towards apex; stigma very thick, knobbed and cavernous, yellow, no secretion; ovary large; barrel shaped, merging with style; disc annular, ridged, green.

**Fruit characters**

Fruit large (average diameter 8.6 cm, length 17.8 cm), ovate-oblong, lemon yellow, surface rough, warty, pitted; apex prominently and broadly nipped, warty, deeply and irregularly furrowed; base broadly necked, irregularly and broadly furrowed; calyx depressed, thick, medium sized, lobes persistent, short, tips acute and drying out; stem long, medium thick; areole and navel absent; styal scar large, depressed; style deciduous; oil glands small, elliptic, moderate, primary glands depressed, aroma weak.

Rind very thick, firm adherence very strong; puffiness none; glandular layer thin; albedo white, hard, thick; central axis medium sized, hollow, irregularly shaped; pith slight, in strands; segments medium (10-13, average 11) closed at the center, adherence strong, septa thick; pulp uniform, light straw coloured, texture medium, vesicles medium long, fusiform, arising from dorsal wall only, oil droplets absent, stalk short (a few long); juice scanty, sugar little, acid much, flavor poor, aroma weak, bitterness none; seeds numerous (76-145, average perfect seeds 109, imperfect seeds 13), medium sized, arranged all along the central axis from apex to base, fresh seeds cream coloured, ovate, pulp, smooth, veins not distinct; cotyledons white; chalazal spot deep brownish purple. (Fig. 13)
Fig. 13
SOUR CITRON (C. medica Linn.)

1/2 NATURAL SIZE
Lemon (C. limon Burn.)

Vegetative characters

A dwarf tree or shrub, hardy, vigour medium; crown rounded to flattened, open; foliage density thin, colour of emerging leaves purplish; trunk robust, short; bark medium thick, moderately rough; branches medium thick, straggling; young shoots angular in cross section, glabrous, spinach green (0960/2), oil glands on the young shoots moderate, ellipsoid, thorns numerous, straight, medium long, medium thick, green with russetted tips.

Leaf lamina medium sized (average length 10.0 cm. breadth 5.8 cm.), medium thick, leathery, glabrous, obovate-oblong, upper surface spinach green (0960/3), lower surface pod green (061); margin serrate, apex subacuminate; base rounded; articulation with the petiole obscure; glands on lower surface of lamina moderate, glands on the midrib on the lower surface of lamina moderate, glands on the midrib on the lower surface, located in shallow furrows on upper surface; petiole short, almost circular in cross section, margined or wing rudimentary; scent of leaves mild; suggestive of citron.

Flower characters

Flowering late; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual only, scent weak and pleasant; flower bud long, oblong, uniform purple; pedicle medium thick, medium long, obconical, irregularly and faintly furrowed, light green, in some cases with faint purple patches, glabrous, glands sparse and slightly sunken; calyx medium sized, thick and fleshy, cup shaped, segments 4-5 (mostly 5), abruptly tapered, light green, in some cases faint purple patches present, finely pubescent on the tips and very sparsely on outer surface; petals 4-5 (mostly 5), long, oblong, strongly reflexed, apex obtuse, glands medium sized and moderately dotted at 2/3\textsuperscript{rd} of the apex side; stamens moderate (28), uneven, slightly shorter than pistil, filaments polyadelphous, united all along the length, medium long, thin, densely
hairy, more towards apex; anthers medium sized, medium sized, ovate, yellow, apex pointed, pollen abundant; style thick, medium long, clavate, slightly curved, glabrous, greenish white, in some cases, particularly in older ones faint purple patches present, glands moderate and raised; stigma thick, subglobose, cavernous, groove, yellow, no secretion; ovary large, broadly conical, margin with the style but not to the extent as in the citron, disc moderately prominent, ring like, indistinct, ridged, light green.

**Fruit characters**

Fruit medium sized (average diameter 5.1 cm, length 6.6 cm) oval, tapering at both the end, lemon yellow; surface smooth, glossy; apex with small nipple, nipple tapered, faintly furrowed towards the apex; base evenly rounded to slightly necked, smooth; calyx raised, medium sized, areole and navel absent; stylar scar medium sized, depressed; style deciduous, rarely persistent; oil glands small, roundish, moderate, even to slightly depressed, oil abundant, aroma distinct and strong.

Rind medium thick, leathery, adherence strong; puffiness none; glandular layer medium thick; albedo white, soft, tasteless, thin; central axis medium sized, solid, stellate; segments medium (9-10, average 10), closed at the center, adherence medium, septa thick; pulp dull white with faint greenish tinge, texture fine, vesicles medium long, fusiform, arising from dorsal wall only, oil droplets absent, stalk short (a few long); juice amount medium, sugar little, acidity, much, aroma fair, bitterness none; seeds numerous (30-40, average perfect seeds 34, imperfect seeds 1), medium sized, arranged all along the central axis from apex to base, fresh seeds muddy tan coloured, conical, smooth, slightly sticky, veins not prominent; cotyledons white; chalazal spot deep brown. *(Fig.14)*
Fig. 14
MALTA (C. limon Burm.)

NATURAL SIZE
**Lemon (C. Limon Burn.)**

**cv. : Villafranca**

**Vegetative characters**

Tree tall, hardy, vigorous; crown somewhat rounded, open; foliage density thin, colour of emerging leaves purplish; trunk robust, medium high; bark thick, moderately smooth; branches robust, upright; young shoots angular in cross section, glabrous, spinach green (0960/1), oil glands on the young shoot moderate, ovalish; thorns numerous, straight, medium long, medium thick, green with yellowish brown tips.

Leaf lamina medium sized (average length 9.2 cm, breadth 4.5 cm), thin glabrous, lamina characteristically twisted, elliptic, upper surface spinach green (0960/1), lower surface spinach green (0960/2); margin serrated; apex sub acuminate; base acute, articulation with the petiole distinct; glands on lower surface of lamina moderate, glands on the midrib on the lower surface visible and slightly raised; veins not prominent, on lower surface slightly distinct, on upper surface indistinct, petiole short, almost circular in cross section, barely margined or wingless; scent of leaves distinct and strong.

**Flower characters**

Flowering late; flowers mostly solitary axillary all along the flowering branch; bisexual as well as staminate, scent mild and pleasant; flower bud long, obovoid oblong, faintly ridged, purplish; pedicel medium thick, medium long, obconical, faintly furrowed, light green, oil glands very sparse and sunken, glabrous; calyx medium sized, cup shaped, segments 5, deltoid, greenish white with light purple margin and apex, finely and sparsely pubescent along the tips only, glands distinct and sparse; petals 5, oblong- elliptic, slightly reflexed, apex acute, glands medium sized and moderately dotted; stamens moderate (30), slightly shorter than pistil, filaments polyadelphous, united all along the length, medium long, flattened, medium thick, glabrous; anthers medium sized, oblong, yellow, apex obtuse, pollen abundant; style medium thick,
medium long, clavate, glabrous, faintly purplish, glands distinct, raised; stigma slender, strongly compressed, yellow, section colourless; ovary medium sized, broadly conical, moderately merging with the style; disc prominent, medium in diameter, cushion like, radially ridged, dull white.

Fruit characters

Fruit medium sized (average diameter 6.0 cm, length 7.6 cm.), oval nipple, lemon yellow; surface smooth, glossy, finely pitted; apex with small nipple, narrowly tapered, slightly rugose; base evenly rounded, smooth; calyx raised, medium sized, lobes irregularly divided, short, thick and persistent; calyx raised, medium long, medium thick; areole and navel absent; sylar scar small, depressed; style deciduous; oil glands small, appplanate triangular, primary glands depressed, moderate, oil abundant and aromatic.

Rind medium thick, leathery, adherence strong; puffiness none; glandular layer medium thick; albedo white, soft, tasteless, thin; central axis small, solid, irregularly circular; segments medium (10-12, average 11), closed at the center, adherence medium to strong, septa thin; filiform, arising from dorsal wall only, oil droplets absent, stalk short (a few long); juice abundant, sugar little, acidity much, flavor poor, aroma medium, bitterness none; seeds numerous (7-19, average perfect seeds 11, imperfect seeds11), medium sized, arranged all along the central axis from apex to base, fresh seeds light brownish, ellipsoid, smooth, slight sticky, veins inconspicuous; cotyledons white; chalazal spot brownish purple.(Fig.15)
Fig. 15
VILLA FRANCA (C. limon Burm.)
Lemon (*C. limon* Burn.)
cv. : Nepali Oblong

Vegetative characters

Tree medium sized, hardy, vigour medium; crown rounded to spreading, open; foliage density thin, emerging leaves purple; trunk medium thick, medium high; bark thick, moderately smooth; branches medium thick, drooping to slightly straggling; young shoots angular in cross section, glabrous, spinach green (0960/1), oil glands on the young shoot few, ovalish; rather thorny, thorns straight, sharp, medium long, slender, dull green with deep brown tips.

Leaf lamina medium sized (average length 9.8 cm, breadth 5.0 cm), medium thick, leathery, surface slightly rumpled, ovate-oblong, upper surface spinach green (0960/1), lower surface spinach green (0960/3); margin serrated; apex acute; base rounded; articulation with petiole obscure; oil glands on lower surface of lamina abundant, glands on the midrib on the lower surface visible; veins prominent on lower surface and slightly raised on upper surface, depressed; petiole short, almost circular in cross section, rarely margined; scent of the leaves distinct and strong.

Flower characters

Flowering mid season; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual as well as staminate, scent weak and not agreeable; flower bud long, ovoid-oblong, purple in patches; pedicel thick, short, obconical, irregularly and faintly ridged, faint purplish patches on light green background, glands sparse and sunken, glabrous; calyx medium sized, segments 5, abruptly pointed, pale green with light purple patches, glabrous; petals 4-5 (usually bisexual flowers are 5-petalled, staminate flowers 4-petalled), long, obovate-oblong, strongly reflexed, apex acute, glands medium sized, dense towards 2/3rd portion of the apex, very few or absent towards base; stamens many (33), shorter than pistil by 1/3rd of the length, filaments polyadelphous, united all along the length, medium long, flattened, thin, sparsely
pubscent on both sides of filaments; anthers medium sized, ovate, yellow, apex acute, pollen abundant; style medium thick, short, more or less cylindrical; glabrous, glands prominent and raised; stigma thick, obliquely knobbed, cavernous, yellow, no secretion; ovary large, barrel shaped to cylindrical, merging with style; disc prominent and elevated, broad in diameter, cushion like, radially ridged, dull white.

**Fruit characters:**

Fruit medium sized (average 7.1 cm, length 11.0 cm), oval, lemon yellow (chrome yellow 605/2); surface rugose; apex prominently nippled, nipple long, narrow and irregularly furrowed; base short necked, irregularly and deeply furrowed; calyx depressed, large, lobes somewhat in circular form and curved up, persistent; stem medium long, medium thick; areole and navel absent; stylar scar medium sized, depressed; style deciduous; oil glands medium sized, ovate, depressed, oil abundant, aroma distinct and strong.

Rind medium thick, firm, adherence strong; puffiness none; glandular layer medium thick; albedo white, soft, tasteless, thin; central axis medium sized, hollow, irregularly circular, pith in cottony strands; segments medium (10-12, average 11), closed at the center, adherence strong, septa thick; pulp greenish white, texture medium, vesicles medium long, fusiform, arising from dorsal wall only, oil droplets absent, stalk short to long; justice abundant, sugar little, acidity much, flavor poor, aroma medium, bitterness none; seeds absent. *(Fig.16)*
Fig. 16
NEPALI OBLONG (C. limon Burm.)

NATURAL SIZE

1 2 3 4 5 6 7 8 8a 8b 9 10

111
**Lemon** (*C. limon* Burn.)

**cv. : Baramasi (Kodur)**

**Vegetative characters**

A dwarf tree or shrub, hardy, vigour medium; crown rounded to flattened, open; foliage density medium; colour of emerging leaves purplish; trunk medium thick, bark thick, moderately smooth; branches slender upright; young shoots angular in cross section, glabrous, spinach green (0960/1), oil glands on young shoots moderate, ovalish; thorns few, straight, medium long, medium thick, green with brown tips.

Leaf lamina medium sized (average length 9.6 cm, breadth 5.2 cm), medium thick, soft, glabrous, elliptic upper surface spinach green (0960), lower surface spinach green (0960/2); margin serrate; apex obtuse; base obtuse; articulation with the petiole fairly prominent; glands on midrib on lower surface visible; veins fairly prominent; petiole short, sub cylindrical in cross section, wing barely margined or rudimentary; scent of the leaves distinct.

