# Evaluation of Citrus Germplasm in North-eastern Hill Region

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Evaluation of citrus germplasm comprising 15 species and 8 hybrids, maintained at ICAR Research Complex, Barapani farm, indicated a wide range of variability in growth and physico-chemical characters within the different species and types. Based on the physico-chemical evaluation of fruits, certain land races like Soh bitara and Kinnow mandarin in sweet orange and mandarin group, lemon mayer and galgal and citragequate can be exploited for commercial scale under mid hills altitude. The fruits of other species which have no commercial value as edible fruit can be utilized for the extraction of oil, citric acid as well as for manufacturing of pectin and in citrus improvement program as a parent.

**Key words : Citrus, Evaluation, Germplasm, Landraces**

The north-eastern hill (NEH) region of India is endowed with enormous genetic diversity in a number of crops (Singh, 1981) and holds an important position with regards to citrus wealth. Diverse forms of fruits of different *Citrus* species grow wild or semi-wild in different states in the region (Verma and Ghosh, 1979). A large number of exotic and indigenous citrus species/ types and landraces were collected and maintained at ICAR Research Complex of NEH Region, Barapani farm, Meghalaya, with the twin objectives of conservation and evaluation for further utilization.

## Materials and Methods

Out of a large collection, 23 citrus types belonging to 15 species and 8 hybrids planted at the same time and maintained at germplasm block at ICAR Research Complex, Barapani, Meghalaya were evaluated for their vegetative growth and physico-chemical characteristics. Observations on the vegetative growth of plant like height, stem girth and spread were taken in the month of December, while fruits for physico-chemical analysis were picked up randomly from the plant as per their maturity. For each species/types individual fruit was weighed on a monopan balance. Fruit size i.e. length and diameter and rind thickness were measured with the help of Vernier calliper. The juice of individual fruit was extracted with the help of manually operated juice extracter machine and after straining through muslin cloth the quantity was measured by measuring cylinder. Total soluble solids (TSS) was recorded with the help of hand refractometer. The acidity and ascorbic acid content in the fruit juice was estimated as per the standard method described in A.O.A.C. (1984).

## Results and Discussion

### *Vegetative Growth*

A wide range of variation in different parameters of vegetative growth among the different species/types and landraces of citrus was observed (Table 1). The plants of Calamodin mandarin, followed by Kinnow and citremon, were found to be vigourous in respect of plant height as compared to other citrus species and types studied. The growth of Satkara plants was mimimum, indicating the dwarfing habit. This may be due to the reason that it grows at lower altitude (less than 400m) and has therefore not adopted well under mid hills conditions (above 900 m). The plants of Cleopatra mandarin and Volkamar lemon exhibited vigorous growth in respect of girth and mean spread respectively. The differential behaviour in vegetative growth among different species/types and land races maintained at Barapani may be attributed due to inherent differential species characters. Similar findings were reported by Singh *et al.* (1999) and Verma *et al.* (1999) under different agroclimatic conditions.

### *Physico-Chemical Characters*

As evident from the data presented in Table 2, wide variability exists in the physico-chemical characters of fruits of different species and types. Among the sweet and sour orange fruit, a good amount of variability was observed. Highest single fruit weight (155.2 g), size of fruit, segments per fruit (11.3), juice content (44.0 ml) and acidity (2.4%) was recorded in Soh bitara fruits. The ascorbic acid, acidity, total soluble solid and rind thickness was found to be minimum in Soh bitara, Kamla Australia, Soh nairiang and Dulcis malta respectively. The fruits of Karun Jamir had the maximum

**Table 1. Plant growth of different citrus species/types and landraces after 13 years of establishment at Umiam, Meghalaya**