**Flower characters**

Flowering early; inflorescence spuriously terminal, large, cymose; flowers bisexual only, scent, weak and pleasant; flower bud long, obovoid, with purple longitudinal striations; pedicel medium thick, short, tapering towards base, light green, gland very few and sunken, glabrous; calyx medium sized, cup shaped, segments 5, deltoid, light green, finely pubescent along the margin, glands moderately distributed, even; petals 5, long, elliptic oblong, slightly reflexed, apex obtuse, glands medium sized, moderately dotted; stamens moderate (30), equal to or slightly longer than pistil, filaments polyadelphous, united all along the length, long, flattened, thin, glabrous; anthers small, oblong, yellow, apex mucronate, pollen abundant; style slender, medium long, terete, glabrous, faintly purplish, glands moderately dotted, slightly raised; stigma medium thick, strongly compressed, yellow, secretion colourless; ovary medium sized,
barrel shaped, moderately merging with style; disc prominent, medium in diameter, cushion like, ridged, green.

**Fruit characters**

Fruit medium sized (average diameter 6.7 cm, length 7.1 cm), oval, golden yellow, surface smooth, shining; apex obtuse, smooth; base evenly rounded, smooth; calyx raised, medium sized. lobes persistent, blunt; stem medium long, medium thick; nipple, areole and navel absent; styrar scar medium sized, even to slightly depressed; style deciduous; oil glands small, roundish, moderate, primary glands slightly depressed, oil abundant, aroma suggestive of sweet lime.

Rind thin smooth, adherence slight; puffiness none; glandular layer medium thick; albedo white, smooth, tasteless, thin; central axis medium sized, semi hollow, irregular stellate; segments medium (10-11, average 10), closed at the center, adherence slight, septa thin; pulp straw coloured, texture fine, vesicles long, filiform, arising from dorsal wall only, oil droplets absent, stalk arising from dorsal wall only, oil droplets absent, stalk short; juice abundant, sugar little, acidity much, flavor poor, aroma weak, bitterness none; seeds medium (10-20, average perfect seeds 4, imperfect seeds 8), medium sized, arranged all along the central axis from apex to base fresh seeds deep muddy tan coloured, ovoid, semi-winged, smooth, veins not distinct; cotyledons white; chalazal spot deep brownish purple. (Fig.17)
Fig. 17
BARAMASI (KODUR) (C.limon Burm.)

NATURAL SIZE
**Lemon** (*C. limon* Burn.)

cv.: Meyer

**Vegetative characters**

The dwarf tree or a shrub, hardy, vigour medium; crown rounded, open; density medium, colour of emerging leaves faint purple; trunk medium thick, medium high; bark thick, moderately smooth; branches slender, upright, young smooth angular in cross sections, glabrous, spinach green (0960/1), oil glands on young shoots moderate, ovalish; rather thorny, thorns straight, medium long medium thick, green with yellowish tips.

Leaf lamina medium size (average length 9.3 cm, breadth 5.5 cm), medium thick, leathery, slightly cupped glabrous, oval, upper surface spinach green (0960), lower surface spinach green (0960/2); margin serrate; apex rounded; base obtuse; articulation with the petiole rather distinct; glands on lower surface moderate, glands on the midrib on lower surface visible; veins moderately prominent, slightly raised on lower surface, even on upper surface; petiole short, sub cylindrical in cross section, with slightly grooved upper side, wing barely margined or rudimentary; scent of the leaves distinct and strong.

**Flower characters**

Flowering early; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual as well as staminate, scent weak and not agreeable; flower bud long, obovoid-oblong with uneven purple patches; pedicle medium thick, short, tapering towards base, irregularly ridged at the base, light green, glands sparse and sunken, glabrous; calyx medium sized, copulate, segments 5, deltoid, light green with light purple, finely pubescent along the margin, outer surface very thinly pubescent, glands prominent, dense, raised; petals 5, medium sized, obovate, strongly reflexed, apex acute, glands fine and moderately dotted; stamens moderate (23), slightly shorter than the pistil, filaments polyadelphous, united all along the length, medium long, acicular,
thin, glabrous; anthers medium sized, oblong, yellow, apex mucronate, pollen abundant; style slender, medium long, tapering, glabrous; stigma medium thick, strongly compressed, yellow, secretion colourless; ovary small barrel shaped, moderately merging with the style; disc prominent, medium in diameter, cushion like, ridged, greenish.

**Fruit characters**

Fruit medium sized, (average diameter 6.6 cm, length 7.1 cm), globose, orange yellow; surface smooth, glossy, apex minutely nipped, smooth; base obliquely round, smooth; calyx raised, medium sized, lobes persistent, sharply pointed; stem medium long, medium thick; areole and navel absent; stylar scar small, raised; style deciduous, oil glands medium sized, broadly ovate, moderate, primary glands slightly raised, oil abundant, aroma somewhat suggestive of sweet lime.

Rind thin, soft, adherence slight to medium; puffiness none; glandular layer medium thick; albedo ivory white, soft, tasteless, thin; central axis medium sized, almost hollow, irregular; segments medium (10-12, average 11), closed at the center, adherence slight to medium, septa membranous, like sweet lime, pulp deep straw coloured, fine, vesicles long, fusiform, arising from dorsal wall only, oil droplets absent, stalk short (a few long); juice abundant, sugar little, acidity low (for a lemon), flavor good like a sweet orange, aroma weak, bitterness none; seeds medium (13-20, average perfect seeds less than 1, imperfect seeds 15), medium sized, arranged all along the axis from apex to base, fresh seeds straw coloured, oval, slightly rugous, veins prominent; cotyledons white; chalazal dark purple. *(Fig.18)*
Fig. 18

MEYER (C. limon Burm.)

NATURAL SIZE
Lemon (C. limon Burn.)
cv. : Seedless (Kodur)

Vegetative characters

Tree medium sized, hardy, vigour medium; crown rounded to flattened, open; foliage density thin, colour of emerging leaves purplish; trunk medium thick, medium high; bark thick, smooth; branches medium thick, spreading; young shoots angular in cross section, glabrous, spinach green (0960/2), oil glands on the young shoots moderate, ovalish; rather thorny, thorns straight, medium long, slender, green with yellowish brown tips.

Leaf lamina medium sized (average length 10.2 cm, breadth 4.4 cm), moderately thick, subcorianceous, surface slightly rumpled, glabrous, oval-oblong, upper surface spinach green (0960/1), lower surface pod green (061); margin serrate; apex sub acute; base rounded; articulation with the petiole obscure; glands on lower surface moderate, glands on the midrib on lower surface visible; veins prominent, slightly depressed on upper surface, slightly raised on lower surface; petiole short, semicircular in cross section, barely winged or rudimentary; scent of leaves suggestive of citron.

Flower characters

Flowering mid seasons; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual as well as staminate, scent weak and not agreeable; flower bud long, obovoid-oblong, ridged with light purple patches, more towards the base; pedicel thick, medium long, obconical, smooth, light green with light purple patches, glands few and sunken, glabrous; calyx medium sized, copulate, segments 5, obtuse, with purplish patches, sparsely pubescent along the tips only, glands raised; petals 4-5 (mostly 4), 4 petalled flowers mostly staminate, 5 petalled mostly pistillate, long, obovate, reflexion of petals medium, apex obtuse, glands fine, dense towards apex,
few at the base; stamens numerous (34), slightly shorter than pistil, filaments polyadelphous, united all along the length, medium long, acicular, thin, finely pubescent on both the sides; anthers medium sized, ovate, bright yellow, apex acute, pollen abundant; style medium thick, medium long, cylindrical, glabrous, glands prominent and raised; stigma thick, strongly compressed, cavernous, yellow, no secretion; ovary large, tapering, merging with style; faintly furrowed disc prominent, broad, ring like, ridged, dull white.

**Fruit characters**

Fruit medium sized (average diameter 6.6 cm, length 7.3 cm), nippled globose, lemon yellow; surface smooth, glossy, very faintly ribbed, finely pitted; apex with small nipple, abruptly tapered, smooth to very faintly furrowed; base obliquely rounded, rugose, faintly furrowed; calyx raised, fleshy, medium sized, lobes persistent, short, slightly curved up, blunt, disc like; stem medium long, medium thick; areole and navel absent; stylar scar medium sized, depressed; style deciduous; oil glands large, appleanate triangular, abundant, primary glands depressed, oil abundant; aroma distinct and strong.

Rind medium thick, leathery, adherence strong; puffiness none; glandular layer medium thick; albedo white, soft, thin, tasteless; central axis large, semi-hollow, irregular; pith slight, cottony; segments numerous (12-14, average 13), closed at the center, adherence strong, septa thin; pulp greenish white, texture medium, vesicles medium long, filiform, arising from dorsal wall only, oil droplets absent, stalk short to long; juice abundant, sugar little, acidity much, flavor poor, aroma weak lemon like, bitterness none; seeds absent to few (0-3, average perfect seeds 1, imperfect seeds less than 1), medium sized, arranged all along the central axis from apex to base, fresh seeds muddy coloured, shape variable smooth, veins not prominent; cotyledons greenish white, chalazal bright brownish purple. (Fig.19)
Fig. 19

SEEDLESS (KODUR) (C. limon Burm.)

NATURAL SIZE

1 2 3 4 5 6 7

8 9

8a 8b 10 11

120
**Lemon (C. limon Burn.)**

**cv. : Italian Round**

**Vegetative characters**

Tree medium sized, hardy, vigour medium; crown irregularly round, open; foliage density thin, colour of emerging leaves faint purple; trunk medium thick, medium high; bark medium thick, moderately smooth; branches slender, spreading to straggling; young shoots rounded in cross section, glabrous, spinach green (0960/1), oil glands on the young shoot few, ovalish; rather thorny, thorns short, slender, green with brownish tips.

Leaf lamina large (average length 10.2 cm, breadth 6.0 cm) fairly thin, soft, glabrous, elliptic, upper surface spinach green (0960/2), lower surface lettuce green (861); margin serrulate; apex and base obtuse; glands on lower surface moderate, glands on the midrib visible; veins fairly prominent, slightly raised on the lower surface, even to depressed on upper surface; petiole short, semicircular in cross section; slightly winged; scent of the leaves distinct and strong.

**Flower characters**

Flowering late; inflorescence spuriously terminal, sometimes axillary (2 flowers per axil), small cymose; flowers bisexual as well as staminate, scent weak and pleasant; flower bud medium long, obovoid, petals slightly open longitudinally, light purple patches present; pedicel slender, medium long, obconical, ridged, light green, glabrous; calyx medium sized, copulate, segments 4-7 (mostly 5), irregularly divided, greenish white, in some cases with faint purplish patches, pubescent absent to very along the tips; petals 4-5 (4 petalled flowers mostly staminate), long, obovate, strongly reflexed, apex obtuse, glands medium sized, moderately dotted; stamens moderate (26), filamented, thin, slightly pubescent; anthers medium sized, oblong, yellow, apex obtuse, pollen abundant; style medium thick, medium long, clavate, in some cases purplish patches present, glands prominent and raised, glabrous; stigma medium thick,
oblate, grooved on one side, cavernous; yellow, secretion milky white; ovary medium sized, barrel shaped, moderately merging with the style; disc not prominent, cushion like, light green, ridges inconspicuous.

**Fruit characters**

Fruit medium sized (average diameter 5.7 cm, length 5.9 cm), sub globose to globose, lemon yellow, surface smooth, glossy; apex with small nipple, smooth to faintly furrowed; base evenly rounded and slightly necked, smooth; calyx raised, medium sized, lobes persistent, short, irregularly divided, abruptly pointed; stem long, slender; areole and navel absent, styal scar medium sized, raised; style deciduous; oil glands small, roundish, abundant, primary glands even, oil abundant, aroma distinct and suggestive of sour lime.

Rind thin, leathery, adherence strong; puffiness none; glandular layer medium thick; albedo white, soft tasteless, very thin; central axis small, semi-hollow, irregularly stellate; segments medium (10-11, average 11), closed at the center, adherence strong, septa membranous; pulp faintly greenish, texture fine, vesicles short, filiform, arising from dorsal wall only, oil droplets absent, stalks short (a few long); juice abundant, sugar little, acidity much, flavor poor, aroma medium, bitterness none; seeds numerous (15-30, average perfect seeds 21, imperfect seeds 1), medium sized, arranged all along the central axis from apex to base, fresh seeds cream coloured ovate, smooth, slightly sticky, veins not prominent; cotyledons light greenish; chalazal spot deep brownish purple. *(Fig.20)*
Fig. 20

ITALIAN ROUND (C. limon Burm.)

NATURAL SIZE
**Hill lemon** (*C. pseudolimon* Tan.)

**Vegetative characters**

Tree tall, hardy, vigorous; crown rounded to flattened, moderately compact; foliage density medium, colour of emerging leaves light purple; trunk robust, short, bark medium thick, fairly smooth; branches robust, upright; young shoots angular in cross section, glabrous, spinach green (0960/3), oil glands on young shoots moderate, ellipsoid; thorns numerous, straight, sharp, medium long, medium thick, muddy coloured.

Leaf lamina large (average length 12.2 cm, breadth 6.5 cm), thin, glabrous, elliptic-oblung, cupped, both surfaces lettuce green (861); margin crenulate; apex acute; base obtuse; articulation with the petiole prominent; glands on lower surface of lamina not visible, glands on midrib on lower surface of lamina visible; veins moderately prominent, slightly raised on upper surface, even on lower surface; petiole short, semicircular in cross section, barely winged or margined; scent of leaf suggestive of sweet lime.

Flowers early; inflorescence spuriously terminal, large, cymose; flowers bisexual as well as staminate, scent weak and pleasant; flower bud long, oblong, uneven purple longitudinal steaks present; pedicel medium thick, short, ridged, light green, glands moderately dotted and sunken, glabrous; calyx medium sized, cup shaped segments 5-6 (mostly 5), irregularly divided, light green, in some cases, with light purple patches, finely pubescent along the tips only, glands prominent; petals 5, obovate-oblong, slightly reflexed, apex obtuse, glands prominent; medium sized, moderately dotted; stamens medium (20), slightly shorter than pistil, filaments polyadelphous, united all along the length, medium long, spindle shaped, thick, anthers medium sized, oblong, yellow, apex obtuse, pollen abundant; style medium thick, medium long, clavate, slightly curved, glabrous, glands prominent and even; stigma
medium thick, subglobose, yellow, secretion milky white; ovary medium sized, cylindrical, moderately merging with style, glabrous; disc prominent, medium in diameter, cushion like, ridged, light green.

**Fruit characters**

Fruit large (average diameter 8.7 cm, length 10.5 cm), oval-oblong, lemon yellow; surface smooth but pitted; apex with short nipple, medium broad; base short necked or protruding, irregularly shallowly furrowed; calyx depressed, medium sized, lobes persistent; stem medium long, medium thick; areole and navel absent; styal scar small, depressed; style deciduous; oil glands medium sized, ovate, moderate, primary glands depressed, oil abundant, aroma between lemon and sweet lime.

Rind medium thick, leathery, adherence medium to strong; puffiness none; glandular layer medium thick; albedo white, smooth, medium thick, tasteless; central axis medium sized, semi-hollow, irregularly stellate; segments medium (10-11, average 11), closed at the center, very few burst, adherence strong, septa thin; pulp straw coloured, texture medium, vesicles long, thin, fusiform, arising from dorsal wall only, oil droplets absent, stalk short to medium; juice abundant, sugar little, acidity much, flavor poor, aroma weak, bitterness none; seeds numerous (27-46, average perfect seeds 26, imperfect seeds 7), large, fresh seeds cream coloured, ovate, smooth, veins not prominent; cotyledons white; chazal spot brownish purple. (Fig.21)
Fig. 21

HILL LEMON (C. pseudolimon Tan.)

NATURAL SIZE
Rough Lemon (*C. jambhiri* Lush.)
cv. : Jatti Khatti

**Vegetative characters**

Tree tall, hardy, vigorous, slight attack of canker; crown irregular, somewhat columnar, compact; foliage density medium, colour of emerging leaves purplish; trunk robust, medium high; bark medium thick, moderately rough; branches dense, medium thick, upright; oil glands on young shoots few, ellipsoid; thorns numerous, straight, sharp, long, medium thick, dull green with light grey striations and brownish tips.

Leaf lamina medium sized (average length 9.9 cm, breadth 4.8 cm), thin, brittle, glabrous, slight cupped, elliptic; upper surface spinach green (0960/2); lower surface spinach green (0960/1); margin serrulate; apex acute; base obtuse; articulation with the petiole short, subcylindrical, wing margined, rarely naked; scent of leaves mild.

**Flower characters**

Flowering mid season; inflorescence mostly solitary axillary all along the flowering branches, cymose, also spuriously terminal; flowers bisexual as well as staminate, scent weak and not pleasant; flower bud medium long, prominently ridged, obovoid, white with pale purplish patches; pedicel medium thick, short, obconical, faintly and irregularly ridged, light green, glands very few, sunken, glabrous; calyx small, stellate, segments 5, deltoid, greenish white, finely pubescent along the margin; petal 5; medium long, lanceolate, slightly reflexed, apex acute, glands fine, sparsely dotted; stamens moderate (24), slightly longer than pistil, filaments polyadelphous, united all along the length, medium long, acicular, glabrous; anthers medium sized, ovate, yellow, apex obtuse, pollen abundant; style slender, short, terete, glabrous; stigma slender, sub globose, yellow, secretion colourless; ovary small, obovate, clearly set off from the style; disc prominet, medium in diameter, cushion like, ridged, pale green.
**Fruit characters**

Fruit medium sized (average diameter 6.5 cm, length 7.5 cm), oval-globose, tapering at both the ends, dull golden yellow; surface wrinkled; apex broadly nipped, nipple pushed in, very slightly depressed, irregularly furrowed and bumpy; base slightly necked, furrowed; calyx depressed, small, lobes persistent, medium long, blunt; stem short, medium thick; areole an irregular furrow; navel absent; stylar scar small, deeply depressed; style deciduous; oil glands small; ovate, moderate, oil abundant, aroma lemon like with faint suggestive of sweet lime.

Rind medium thick, leathery, adherence slight; puffiness slight, glandular layer thick; albedo white, soft, thin, tasteless; central axis large, hollow, irregularly stellate; segments medium (9-10, average 10), closed at the center, adherence slight, septa thin; pulp straw coloured, texture fine, vesicles medium long, fusiform, arising from dorsal wall only, oil droplet long, stalk short; juice abundant, sugar little, acidity high, flavor poor, aroma weak, bitterness none; seeds numerous (28-44, average perfect seeds 32, imperfect seeds 3), medium sized, fresh seeds tan coloured, ovate, bluntly pointed, pulp smooth, veins not prominent; cotyledons slightly greenish white, chalazal spot brownish purple. *(Fig.22)*
Fig. 22

JATTI KHATTI (C. jambhiri Lush.)

NATURAL SIZE

1

2 3 4 5 6 7

8

9

8a 8b 10 11
Rough Lemon (*C. jambhiri* Lush.)
cv. : Florida Rough

**Vegetative characters**

Tree tall, moderate hardy, vigour medium, slight attack of canker; crown irregularly columnar, moderately compact; foliage dense, colour of emerging leaves purle; trunk medium thick, long; bark medium thick, rough; branches medium thick, upright; young shoots angular in cross section, glabrous, spinach green (0960/1); oil glands on young shoot moderate, ovalish; sparingly thorny, thorns straight, medium thick, medium long, rosetted on yellowish green background.

Leaf lamina medium sized (average length 9.6 cm, breadth 5.2 cm) thin to medium thick, leathery, slightly cupped, glabrous, elliptic, upper surface spinach green (0960), lower surface spinach green (0960/2); margin crenulate, apex and base obtuse; articulation with petiole moderately prominent; glands on lower surface of lamina abundant, glands on the midrib on lower surface visible; veins moderately prominent, slightly raised on lower surface, even on upper surface; petiole short, almost circular in cross section, wing margined, rarely naked, scent of the leaves feeble.

**Flower characters**

Flowering mid season; inflorescence solitary axillary all along the flowering branch, sometimes 2 to 3 flowers per axil; flowers mostly staminate, scent weak and not pleasant; flower bud medium long, obovoid-oblong, ridged with light purple streaks; pedicel slender, short, greenish white, glands very fine and sunken, glabrous; calyx small, stellate, segments 5, deltoid, yellowish white, finely and sparsely pubescent along the margin, petals 4-5 (mostly 5), petals medium long, obovate-lanceolate, slightly reflexed, apex obtuse, glands medium long, acicular, thin, glabrous; anthers medium long, terete, glabrous; stigma medium thick, subglobose, yellow,
secretion colourless; ovary medium sized, obovate, clearly set off from style; disc
cushion like, radially ridged greenish white.

**Fruit characters**

Fruit medium sized (average diameter 6.5 cm, length 7.0 cm), oval-globose, clear golden yellow (butter cup yellow 5/1); surface finely pitted, slightly rugose, in some cases faintly ribbed; apex broadly nippled, depressed, wrinkled; base raised to slightly necked, irregularly furrowed; calyx depressed, small, lobes persistent, medium long, blunt; stem short, medium thick; areole a deep irregular furrow, wrinkled; navel absent; styrar scar small, deeply depressed; style deciduous; oil glands small, ovate, moderate, depressed, oil abundant, aroma lemon like but also suggestive of sweet lime.

Rind medium thick, leathery, adherence slight; puffiness slight, very late in season; glandular layer thick; albedo white, soft, thin, tasteless; central axis segments medium (8-10, average 10), closed at the center, adherence slight, septa thin; pulp straw coloured, texture medium, vesicles medium long, fusiform, arising from dorsal wall only, oil droplets absent, stalk short; juice abundant, sugar little, acidity high, flavor poor, aroma weak, bitterness none; seeds numerous (24-37 average perfect seeds 25, imperfect seeds 5), medium sized, arranged all along the central axis from apex to base, fresh seeds muddy tan coloured, ovate, smooth, veins not prominent; cotyledons white, faintly green; chalazal spot brownish purple. (Fig.23)
Fig. 23

FLORIDA ROUGH (C. jambhiri Lush.)

NATURAL SIZE
**Rough Lemon** (*C. jambhiri* Lush.)  
**cv. : Jambhiri Round**  
**Vegetative characters**

Tree tall hardy, vigorous; crown rounded, compact; foliage density medium, colour of emerging leaves purplish; trunk robust, medium high; bark thick, moderately rough; branches numerous, robust, upright, branches numerous, robust, upright, branches spreading; young shoots angular in cross section, glabrous, spinach green (0960/1); oil glands on the young shoots moderate, ellipsoid; thorns numerous, straight, medium long, medium thick, dull green with brownish tips.

Leaf lamina medium sized (averaged length 9.5 cm, breadth 5.8 cm), thin to medium, glabrous, slightly cupped, oval, upper surface spinach green (0960/1), lower surface spinach green (0960/3), margin crenate; apex rounded with emerging; base rounded; articulation with petiole moderately prominent; glands on lower surface of lamina moderate, glands on the midrib on the lower surface visible; veins fairly prominent, slightly raised on lower surface, even on upper surface; petiole short almost circular in cross section, wing margined or rudimentary; scent of leaves aromatic like of lemons.

**Flower characters**

Flowering mid season; inflorescence solitary axillary all along the flowering branch, rarely 2 to 3 flowers per axil; flowers mostly staminate, scent weak and not pleasant; flower bud medium long, obovoid, ridged, uniformly purple; pedicel slender, short, obconical, faintly ridged, light green, glands very few and sunken, glabrous; calyx medium sized, stellate, segments 5, deltoid with pointed tips, greenish white, finely pubescent along the tips only; petals 5, medium sized, obovate-lanceolate, slightly reflexed, apex obtuse, finely and sparsely dotted; stamens medium (24), equal to pistil in length, medium long, acicular, thin, glabrous; anther medium long, terete, glabrous; stigma medium in diameter, globose, yellow, no secretion; ovary small,
cylindrical, clearly set off from the style; disc prominent, medium diameter, radially ridged, cushion like, greenish.

**Fruit characters**

Fruit medium sized (average diameter 6.1 cm, length 5.1 cm), compressed globes, light golden yellow (Chrome yellow, 605); surface finely pitted, smooth; apex flattened to slightly depressed, nipple faint, flatted; base slightly depressed, irregularly furrowed; calyx slightly depressed, medium sized, lobes persistent, medium and blunt; stem short, medium thick; areole shallow; navel absent; styal scar medium sized, depressed; style deciduous; oil glands small, ovate, moderate, depressed, oil abundant, aroma lemon like, but faintly like sweet lime.

Rind medium thick, leathery, adherence slight, puffiness none; glandular layer thick; albedo white, soft, thin, tasteless; central axis large, hollow, irregularly stellate; pitch very slight; segments medium (9-11, average 10), adherence slight to moderate, septa thin; pulp straw coloured, texture medium to fine, vesicles medium long, fusiform, arising from dorsal wall only, oil droplets absent, stalk short; juice abundant, sugar little, acidity much, flavor poor, aroma faint, bitterness none; seeds numerous (16-45, average perfect seeds 25, imperfect seeds 5), medium sized, fresh seeds brownish, ovate, smooth, veins not prominent; cotyledons very light green; chalazal spot brownish purple.  (Fig.24)
Fig. 24

JAMBHIRI ROUND (C. jambhiri Lush.)

NATURAL SIZE)
**Karna Khatta (C. karna Raf.)**

**Vegetative characters**

Tree tall, hardy, vigorous; crown irregularly columnar, compact; foliage density medium, colour of emerging leaves faint green; trunk robust, long; bark medium thick, moderately rough; branches robust, upright; branches spreading; young shoots slightly angular in cross section, glabrous, spinach green (0960/1), oil glands on young shoots few, roundish; rather thorny, thorns long, thick, green with light brownish tips.

Leaf lamina large (average length 10.2 cm, breadth 5.9 cm), thin, smooth, glabrous, elliptic, upper surface spinach green (0960/1), lower surface spinach green (0960/2); margin serrulate; apex acute; base obtuse; articulation with the petiole prominent; glands on lower surface of lamina moderate; veins moderately prominent, slightly raised on lower surface; petiole medium long, circular in cross section, narrowly winged, wing club shaped; scent of leaves distinct and strong.

**Flower characters**

Flowering early; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual as well as staminate, scent weak and not pleasant; flower bud long, oblong, faintly furrowed with light purple patches; pedicel medium thick, medium long, tapering, irregularly and faintly ridged, light green, in some cases with faint purple patches, glabrous, glands very few and slightly sunken; calyx medium sized, stellate, segments 5, not markedly divided, glands moderate and sunken; petals 5, long, slightly reflexed, apex obtuse, glands finely and moderately dotted; stamens moderate (28), slight shorter than pistil, filaments polyadelphous, united all along the length, long, flattened, thin, glabrous; anthers small, ovate-oblong, medium long, terete, glabrous, glands somewhat prominent and raised; stigma thick, subglobose, yellow, secretion colourless; ovary medium sized, barrel shapped, moderately merging with the style, glabrous; disc prominent, medium in diameter, cushion like, light green.
Fruit characters

Fruit large (average diameter 10.1 cm, length 10.5 cm), ovoid-globose, tapering at both the ends, light orange (saffron yellow 7); surface rough, bumpy and faintly ribbed, pitted; apex broadly nipped, nipple obtuse, merging with apex, rugose and pitted; base slopping, surface irregularly furrowed; calyx depressed, medium sized, lobes persistent, short, irregularly divided and blunt; stem long, medium thick; areole and navel absent; stylar scar large, depressed; style deciduous; oil glands medium sized, broadly elliptic, moderate, oil medium, aroma suggestive of sour orange.

Rind very thick, adherence medium to strong; puffiness none; glandular layer thin; albedo ivory white, soft, spongy, sweetish, thick; central axis medium sized, solid, circular; segments medium (10-13, average 12), close at the center, adherence medium, septa thick; pulp dull orange coloured, texture medium, vesicles long, lanceolate-fusiform, arising from dorsal wall only, oil drops absent, stalks short to long; juice abundant; sugar little, acidity much, flavor poor, aroma distinct, mildly like sour orange; seeds numerous (24-45, average perfect seeds 30, imperfect seeds 3), large, fresh seeds deep tan coloured, arranged all along the central axis from apex to base, ovate, rugose, veined, slightly sticky, veins prominent, cotyledons white, chalazal spot brownish purple. (Fig.25)
Sweet Orange (*C. sinensis* Osbeck.)

cv. : Blood Red

**Vegetative characters**

Tree medium sized, hardy, vigour medium; crown rounded, open; foliage dense, colour of emerging leaves light green; trunk robust, short; bark thick, moderately smooth; branches medium thick, upright; young shoots rounded in cross section, glabrous, spinach green (0960/1), oil glands on the young shoots moderate, ovalish; sparingly thorny, thorns straight, short, slender, light green.

Leaf lamina medium sized (average length 10.8 cm, breadth 5.3 cm), medium thick, brittle, elliptic, upper surface spinach green (0960), lower surface spinach green (0960/1); margin minutely crenulate; apex acute; base obtuse; articulation with petiole prominent; glands on lower surface of lamina moderate; veins distinct, slightly raised on lower surface, even on upper surface; petiole medium long, circular in cross section, narrowly winged, wing conical; scent of the leaves mild.

**Flower characters**

Flowering late; inflorescence small, cymose, spuriously terminal, also 2 to 3 flower per axil; flower bisexual as well as staminate, scent strong and pleasant; flower bud medium long, ovoid, faintly and irregularly ridged, white; pedicel medium thick, short, terete, greenish white, glands sparse and depressed, glabrous; calyx medium sized, cup shaped, segments 5, irregularly divided, greenish white to dull white, finely pubescent along the tips only; petals 4-5 (mostly 5), medium long, lanceolate, strongly reflexed, apex acute, glands medium sized and moderately dotted; stamens moderate (22), equal to pistil length, filaments polyadelphous, united all along the length, medium long, flattened, thin, glabrous; anthers medium sized, ovate-oblong, yellow, apex obtuse, pollen abundant; style slender, short, terete, glabrous; stigma slender, flattened (disc like), yellow, secretion milky white; ovary medium sized, obovate,
clearly set off from the style; disc prominent, narrow, cushion like, inconspicuously ridged, white.

**Fruit characters**

Fruit medium sized (average diameter 6.9 cm, height 7.0 cm), subglobose, persimmon orange (710), surface rugose, pitted; apex slightly truncate, slightly rugose; base tapering, rough, faintly and irregularly furrowed; calyx even, medium sized, lobes persistent, short, irregularly divided; stem medium long, medium thick; areole and navel absent; style scar medium sized, slightly depressed; style deciduous; oil glands small, ovate, abundant, primary glands depressed, oil abundant, aroma distinct and strong.

Rind medium thick, leathery, adherence medium; puffiness none; glandular layer thin; albedo ivory white, soft, thick; central axis small, solid, irregularly circular; segments medium (11-12, average 11), closed at the center, adherence medium, septa medium thick; pulp orange buff, texture medium to fine, vesicles medium long, fusiform, arising from dorsal and 1/4\(^{th}\) of the radial wall, oil droplets absent, stalk short (a few long); juice abundant, sugar medium, acidity little, flavor good, aroma medium, bitterness none; seeds few (1-6, average perfect seeds 3, imperfect seeds 1), medium sized, arranged all along the central axis from apex to base, fresh seeds cream coloured, winged, smooth, slightly sticky, veins not prominent; cotyledons white; chalazal spot tan coloured. (Fig.26)
Fig. 26
BLOOD RED (C. sinensis Osbeck)
NATURAL SIZE
Sweet Orange (*C. sinensis* Osbeck.)

cv. : Valencia Late

**Vegetative characters**

Tree medium sized, hardy, vigour medium; crown rounded, moderately compact; foliage density medium, colour of emerging leaves light green; trunk medium thick, medium high; bark thick, rough; branches medium thick, upright; young shoots rounded in cross section, glabrous, spinach green (0960/1), oil glands on the young shoots moderate and roundish; thorns few, short, slender, greenish brown.

Leaf lamina medium sized (average length 9.3 cm, breadth 5.5 cm), medium thick, leathery, glabrous, broadly elliptic, upper surface spinach green (0960), lower surface spinach green (0960/1); margin crenulate; apex and base obtuse, articulation with the petiole prominent; glands on lower surface spinach green (0960/1); margin crenulate; apex and base obtuse; articulation with the petiole prominent; glands on lower surface of lamina abundant; veins obscure, slightly raised on lower surface, even on upper surface; petiole medium long, circular in cross section, moderately winged, wing conical; scent of the leaves distinct and strong.

**Flower characters**

Flowering early; inflorescence spuriously terminal, as well as mixed type, medium sized, cymose; flowers bisexual only, scent mild and pleasant; flower bud medium long, ovoid-oblong, furrowed towards base, white; pedicel medium thick, long, tapering, irregular ridged, green, glabrous, glands fine and slightly sunken; calyx medium sized, stellate, segments 5, deltoid, greenish white, finely pubescent along the tips only, glands medium sized and moderately dotted; stamens moderate (22), equal to pistil length, filaments mostly polyadelphous rarely monadelphous, united all along the length, long, flattened, glabrous; anthers small, oblong, yellow, apex obtuse, pollen abundant; style slender, medium long, terete, curved, glabrous; stigma medium in diameter, knobbed, yellow, secretion milky white; ovary medium sized, ovate, clearly
set off from the style; disc prominent, medium in diameter, cushion like, radially ridged, dull white.

**Fruit characters**

Fruit medium sized (average diameter 7.0 cm, length 6.8 cm), oblong-globose, tangerence orange; surface smooth, but pitted, glossy; apex truncated, smooth to slightly rugose; base truncated, faintly and irregularly ribbed; calyx even, medium sized, lobes persistent, irregularly divided, segment tips sharply pointed; stem medium long, medium thick; areole faint, navel absent; styrar scar medium sized, even to slightly depressed; style deciduous; oil glands small, flattened, ovate, abundant, primary glands slightly depressed, oil abundant, aroma distinct and strong.

Rind medium thick, leathery, adherence strong; puffiness none; glandular layer thick; albedo ivory white, soft, thin, tasteless; central axis medium sized, solid, more or less regular, stellate, slightly burst; segments medium (10-13, average 11), adherence strong, septa medium thick; pulp deep straw to light yellow coloured and texture medium to fine, vesicles medium long, fusiform, arising from dorsal wall and few from 1/4th portion of radial wall, oil droplets absent, stalk long; juice abundant, sugar medium, acidity medium, flavor faint, aroma medium; seeds few (3-10, average perfect seeds 2, imperfect seeds 4), large, fresh seeds cream coloured, obliquely ovate, medium smooth, veins inconspicuous; cotyledons white; chalazal spot light tan coloured. (Fig.27)
Fig. 27

VALENCE LATE (C. sinensis Osbeak)

NATURAL SIZE
Sweet Orange (C. sinensis Osbeck.)
cv. : Washington Navel

Vegetative characters

Tree medium sized, hardy, vigorous; crown rounded, compact; foliage medium dense, emerging leaves light green; trunk medium thick, medium high; bark medium thick, rough; branches medium thick, spreading; young shoots angular in cross section, glabrous, spinach green (0960/1), oil glands on the young shoots moderate, oval; thorns few, short, slender, green with brownish tips.

Leaf lamina (average length 11.4 cm, breadth 5.6 cm), thick, leathery, glabrous, ovate-elliptic, both the upper and lower surface spinach green (0960/1); margin crenullated; apex obtuse with emergination; base acute; articulation with petiole prominent; glands on lower surface of lamina abundant, glands on the midrib on lower surface of lamina visible; veins obscure, slightly raised on lower surface; petiole medium long, circular in cross section, narrowly winged, wing conical; scent of the leaves distinct and strong.

Flower characters

Flowering early; inflorescence spuriously terminal as well as mixed type, large, cymose; flowers bisexual only, scent weak and pleasant; flower bud medium long, elliptic, faintly and irregularly furrowed towards apex, white; pedicel medium thick, medium long, tapering towards apex, white; distinctly ridged towards apex, light green, glands sparse, glabrous; calyx medium sized, cupulate, segments 5, deltoid, light green, very thinly pubescent along the tips only; petals 5, long, elliptic-oblong, strongly reflexed, apex obtuse, glands medium sized, sparse; stamens moderate (23), equal to pistil in length, filaments polyadelphous, united along the length, medium long, flattened, thick, glabrous; anthers medium sized, ovate-oblong, light yellow to cream coloured, apex obtuse, pollen moderately abundant; style medium thick, medium long, terete, slightly curved near the apex, glabrous; stigma medium thick, strongly
compressed, secretion milky white; ovary medium sized, obovate, clearly set off the style; disc prominent, broad, cushion like, dull white.

**Fruit characters**

Fruit medium sized (average diameter 7.9 cm, length 7.6 cm), subglobose, persimmon orange (7010); surface smooth, glossy, slightly pitted; apex slightly truncated to rounded; base truncated, rugose, faintly and irregularly divided, apex acute; stem medium long, medium thick; areole absent; navel 0.82 cm in diameter, 80% navelled, both rudimentary and gleshy, closed type; style deciduous; oil gland medium sized, ovate, abundant, primary glands depressed, oil abundant, aroma distinct and strong.

Rind medium thick, leathery, adherence medium; puffiness none; glandular layer medium thick; albedo ivory white, soft, thick; central axis medium sized, solid robust, irregular stellet; segment medium (9-12, average 11), closed at the center, adherence medium, septa thin, fusiform, arising from dorsal wall only, oil droplets absent, stalk short (some long); juice abundant, sugar medium (a little bit more than other sweet oranges studied), acidity medium (a little less than other sweet orange studied), flavor excellent, aroma medium, bitterness none; seeds few (4-7, average perfect seeds 2, imperfect seeds 3), medium sized, fresh seeds light cream coloured, ovate, smooth, veins indistinct; cotyledons white; chalazal spot light tan coloured. *(Fig.28)*
Fig. 28

WASHINGTON NAVAL (C. sinensis Osbeck)

NATURAL SIZE
Sweet Orange (*C. sinensis* Osbeck.)
cv. : Whittakar

**Vegetative characters**

Tree medium sized, hardy, vigorous; crown rounded, moderately compact; foliage density medium, emerging leaves light green; trunk medium high; bark medium, thick, tough; branches medium thick, upright; young shoots rounded in cross section, glabrous, spinach green (0960), oil glands on the young shoots moderate; thorns few, short, slender, greenish brown.

Leaf lamina large (average length 10.0 cm, breadth 6.1 cm), thick, leathery, broadly elliptic, upper surface spinach green (0960), lower surface spinach green (0960/1); margin crenulated; apex and base obtuse; articulation with petiole distinct; glands on lower surface, even on upper surface; petiole medium long, circular in cross section, narrowly winged, wing club shaped; scent of the leaves distinct and strong.

**Flower characters**

Flowering mid season; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual only, scent strong and pleasant; flower bud long, ovoid, furrowed towards base, white; pedicel medium thick, short, tapering towards base, ridged, greenish, glands sparse and sunken, glabrous; calyx medium sized, stellate, segments 5, sharply tapered, greenish white, finely pubescent along the tips only; petals 5, medium long, lanceolate, strongly reflexed, apex acute, glands sparse; stamens moderate (23), equal to pistil in length, filaments polyadelphous, united all along the length, medium long, flattened, thin, glabrous; anthers medium sized, oblong, yellow, apex obtuse, pollen abundant; style medium thick, medium long terete, slightly curved, glabrous; stigma medium in diameter, strongly compressed, light yellow, secretion milky white; ovary medium sized, cylindrical, clearly set off from the style, disc prominent, broad cushion like, radially ridged white
Fruit characters

Fruit medium sized (average diameter 7.3 cm, length 6.7 cm), subglobose, tangerine orange; surface smooth, glossy, pitted; apex slightly depressed, faintly and irregularly furrowed; calyx even, medium sized, lobes persistent, mostly five lobed with acute apex; stem, medium long, medium thick; areole inconspicuous; navel almost absent, rarely present; stylar scar large, depressed; style deciduous; oil glands medium sized, ovate, abundant, primary glands depressed, oil abundant, aroma distinct and strong.

Rind medium thick, leathery, tasteless, adherence medium to strong; puffiness none, glandular layer thick; albedo cream coloured, soft, thin, tasteless; central axis medium sized, solid, stellate; segments medium (11-14, average 12), closed at the center; adherence strong, septa very thin; pulp straw coloured, texture fine and melting; vesicles medium long, lanceolate-fusiform, arising from dorsal wall only, oil droplets absent, stalk long (a few short); juice abundant, sugar medium, acidity medium, flavor fair, aroma medium, bitterness none; seeds numerous (15-38, average perfect seeds 16, imperfect seeds 9), large, arranged all along the axis from apex to base, fresh seeds cream coloured, shape variable, surface smooth, veins not prominent; cotyledons white; chalazal spot tan coloured. (Fig.29)
Fig. 29

WHITTAKER (C. sinensis Osbeck)

NATURAL SIZE
Tangelo (*C. reticulata* × *C. paradise*)
cv. : Sunshine

**Vegetative characters**

Tree dwarf or a shrub, hardy, slow growing, vigour medium; crown rounded, compact; foliage dense, colour of emerging leaves light green; trunk slender, medium long, bark medium thick; rough; branches slender, upright; young shoots angular in cross section, glabrous, spinach green (0960/1), oil glands on the young shoots moderate, ovalish; sparingly thorny; thorns straight, short, slender, greenish brown.

Leaf lamina medium sized (average length 9.3 cm, breadth 4.8 cm), thin, elliptic, upper surface spinach green (0960/1), lower surface spinach green (0960/2); margin crenulated; apex acute and emerginated; base obtuse; articulation with the petiole prominent; glands on lower surface of lamina moderate; veins obscure, even on both the surface; petiole long, almost circular in cross section, narrowly winged, wing club; scent of the leaves distinct and suggestive of sweet orange.

**Fruit characters**

Fruit medium sized (average diameter 6.0 cm, length 5.4 cm), ovate-globose, cadmium orange (18/2); surface smooth, glossy, slightly pitted; apex truncated, smooth; base truncated to slightly depressed, slightly rugose; calyx depressed, small lobes persistent, short, regularly 5 lobed, pointed; stem medium long, slender; nipple and areole absent; styrar scar medium sized, even to slightly depressed; style deciduous; oil glands small, ovalish, many, primary glands slightly depressed, oil abundant, aroma distinct and strong.

Rind medium thick, adherence medium; puffiness none; glandular layer thick; albedo ivory white, soft, thin, tasteless; central axis medium sized, semi- hollow,
stellate; segments medium (9-11, average 10), closed at the center, adherence medium slight, septa thin; pulp light orange coloured, texture fine, melting, vesicles medium long, fusiform, arising from dorsal wall and 1/4\textsuperscript{th} portion of radial wall, oil droplets absent, stalk short (a few long); juice abundant, sugar medium, acidity little, flavor good, aroma mild, bitterness none; seeds numerous (18-32, average perfect seeds 4, imperfect seeds 17), medium sized, arranged all along the central axis from apex to base, fresh seeds light cream coloured, ellipsoid and necked, smooth, veins inconspicuous; cotyledons greenish white; chalazal spot tan coloured. (Fig.30)
Fig. 30

SUNSHINE (C. reticulata X C. paradisi)

NATURAL SIZE
Mandarin (*C. reticulata* Blanco.)

**cv. : Kaula**

**Vegetative characters**

Tree medium sized, vigour medium, hardy; crown rounded, compact; foliage dense, colour of emerging leaves light green; trunk medium thick, medium high; bark medium thick, moderately smooth; branches medium thick, spreading; young shoots slightly angular to rounded in cross section, glabrous, spinach green (0960/1), oil glands on the young shoots many, ovalish; thorns absent.

Leaf lamina medium sized (average length 7.9 cm, breadth 4.6 cm), thin, smooth, glabrous, elliptic, upper surface spinach green (0960), lower surface spinach green (0960/1), margin crenate; apex obtuse with emrgination; base obtuse; articulation with the petiole distinct; oil glands on the lower surface of lamina numerous; veins inconspicuous, even on both surfaces, petiole medium long, almost circular in cross section, slightly winged or rudimentary; scent of the leaves distinct and strong.

**Flower characters**

Flowering early; flowers mostly solitary axillary all along the flowering branch, occasionally 2 to 3 flowers per axis; flowers bisexual only, scent strong and pleasant; flower short, obovoid, prominently ridged, white; pedicel slender, short, terete, light green glands sparse and sunken, glabrous; calyx small, stellate, segments 5, deltoid, greenish white, finely pubescent along the margin; petals 5, short, obovate-oblong, boat shaped, slightly reflexed, apex obtuse, glands very sparsely dotted; stamens few (19), equal to pistil in length, filaments monadelphous, united all along the length, medium sized, ovate-oblong, terete, curved, glabrous; stigma slender, globose, yellow, secretion colourless; ovary small, obovate, clearly set off from the style; disc prominent, narrow, cushion like greenish white.
**Fruit characters**

Fruit medium sized (average diameter 7.3 cm, length 5.8 cm), oblate, Indian orange (713/3); surface faintly rugous, pitted, glossy, very faintly and irregularly ribbed; apex broadly depressed, rugose, pitted; base low collared, irregularly and bluntly furrowed; calyx depressed, small, lobes persistent and short, regularly five parted and obtusely pointed; stem medium long, medium thick; nipple and areole absent; stylar scar large, even, style deciduous; oil glands, ovate, many, primary glands depressed, oil abundant, aroma distinct and strong.

Rind medium thick, soft, adherence very slight; puffiness slight; glandular layer thick; albedo light cream coloured, soft tasteless, very thin, central axis large, hollow, stellate; pith in strands; segments medium (9-11, average 10), deltoid in cross section, closed at the center, adherence slight, septa thin; pulp orange coloured, texture fine; melting; vesicles short, stout, fusiform, arising from dorsal and half or radial wall, oil droplets absent, stalk short; juice abundant, sugar medium, acidity medium, flavor fair, aroma medium, bitterness none; seeds medium (13-29, average perfect seeds 19, imperfect 1), arranged all along the central axis from apex to base, fresh seeds light cream coloured, winged, surface smooth, sticky, veins inconspicuous; cotyledons light green, chalazal spot light tan coloured. (Fig.31)
Fig. 31

KAULA (C. reticulata Blanco)

NATURAL SIZE
Mandarin (C. reticulata Blanco.)
cv. : Nagpuri

Vegetative characters

Tree medium sized, hardy, vigour medium; crown rounded, compact; foliage dense, colour of emerging leaves light green; trunk robust, medium high; bark thick; smooth; branches medium thick, upright; young shoots rounded in cross section, glabrous, spinach green (0960/1), oil glands on the young shoots many, ovalish; thorns absent.

Leaf lamina small (average length 8.6 cm, breadth 4.2 cm), thin, smooth, glabrous, obovate-elliptic, both surfaces spinach green (0960), margin crenulate; both the apex and base acute; articulation with the petiole distinct; oil glands on lower surface abundant; veins inconspicuous, even on both the surfaces; petiole medium long, almost circular in cross section, wing rudimentary or barely margined; scent of the leaves distinct and strong.

Flower characters

Flowering early, flowers mostly solitary auxiliary all along the flowering branch, sometimes, 2-3 flowers per axil; flowers bisexual only, scent strong and pleasant; flower bud short, obovoid; prominently ridged; white; pedicel slender, short; terete; light green, glands few to absent, glabrous; calyx small, stellate, segments 5, deltoid, glands prominent; dense, greenish white, finely pubescent along the tips only; petals 5, short, lanceolate, boat shaped, slightly reflexed, apex acute, glands fine and sparsely dotted; stamens few (15-16, average 16), slightly shorter than pistil, filaments polyadelpous, rarely monadelpous, united all along the length, medium long, flattened, glabrous, thin; anthers medium sized, ovate-oblong, yellow, apex rounded, pollen abundant; style slender, short, terete and curved, glabrous; stigma slender, obliquely knobbed, yellow, secretion colourless; ovary small, obovate, clearly set off from the style; disc prominent, narrow, cushion like, greenish white.
Fruit characters

Fruit medium sized (average 6.5 cm, length 5.5 cm), oblate, golden orange; surface smooth to faintly rugose, pitted, glossy, faintly and irregularly ribbed; apex broadly depressed, rugose; base low collared, deeply furrowed, mostly five lobbed, sharply pointed, stem short, medium thick; nipple and areole absent; stylar scar medium sized; style deciduous; oil glands small, ovate, many, primary glands depressed, oil abundant, aroma distinct and strong.

Rind medium thick, soft but bitter, adherence very slight; glandular layer thick; albedo ivory white, soft, tasteless, very thin, central axis large, hollow, stellate; pith slight in strands; segments medium (10-11, average 10), deltoid in cross section, closed at the center, some are slightly burst, adherence very slight, septa thin, pulp orange coloured, texture fine, melting, vesicles short, stout, fusiform, arising from dorsal wall, very few from radial wall, oil droplets absent, stalk short; juice abundant, sugar medium, acidity medium flavor fair, aroma medium, bitterness none, seeds medium (11-22, average perfect seeds 11, imperfect seeds 5), medium sized, thick, arranged all along the central axis from apex to base, fresh seeds cream coloured, irregularly conical with pointed micropyle, surface smooth, veins inconspicuous; cotyledons light green, chalazal spot tan coloured. (Fig.32)
Fig. 32

NAGPURI (C. reticulata Blanco)

NATURAL SIZE
**Mandarin** (*C. reticulata* Blanco.)

**cv. : Coorg**

**Vegetative characters**

Tree medium sized, hardy, vigour medium; crown obconical, compact; foliage dense, colour of emerging leaves light green; trunk medium thick, medium high, bark; medium thick; smooth; branches medium thick, upright; young shoots rounded in cross section, glabrous, spinach green (0960), oil glands on the young shoots moderate, ovalish thorns absent.

Leaf lamina small (average length 8.3 cm, breadth 4.2 cm), thin, brittle, smooth; glabrous; elliptic; upper surface spinach green (0960), lower surface spinach green (0960/1); margin crenulate; apex sub acuminate; base acute; articulation with petiole distinct; oil glands on lower surface of lamina abundant; veins inconspicuous, even on both surfaces; petiole medium long, almost circular in cross section; wing rudimentary or barely margined; scent of the leaves distinct and strong.

**Flower characters**

Flowering early; flowers mostly solitary axillary all along the flowering branch, rarely 2 flowers per axil; flowers bisexual, scent strong and pleasant; flower bud short; oval, deeply ridged, white; pedicel slender; short; cylindrical to slightly obconical, light green, glands very few, glabrous; calyx small, stellate, segments 5, deltoid, boat shaped, greenish white, finely pubescent along the tips only, petals 5, short, obovate-oblong; slightly reflexed, apex obtuse, glands fine and very sparsely dotted; stamens few (16), slightly shorter than pistil, filaments mostly polyadelphous, rarely monadelphous, united all along the length, medium long, flattened, glabrous, thin; anthers medium sized, ovate, yellow, apex rounded, pollen abundant; style slender, short, terete, glabrous; stigma slender; strongly compressed, yellow, secretion, milky white; ovary small, obovate, clearly set off from the style; disc prominent, narrow, cushion like, greenish white.
Fruit characters

Fruit medium sized (average diameter 7.9 cm, length 6.8 cm), oblate, tengerene orange (9/1); surface smooth, glossy, irregularly and faintly ribbed; apex broadly depressed, surface smooth; base truncated to depressed, surface broadly and deeply furrowed; stem medium long; medium thick; nipple and areole absent; stylar scar medium sized, even; style deciduous; oil glands small; depressed, ovate, abundant, primary glands slightly raised, oil abundant, aroma distinct and strong.

Rind medium thick, soft, leathery, adherence slight; puffiness much; glandular layer thick; albedo, ivory white soft, thin; central axis large, hollow, stellate; pith in strands; segments medium (9-12, average 10), deltoid in cross section, closed at the center, adherence slight septa thin; pulp orange, texture fine, melting, vesicles short, stout, fusiform, arising from dorsal wall, very few from 1/4\textsuperscript{th} of radial wall, stalk short; juice abundant, sugar medium, acidity medium, flavor poor, aroma weak, bitterness none; seeds medium (13-15, average perfect seeds 10, imperfect seeds 4), arranged all along the central axis from apex to base; medium sized, fresh seeds light cream coloured, irregularly ovate with pointed micropylar end, plump, surface smooth, veins inconspicuous; cotyledons pale green (lighter than other mandarin varieties); chalazal spot tan coloured. (Fig.33)
Fig. 33

COORG (C. reticulata Blanco)

NATURAL SIZE
**Rangpur lime** (*C. limonia* Osbeck.)

**Vegetative characters**

Tree medium sized, hardy, vigorous; crown rounded, compact; foliage density medium, colour of emerging leaves purple; trunk robust, short; bark thick, moderately smooth; branches robust, spreading and straggling; young shoots angular in cross section, glabrous, spinach green (0960), oil glands on the young shoots moderate; sparingly thorny, thorns straight, sharp, medium long, slender, green with dull yellowish tips.

Leaf lamina small (average length 8.6 cm, breadth 4.2 cm), medium thick, oval-oblong, glabrous, slightly cupped, upper surface spinach green (0960), lower surface spinach green (0960/1); margin crenate; apex acute; base rounded; articulation with the petiole distinct; glands on lower surface of lamina abundant, glands on the midrib on lower surface visible; veins moderately prominent, slightly raised on lower surface, even on upper surface; petiole medium long, semicircular in cross section, wing margined or rudimentary; scent of the leaves strong, mandarin like.

**Flower characters**

Flowering mid season; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual as well as staminate, scent mild and pleasant; flower bud medium long, obovoid-oblong, ridged, more prominently towards apex, light purple; pedicel short, slender, obconical, greenish, glands sparse and sunken, glabrous; calyx small, stellate, segments 5, deltoid, light green, finely pubescent along the margin; petals 5, medium long, obovate, boat shaped, slightly reflexed, apex acute, glands small and sparsely dotted; stamens moderate (22), equal to pistil in length, filaments polyadelpheous, united all along the length, medium long, flattened, thin, glabrous; anthers medium sized, oblong, golden yellow, apex obtuse, pollen abundant; styles slender, medium sized, oblong golden yellow, apex obtuse, pollen abundant; terete,
glabrous; stigma medium thick, strongly compressed, yellow, secretion colourless, sticky; ovary small, barrel shaped, clearly set off from the style; disc prominent, medium in diameter, cushion like, dull white.

**Fruit characters**

Fruit small (average diameter 5.6 cm, length 5.1 cm), obliquely rounded, orange coloured with cadmium patches (tangerence orange 7/1); surface smooth, glossy, finely pitted; apex rounded, smooth, pitted; base obliquely rounded, rugose, faintly furrowed; calyx even, medium sized, lobes persistent, broad; stem medium long, medium thick; areole and nipple absent; styal scar small, even; style deciduous; oil glands medium sized, subglobose, moderate, slightly depressed, oil medium, aroma strong like mandarin.

Rind thin soft, adherence slight to medium; puffiness none; glandular layer thin; albedo orange white, soft, thin, tasteless; central axis medium sized, hollow to semi-hollow, slightly burst, irregular stellate; segments few (7-10, average 8), closed at the center, adherence slight to medium, septa thin; pulp light orange, texture fine, melting, vesicles short, fusiform, arising from dorsal wall only, oil droplets absent; juice abundant, sugar little, acidity high, flavor poor, aroma weak, bitterness none; seeds numerous (18-24, average perfect seeds 18, imperfect seeds 3), small, fresh seeds light brownish tan coloured, irregular, ovate, smooth, veins inconspicuous; cotyledons light greenish; chalazal spot purplish brown. **(Fig.34)**
Fig. 34

RANGPUR (C. limonia Osbeck)

NATURAL SIZE
Sweet lime (*C. limettioides* Tan.)

**Vegetative characters**

Tree medium sized, hardy, vigorous; crown rounded, open; foliage density medium, colour of emerging leaves light green; trunk robust, medium high; bark thick, moderately rough; branches robust, spreading and straggling; young shoots angular in cross section, glabrous, spinach green (0960/2) with whitish streaks, oil glands on the young shoots moderate, ellipsoid; thorns few, straight, short, slender, greenish.

Leaf lamina medium sized (average length 8.5 cm, breadth 5.2 cm); medium thick, leathery, glossy, glabrous, oval, upper surface spinach green (0960/2), lower surface spinach green (0960/3), cupped; margin crenate; both apex and base obtuse; articulation with petiole distinct; glands on lower surfaces; petiole medium long, almost circular in cross section, wing barely margined or rudimentary; scent of the leaves very distinct and mild.

**Flower characters**

Flowering mid season; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual as well as staminate, scent weak and pleasant; flower bud long, obovate-oblong, somewhat furrowed towards base, white; pedicle medium thick, short, obconical, ridged, greenish, glands sparse and sunken, pubescent; calyx medium sized, flattened, segments 5, deltoid, light green, finely pubescent along the tips only; petals 5, long, elliptic slightly reflexed, apex acute, glands moderate, stamens moderate (27), equal to pistil in length, filaments mostly polyadelphous, rarely monadelphous, united all along the length, medium long, flattened, thin, glabrous; anthers medium sized, ovate-oblong, yellow, apex obtuse, pollen abundant; style medium thick, medium long, terete, glabrous; stigma large, thick, obliquely knobbed, yellow, secretion milky white; disc prominent, medium broad, ring like, radially ridged, light green.
Fruit characters

Fruit medium sized (average diameter 6.4 cm, length 6.1 cm), globose, light yellow (sap green 62/3); surface smooth, glossy, even to minutely pitted; apex with small nipple, smooth to slightly rugose; base evenly rounded, smooth to slightly rugose; calyx raised, medium sized, lobes persistent, short and irregularly divided; stem medium long, medium thick; areole and navel absent; styal scar medium sized, raised; style deciduous; oil glands small; ovalish; moderate, primary glands even to minutely pitted, oil medium, aroma very distinct and pleasant.

Rind thin, leathery, adherence strong; puffiness none; glandular layer thick; albedo greenish white, soft thin, slightly bitter; central axis medium sized, solid, irregularly stellate; segments medium (10-13, average 12), closed at the center, adherence strong, septa thin but firm; pulp straw coloured, texture fine, vesicles medium long, fusiform, arising from dorsal wall only, oil droplets absent, stalk short (a few long); juice medium, sugar low, acidity low, flavor fair, aroma distinctive, slightly bitter; seeds medium (12-14, average perfect seeds 12, imperfect seeds 1), large, arranged all along the central axis from apex to base, fresh seeds light cream coloured, ovate, smooth, plump, veins inconspicuous; cotyledons faint greenish white; chalazal spot deep cream coloured. (Fig.35)
Fig. 35

SWEET LIME (C. limettioides Tan.)

NATURAL SIZE
**Sweet lime (C. Sour mutant) (C. limettioides Tan.)**

**Vegetative characters**

Tree medium sized, semihardy, vigour medium; crown rounded to flattened, open; foliage density medium, colour of emerging leaves light green. Trunk robust, short; bark thick, moderately smooth; branches medium thick, spreading; young shoots with whitish streaks, rounded in cross section, glabrous, spinach green (0960/3), oil glands on the young shoots moderate, roundish; thorns absent; leaf lamina medium sized (average length 8.0 cm, breadth 5.2 cm), thick, leathery, waxy, glabrous, cupped, oval, upper surface spinach green (0960/2), lower surface spinach green (0960/3); margin crenulate; apex rounded; base obtuse; articulation with the petiole distinct; glands on lower surface visible; veins moderately prominent, slightly raised upper surface, even on lower surface; petiole medium long, almost circular in cross section, wing barely margined or absent; scent of leaves very distinct and mild.

**Flower characters**

Flowering mid season; inflorescence spuriously terminal, medium sized, cymose; flowers bisexual as well as staminate, scent weak and not pleasant; flower bud long, obovoid-oblong, faintly ridged towards base, dull white, in some cases with faint purplish patches towards the base; pedicel medium thick, short, tapering towards base, faintly ridged, light green, glands sparse and sunken, glabrous; calyx medium sized, flattened, irregularly divided, segments 4-5 (mostly 4), abruptly pointed, greenish white, finely pubescent along the tips only, glands prominent and slightly raised; petals 4-5(mostly 4, petalled flowers are staminate), long, oblong-elliptic, slightly reflexed, apex obtuse, glands medium sized and moderately dotted; stamens moderate (28), equal to slightly longer than pistil, filaments mostly polyadelphous, rarely monadelphous, united all the length, medium sized, oblong, yellow apex acute, pollen abundant; style slender, medium long, terete, glabrous, glands raised, ellipsoid; stigma...
large; medium thick, obliquely knobbed, ellipsoids; stigma large medium thick, obliquely knobbed, yellow, secretion milky white; ovary medium sized, barrel shaped, moderately merging with the style; disc prominent, medium broad, cushion like greenish white.

**Fruit characters**

Fruit small to medium (average diameter 5.4 cm, length 5.2 cm), globose, light yellow (sap green 62/3), surface smooth, glossy; apex with a faint nipple, faintly rugose, base obliquely rounded, smooth; calyx raised, medium sized, lobes persistent, short, thick; stem medium long, medium thick; areole and navel absent; stylar scar medium sized, raised style deciduous; oil small, ovalish, abundant, primary glands even, oil abundant, aroma distinct and pleasant. *(Fig.36)*
Fig. 36

SWEET LIME (SOUR MUTANT) C. limettioides Tan.)
**Calamondin** (*C. madurensis* Lour.)

**Vegetative characters**

Tree medium sized, hardy, vigour poor; crown columnar, open; foliage dense, colour of emerging leaves light green; trunk medium thick, short; bark thick; rough; branches medium thick, upright; young shoots almost angular in cross section, glabrous, spinach green (0960/2), oil glands on the young shoot many; thorns absent, leaf lamina very small (average length 5.9 cm, breadth 3.2 cm), medium thick, leathery, glabrous, elliptic, upper surface spinach green (0960/2); margin cranulate towards apex; apex rounded; base obtuse; articulation with the petiole distinct; glands on lower surface of lamina many, small, slightly raised; veins obscure; petiole medium long, almost circular in cross section, margined or wing rudimentary; scent of the leaves distinct and suggestive of mandarin.

**Flower characters**

Flowering early; flowers solitary axillary all along the flowering branch, bisexual only, scent strong and pleasant; flower bud short, obovoid, ridged, white; pedicel slender, medium long, obconical, greenish white; glabrous; calyx small, stellate, segments 5, deltoid, greenish white, finely and sparsely pubescent along the tips only, glands sparse and raised; petals 5, medium long, obovate, strongly reflexed, apex acute, glands sparsely dotted; stamens moderate (23), longer than pistil by 1/3rd length, filaments monadelphous, united all along the length, pollen abundant; style slender, short, terete, glabrous; stigma slender, oval, yellow, secretion colourless; ovary small, obovate, clearly set off from the style; disc prominent, narrow, cushion like, white.
Fruit characters

Fruit small (average diameter 2.5 cm, length 2.3 cm), compressed globose, orange coloured (persimmon orange 710/1); surface smooth, glossy; apex; rounded to slightly depressed, smooth; base truncated to rounded, smooth; calyx raised, small, lobes persistent, irregularly divided, mostly 5 lobed, bluntly pointed; stem medium long, medium thick; areole and nipple absent; styylar scar small, slightly raised; style deciduous; oil glands small, oval, many, even, oil medium, aroma distinct and suggestive of mandarin, rind thin, soft, slight leathery, bitter, adherence slight; puffiness none; glandular layer thick; albedo cream white, soft, very thin, tasteless; central axis small, semi-hollow, rounded; segments few (6-8, mostly 8), closed at the center, adherence slight, septa thin; pulp orange coloured, texture fine, melting, vesicles short, fusiform, arising from dorsal wall, very few from radial wall; juice abundant, sugar little, acidity much, flavor poor, aroma mild, bitterness none; seeds few (2-5, average perfect seeds 2, imperfect seeds 1), short and plump, fresh seeds cream coloured with greenish tinge, ovate, smooth, veins inconspicuous; cotyledons green; chalazal spot tan coloured.  

(Fig.37)
Fig. 37

CALAMONDIN (C. madurensis Lour.)

NATURAL SIZE
Kumquat (*Fortunella margarita* Swingle.)
cv.: Nagami

**Vegetative characters**

Small shrub, hardy, vigour poor; crown rounded to flattened, open; foliage medium dense, colour of emerging leaves light green; trunk slender, short; bark thin, moderately smooth; branches slender, spreading; young shoots rounded in cross section, glabrous, spinach green (0960/1), oil glands on the young shoots many; thorns absent.

Leaf lamina very small (average length 7.9 cm, breadth 3.4 cm), medium thick, leathery, glabrous, lanceolate, upper surface spinach green (0960), lower surface spinach green (0960/2); margin crenulate; both apex and base acute; articulation with petiole fairly distinct; glands on the lower surface of the lamina many; veins obscure, even on both the surfaces; petiole medium long, circular in cross section, margined or wing rudimentary; scent of leaves feeble.

**Flower characters**

Flowering all the year round; flowers solitary axillary all along the flowering branch, sometimes a pair of flowers per axil, small bisexual only, scent weak and pleasant; flower bud short, slight tapered towards base, smooth, greenish, glands fine, many, slight sunken, glabrous; calyx small, stellate segments 5; deltoid, yellowish white, finely and sparsely pubescent along the margin, glands medium sized, petals 5, short, elliptic-obleng, slightly reflexed, apex acute, glands prominent and sparse, white; stamens few (16), slightly longer than pistil, filaments polyadelphous united all along the length, long, flattened, thin, glabrous; anthers small, ovate-obleng, yellowish, apex mucronate, pollen moderate; style slender, short, glabrous, dull white, glands moderate and slight raised; stigma slender, knobbed, light yellow, secretion colourless; ovary small, barrel shaped, clearly set off from the style; disc prominent, narrow, cushion like, dull white.
Fruit characters

Fruit small (average diameter 2.3 cm, length 3.3 cm), ovate, orange coloured; surface smooth, shiny; apex rounded to slightly depressed, smooth; base narrowed, smooth; calyx raised, small, lobes short and persistent; stylar scar small, raised; style deciduous; oil glands medium sized, ovalish, moderate, even, oil abundant, aroma spicy.

Rind thin, soft, sweetish, adherence medium; fluffiness none; glandular layer thin; albedo ivory white, soft, slimy, sweet, medium thick; central axis small, solid, irregular; segments few (4-5, mostly 4), closed at the center, adherence medium, septa thick; pulp straw coloured, texture fine, melting, vesicles short, ovate, arising from dorsal wall only, oil droplets absent, stalk short; juice little, sugar little, acidity moderate, flavor poor, aroma mild, bitterness none; seeds few (2-4, average perfect seeds 3, imperfect seed 1), large; fresh seeds faint green, ellipsoid, plump, smooth, shiny, veins inconspicuous; cotyledons deep green; chalazal spot light tan coloured. (Fig.38)
Fig. 38

NAGAMI (Fortunella Margarita Swingle)

NATURAL SIZE
As discussed subsequently, the vegetative characters have been found to be highly useful in the classification of the species and in addition are available throughout the year. The following key has been based upon the vegetative characters alone.

**Key to the species of citrus fruits**

A.   Petiole wing almost missing.

AA.  Wing small, spatulate or linear.

AAA. Petiole moderately winged

AAAA. Wing large, cordate, definitely overlapping the base of lamina, young shoots densely hairy, leaves thick, large, emerging leaves light green.  

   eg.- *C. grandis*

B.   Articulation absent to obscure, base of leaf obtuse to rounded, leaf margin serrate to serrulate, surface rumpled.

C.   Tree dwarf, thorns prominent, scent of leaf feeble. eg. - *C. medica*

CC.  Tree medium to dwarf, thorns moderate, scent of leaf stong.

D.   Emerging leaves purplish, bark without longitudinal striates, tree tall, thorns numerous.

DD.  Emerging leaves light green, branchlets with light longitudinal striations, leaves cupped.  

   eg.– *C. limettioids.*

E.   Leaf medium, elliptic, apex and base acute, glands on lower surface visible, tree tall, thorns numerous.

EE.  Articulation distinct, leaf surface even or cupped, apex and base of leaf acute or obtuse.
EE. Leaf large, oval, cupping, tree spreading, open glands on lower surface not visible, thorns medium long.

F. Leaf flat or slightly twisted, thorns medium long.

FF. Leaf cupped, thorns long.

G. Lower leaf surface much lighter green with indistinct veins and raised glands.

GG. Glands on lower surface not raised

H. Tree or a small shrub, leaf lanceolate. eg.- *C. Fortunella*

HH. Tree medium sized, leaf elliptic. eg. - *C. madurensis*

I. Wing linear, crushed leaf not pungent

II. Wing spathulate, crushed leaf smelling like sour orange, thorns very large and numerous, leaves slightly cupped. eg. - *C. karna*

J. Emerging leaves light green, veins on lower surface indistinct, branches erect, thornless. eg.- *C. reticulata*

JJ. Emerging leaves purple, veins slightly raised on lower surface, tree sparing thorny, branches on tree sparingly thorny, branches spreading to straggling . eg.- *C. lomonia*

K. Young shoots glabrous

KK. Young shoots hairy

L. Petiole medium long, wing spathulate, lamina elliptic, thorns few, very small. eg.- *C. sinensis*
LL. Petiole long, wing clavate, lamina long, oblong, very glossy, tough, characteristically twisted, tree very thorny. eg. - *C. pennivericulata*

M. Leaves medium sized, apex subacute, tree medium sized, oil glands on shoots medium in number, thorns short and slender, wing cordate, moderately broad, slightly overlapping the base of lamina. eg.- *C. paradise*

MM. Leaves large, apex obtuse or rounded, oil glands on young shoots few

N. Wing cordate, narrow, slightly overlapping the base of lamina, leaf apex rounded, tree dwarf, thorns short. eg.- *C. megeloxycarps*
DISCUSSIONS

In spite of the emphasis on the use of modern techniques of cytology, anatomy, physiological reaction etc, the morphological descriptions continue to remain the mainstay of plant classification. The new techniques have been mainly used as supporting evidence, to check classification based upon morphological characters. The need for accurate morphological description is therefore evident. The characters used should be described in such terms that every one may get the same clear picture from the description.

The objective of the present investigation is two-fold. Firstly to determine the really important characters for the description of the various citrus plants and secondly to modify the description of these characters in such a manner that the descriptions are objective oriented, with a single personal interpretation, based upon standardized criteria of categorization. The morphology aspect has been finalized after careful study of the plant material and tabulating them under each character, comparing them and then fixing the limits of demarcation.

It will be of interest to highlight some of the conclusions. The foliage density has been based on the number of leaves per unit length of the shoot. However, the results did not conform to the overall visual impression given by the tree. For example, foliage density has been found to be medium in Gajanimma, Amilbed, Rangpur lime and Rough lemons. Actually, these trees give the impression of being full of dense leaves. This is due to the fact that the visual impression is determined by the number of leaves per shoot as well as the size of the leaves and the degree of branching. Therefore, the visual impression of the compactness of the crown remains the better character to record, and the number of leaves per unit length of branch lets cannot replace it.

Determination of the size of fruit as well as the leaf has been based upon the product of the length and breadth. This is based upon the assumption that the basic
shape of these does not vary much. This has been found to be fairly accurate and the results agree with the general impression of size created by the leaves and fruits of all the specimens. The length or breadth alone did not give an accurate idea of the size. The length of the leaf excludes the petiole. The D/H index of the fruit gives an idea of the fruit shape, whether it is flattened or elongated.

The length of the anther and the petiole has not been classified on the basis of the actual measurement but in relation to the size of the filaments and the leaf lamina, respectively. The result of this conforms to the general visual impression of these characters. For example, the anthers in Gajanimma look very large, but in measurement they fall in the medium size. They look large because the filaments are very shot. When their relative size was compared the anthers came in the ‘large’ category.

With regard to the second question viz. “what are the important characters for classification and description”, the important characters have been classified as primary, secondary and tertiary in the order of their importance. The importance of a character is determined by the constancy with which it is found in all members of species, the range of variation between the different species and the ease with which it can be put in few, distinct categories.

Among the vegetative characters the leaf provides the most useful characters at the species level. The articulation of the leaf helps to separate the citron and citron-lemons from the rest; the size, and shape of the petiole wing can separate the species into these groups:

- The Citron and Citron-Lemon,
- Rough lemons, Sweet lime, and Lemons;
- Rangpur lime, Mandarin and Karna Khatta;
- Sweet orange and Grapefruit;
- and Pummelo.
The leaf is cupped in sweet lime, Hill lemon and to some extent in Rough lemons and Karna Khatta, rumpled in Citron and Citron-lemons, and twisted in Gajanimma and slightly twisted in True lemons. These three characters are considered primary characters.

The secondary characters are the length of the petiole (short in Citron, Citron-lemons, Rough lemons and Hill lemon; long in Gajanimma, Pummelo and Grape fruit; and intermediate in the others), hairiness of the young shoots (densely hairy in true Pummelos; slightly hairy in Grapefruit and Pummelo hybrids, which are numerous since it is monoembryonic), colour of the emerging leaves (purple tinged in Acid forms of all species, except Karma, Calamondin, Kumquat, Sour orange, Amil-bed, Keem and the sour fruited Sweet lime) and leaf margin (serrate or serrulate in Citron or Citron-lemon, undulate in Pummelo and crenate or crenulate in others).

The tertiary characters are tree habit (very dwarf in Kumquat, dwarf and straggling with indistinct trunk in Citron-lemons; upright branches in Calamondin, True lemons, Mandarins of the Nagpur type; spreading trees of medium size in others), oil glands and veins on lower surface of leaf (numerous raised glands and indistinct veins in Kumquat and Calamondin; rather indistinct veins in Mandarins, Sweet lime, some C Vs of Sweet orange and Grape fruit and distinct in others), leaf shape (it is a constant character, but unfortunately the categories are numerous and intergrading; in fact the shape of the apex and base of the leaf is more useful in this connection), leaf size (it is influenced by the season, age and vigour of the plant and the cultural practices etc. Only gross differences in size are useful. For example, the leaves of Pummelo, Keem and Amilbed are large, those of Kumquat and Clamondin very small and of Mandarin rather small), colour of foliage (dark green in Mandarin, Sour orange, Rangpur lime; light green in Sweet lime, Rough lemons, Hill lemon; dark green on the upper surface and very light on the lower in Kumquat, Calamondin, Gajanimma and moderately green in the others) and size and number of thorns (the thorns are influenced by the
vigour and age of the tree. Only gross difference can be considered. For e.g., the thorns are numerous and prominent in Gajanimma, Citron, Karma and absent in Mandarins, Kumquat, Calamondin and Sweet lime).

Some species in particular have a very distinct odour when the leaf is crushed. In this respect, the Sour orange and its hybrids, Mandarins, Rangpur lime and other Mandarin hybrids, Citrons and Lemons, Pummelo and Pummelo hybrids fall in distinct and separate groups. However, it is not possible to compare many specimens at one time without losing the sense of smell and it is hard to carry a living memory of the smell of all the different groups in order to be able to classify a given specimen without comparing it with the other.

Among the flower characters, those of primary order are the style (thick, merging with ovary, tending to be partially persistent and with few prominent and raised glands in Citron and Citron-lemons, number of stamens (numerous in Pummelo, Keem, Amilbed, Citron and some Citron-lemons; few in Mandarins and Kumquat and moderate in others), and length and hairiness of filaments (shorter than pistil in Pummelo, Amilbed, Keem, Citron, Lemons, Hill lemon, Karna Khatta and Mandarins; longer than pistil in Gajanimma, Rough lemons, Kumquat and Calamondins; equal to the pistil in Grapefruit, Sweet oranges, Rangpur lime, Sweet lime and Kaula mandarin; more or less monadelphous in Kumquat, Calamondin, Mandarins and rarely in Sweet lime, free in Gajanimma and polyadelphous in others; hairy in Citron and Citron-lemons and glabrous in all others).

The secondary characters are the nature of inflorescence (mostly large, terminal in Pummelo, Citron, Citron-lemons, Amilbed, Keem, Gajanimma, mostly solitary or paired axillary flowers in Kumquat, Calamondin, Mandarins, Rough lemons and true lemons and medium sized and terminal in the others). Sex of flowers (almost always bisexual flowers in Pummelo, Keem, Sweet oranges, Mandarins, Kumquat and Calamondin, perfect as well as staminate in others) and the shape of the calyx (large,
cup shaped with deep sunken glands in Pummelo, Keem, Amilbed; smooth, cup shaped, segments almost completely fused and pedicel merging with calyx in Citron, Citron-lemons; small, flattened, stellate and whitish with raised glands in Kumquat, Calamondin, Mandarin, Rough lemons and Rangpur lime; and medium sized, whitish and semi-cup shaped in Sweet oranges, Grapefruit, Tangelo, Karna, Gajanimmma, Hill lemon and Sweet lime).

The tertiary characters are the number of petals (often four in Pummelo and Gajanimmma and mostly 5 in the others) and their reflexion (strongly reflexed in Pummelo, Amilbed), (annular in Citron, Citron-lemons and Sweet lime and cushion like in others; whitish in Sweet oranges, Grapefruit, Calamondins, Kumquat, Mandarins, Rangpur, Gajanimmma, Pummelo and some lemons), stigma (cavernous in Gajanimmma, Citron and Citron-lemons, non-cavernous in others; very large and bulgy in Pummelo, Sweet lime, Amilbed, keem Gajanimmma and medium to small in others) and not pointed in the others). The pigmentation of the flower bud (most acid forms are purple pigmented) is a definite character, but it has been omitted, since when the flower is pigmented, the emerging leaves are also pigmented. The opposite may not be true. In the case of sour lime the flower bud is white, but the emerging leaves are faintly purplish. The number of blooms in a year has been ignored since under the more tropical conditions all citrus can flower several times a year. However, under sub tropical conditions only Citron, Citron-lemons, Kumquat, Calamondin and Rangpur produce more than one flowering flush in a year.

Among the fruit characters the primary ones are the thickness, texture and adherence of the rind (thick and spongy in Pummelo, Amilbed and Grape fruit; hard with sweet albedo in Citron and to some extent in Karna, Keem and Kumquat; rather thin, soft, brittle, very bitter and loosely adhering in Mandarins, Rangpur; thin and leathery in Sweet lime and Calamondin; medium thick, firm and strongly adhering in Lemons, Gajanimmma, Sweet oranges and Hill lemon; medium thick, firm and rather loosely adhering in Rough lemons and Tangelos), central axis (large stellate and hollow
in Mandarins, Rangpur, Rough lemons; medium sized, roundish and hollow in Citron-lemon, Amilbed, keem, Tangelo and solid in the others) and colour of cotyledons (green in Kumquat, and Calamondin; light green in Mandarins; faintly greenish in Sweet lime, Rough lemons, Tangelo and some Lemons; and white in the others)

The secondary fruit characters are the nature of oil glands on rind (large, raised and few in Pummelo, Amilbed and Keem; medium sized, small numerous and sunken in Mandarins and Rangpur; moderate in number and slightly depressed in Rough lemon and others).

The tertiary fruit characters are the number of segment (few in Kumquat, Calamondin and Rangpur; numerous in Pummelo, Grapefruit, Amilbed, Keem, Gajanimma and Citron), thickness of septa (thick in Pummelo, Amilbed, Keem and Citron; thin in Mandarins, Calamondin and Rangpur; and medium in others); orientation of the vesicles (herringbone in Gajanimma; arising from dorsal wall only in others), length of vesicles (short in Kumquat, Calamondin, Mandarins and Rangpur; long in Amilbed, Keem, Karna, Hill lemon and medium in others), the presence of opaque oil droplet in vesicles (present in Gajanimma), colour of chalazal which is purplish in acidic forms and surface of seed (rough with raised veins in Pummelo, Amilbed, Keem and Karna; more or less smooth in others). The fruit size and the juice characters indicating the taste are influenced by the environment greatly and are not considered important. The nipples of the fruit is a character which is prominent but within species prominent or obscure nipple are found in Rough lemons, Sweet lime, Karna and Hill lemon, etc. Therefore, it is not considered important at the species level.

For the classification of varieties and C Vs the vegetative and flower characters have not been found to be useful. In fact the different forms of Rough lemon showing differences in fruit characters (shape and size of nipple, nature and thickness of rind and colour of fruit) are held together by the vegetative characters (shape and cupping of leaf and the nature of the petiole wing). The only characters found useful in this regard are
leaf size and shape and drooping or upright nature of branches in Mandarins and Lemons, the nature of the style in Lemons and the colour of anthers in seedless C V s, where the anthers are cream coloured instead of deep yellow, when the pollen is sterile.

On the other hand, the fruit characters are most important in the identification of cv.’s and the following are considered important. Thickness of rind and gross differences in colour (orange as well as yellowish colour found among Mandarins, Rangpur, Lemons, Grapefruits and Pummelo), nature of fruit surface and presence of furrows, shape and size of nipple, shape of base, presence of areole, presence and nature of navel, size of stylar scar, number of seeds and quantity and quality of juice. Traditionally, the flower characters are considered the most constant and dependable for delineation of the species. The vegetative characters are not considered so important. However, the present study indicates that in case of citrus the vegetative characters are the most important for the classification of the species. The different types of the Rough lemons are held together by the leaf characters and the loosely adhering rind. All the species studied can be separated clearly with aid of these characters, as is evidenced by the key to the different species given at the end of the “Experimental Result”.

It is of interest to note that in this key the related species occupy places close to each other. The Citron is followed by Citron-lemons and then the Lemon, which is considered a satellite species of the former by Swingle (1948). Then come Jambhiri, which is lemon hybrid and the Hill lemon. These two species and the Sweet lime, all of which show cupping of the leaves are grouped together. The only other species which shows cupped leaves is the Karna. Fortunella is followed by Calamondin, which is considered to be its hybrid with Mandarin. Then comes the Mandarin. Karna is followed by the Sweet orange. The Pummelo is preceded by its hybrids Keem and Amilbed and the only other large fruited therefore resulted in natural and orderly arrangement of the different species and not an artificial one. The use of these characters therefore seems to be well founded. The main characters of this key are the
development of the wing, which has also been given the same importance by Swingle (1948). In addition, the vegetative characters have the advantages of being always available, unlike the fruit and the flower characters, which are available in limited seasons only.

Vegetative characters have also been employed in the classification of mango cv.’s by Mukherjee (1949), Naik and Gangolly (1950), Gangolly et al. (1957), Singh and Singh (1956), in the classification of apple cv.’s by Shaw (1922) and in pulp varieties by Alderman and Shoemaker (1925). However, in the classification of citrus these were not found so useful. In fact the fruit provided almost all the characters for the identification of the citrus cv.’s.

The importance of the cupping of the leaves, the nature of the veins and glands on its lower surface, the colour of the anthers, the shape, thickness and glands on the style and the presence of the hairs on the filaments of anther has been brought out by the present study. These are not known to have been used by earlier workers, except the hairiness of the filaments, which has been reported by Tanaka (1939) in case of the small fruited citron, *C. nana*. However, the present author has found this character to occur in the case of the Citron lemon also. It is felt that the true Citrons and most of their lemon hybrids are hairy and may thus have lost this character.
Recommendation of identified Citrus for commercial cultivation/root stock 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. The citrus species and varieties identified through extensive survey in the state can be recommended for commercial cultivation or as root stock for harnessing better growth, yield, quality and resistance to different insect pests and diseases. There is no single rootstock available that can be regarded as ideal for all the citrus species under varying soil and climatic conditions of Orissa.

To harness beneficial effect of rootstock, the citrus species can be grown on different rootstocks which can be standardized and found suitable for different regions in the state. These varieties or species of citrus can be grown on location specific basis.

- In Pallahara area of Dhenkanal district, citrus species like Karna Khatta, Rough lemon, Jambheri and Rangpur lime can be recommended for rootstock purpose while Mandarin, Kagzi lime, Sweet lime have been found suitable for commercial cultivation.

- In Angul district, species like Jambheri and Kagzi lime were found suitable for rootstock purpose and varieties like Nagpur orange (Mandarin), Grape fruit, Gangakulia lime and Sweet lime were found promising for commercial production.

- Citrus species like Mandarin orange (Loose skin orange), Kinnow mandarin, Mosambi cv. of Sweet orange, Lemon, Pummelo and Grape fruit were found suitable for commercial cultivation in the district of Gajapati and Ganjam in general and in areas of Loba, Sindiba, Munising,
Raising, Talasahi, Talamunda, Jholasahi and Subolada in particular. However, most of the species were commercially propagated only through seed and vegetative propagation is rarely practised through budding. In these areas, Karna Khatta and Rough lemon were found promising for root stock purpose for maximizing yield of good quality fruits.

- In the areas of Mandibisi, Gunupur and Niamgiri hills of Rayagada district, species like Kagzi lime, Mandarin, Pummelo, Gajalemon and Citron were grown commercially. Here, the species like Jatti Khatti, Sweet orange and Karna Khatta were found suitable for root stock purpose.

- In Koraput district, Kagzilime is grown on commercial basis, whereas Karna Khatta and Rough lemon were found suitable for rootstock purpose.

- In Deogarh district, citrus species like Mandarin, Mosambi cv. of Sweet orange, Kagzi lime, Sweet lime and Narangi were grown commercially. In these areas, rootstock trial should be conducted for improving productivity, quality with resistance to biotic and abiotic stresses by budding of these plants on various rootstocks like Rough lemon, Jambhiri, Karna Khatta etc.

- In Baragarh district (particularly in the areas of Paikmala area) Sweet orange cv. Mosambi is grown commercially as the soil and climate of the area is well suited for its profitable cultivation.

- Citrus species like Mandarin orange, Grape fruit and Jambheri were found suitable in Kuchinda area of Sambalpur district of Orissa.

- In Sundergarh district (Lahunipada area), Mandarin, Matlong cv. of Pummelo, Grape fruit and Sarbati lemon were grown on commercially. In these areas various rootstocks resistant to biotic and abiotic stresses were found suitable for improving tree vigour along with increase in productivity and quality fruits.
TYPES OF CITRUS FOR COMMERCIAL CULTIVATION/USE AS ROOTSTOCK

Plate 13 : Rangpur Lime for rootstock purpose

Plate 14 : Sweet orange C V Washington Navel for commercial cultivation

Sweet orange cv.. Hamlin  Sweet orange cv.. Pine apple

Plate 15 : Sweet orange varieties for commercial cultivation
Lemon cv. *Eureka*  
Lemon cv. *Meyer*

Plate 16: Lemon C Vs for commercial cultivation and rootstock purpose

Pummelo cv. Red Flesh  
Grape fruit  
Sweet lime

Plate 17: Pummelo and Grape fruit for commercial cultivation and sweet lime for rootstock

Coorg Orange

Plate 18: Coorg Orange for commercial cultivation and rootstock purpose
Acid lime leaves, flowers & fruits

Plate 19: Acid lime: Both for commercial cultivation and rootstock purpose

Fruits of *Citrus jambhiri*

Plate 20: Jambheri for rootstock purpose