| S. No. | Citrus species | Plant height (cm) | Stem girth (cm) | Plant spread (cm) | | |
|---|---|---|---|---|---|---|
| | | | | EW | NS | Mean |
| **Sweet orange *(C. sinensis)*** | | | | | | |
| 1 | Kamla Australia | 442.5 | 48.7 | 305.0 | 305.0 | 305.0 |
| 2 | Sohbitara | 440.0 | 38.0 | 200.0 | 220.0 | 210.0 |
| 3 | Soh Nairiang | 446.6 | 39.9 | 231.6 | 236.6 | 234.1 |
| 4 | Dulcis malta | 450.0 | 40.0 | 310.0 | 400.0 | 355.0 |
| **Sour Orange *(C. aurantium)*** | | | | | | |
| 5 | Karun Jamir | 412.5 | 38.6 | 276.2 | 272.5 | 274.3 |
| **Mandarins** | | | | | | |
| 6 | Cleopatra (C. redhni) | 413.7 | 55.9 | 236.2 | 323.7 | 325.0 |
| 7 | Kinnow (Hybrid) | 490.0 | 55.0 | 360.0 | 345.0 | 352.5 |
| 8 | Calamondin | 518.0 | 50.6 | 297.0 | 393.0 | 295.0 |
| **Lemon/rough lemon** | | | | | | |
| 9 | Lemon Meyor *(C. meyerii* Y. Tan) | 234.0 | 23.5 | 196.6 | 190.0 | 193.3 |
| 10 | Volkamer lemon *(C. Volkameriana)* | 418.7 | 43.7 | 355.0 | 430.0 | 392.5 |
| 11 | Galgal *(C. pseudlimon)* | 365.5 | 36.2 | 292.5 | 256.6 | 274.5 |
| 12 | Estes rough lemon | 386.2 | 43.1 | 358.7 | 357.5 | 358.1 |
| **Trifoliate orange and its Hytbrids** | | | | | | |
| 13 | Troyer citrange | 375.0 | 27.9 | 137.5 | 135.0 | 136.2 |
| 14 | Citrangequate | 415.0 | 42.1 | 270.0 | 250.2 | 250.1 |
| 15 | Yuma citrange | 385.0 | 29.2 | 145.0 | 155.0 | 150.0 |
| 16 | Carrizo citrange | 370.0 | 25.6 | 152.5 | 135.0 | 141.2 |
| 17 | Trifoliate orange *(P.trifoliata)* | 247.5 | 19.6 | 145.0 | 137.5 | 141.2 |
| 18 | Citremon | 485.0 | 35.0 | 220.0 | 265.0 | 242.5 |
| **Papeda Group** | | | | | | |
| 19 | Satkara *(C. mucrioetera)* | 165.0 | 17.3 | 130.0 | 95.0 | 112.5 |
| 20 | Soh Shykhoit *(C. latipes)* | 480.0 | 48.0 | 302.0 | 290.0 | 296.2 |
| **Others** | | | | | | |
| 21 | Grapefruit | 351.0 | 35.2 | 320.0 | 312.5 | 316.0 |
| 22 | Sweet lime *(C. limiettiodies)* | 441.0 | 44.0 | 355.0 | 321.0 | 338.0 |
| 23 | Ada Jamir | 352.5 | 37.0 | 250.0 | 232.5 | 241.2 |

acidity (5.1%) with minimum number of seeds (7.0) and segment (8.7) as well as juice content (19.2 ml) as compared to sweet orange types. Out of three mandarin species, Kinnow has least acidity and was the juicy fruit. However, the ascorbic acid content, number of seeds per fruit and rind thickness were observed to be more in Kinnow than other two types of mandarins. The variability in physico-chemical characteristics of different mandarins have also been reported by Singh and Lal (1982).

Among the lemon types, the fruits of galgal were found to be greater in weight (360.5g), size and juice (110.0 ml). Fruit size, weight, segments/fruits and juice content was recorded minimum in Estes rough lemon. However, the ascorbic acid was recorded more in the same fruit juice than the others. Among the trifoliate hybrids Citrangequat hybrid under mid hills conditions produced the bigger size, thicker skinned, least acidic fruits under mid hills conditions production the bigger size, thicker skinned, least acidic fruits with minimum number of segments as compared to other hybrids. The smallest size of fruit with least number of segments and juice content was recorded in trifoliate orange. However, number of seeds/fruit was found maximum in the same followed by Yuma and Carrizo citrange. The maximum TSS, acidity and ascorbic acid content was found in Troyer citrange follwed by Citremen and Carrizo citrange respectively

Out of two Papeda species, *Citrus latipes* and *C. macroptera*, a wide variation in morphological and

**Table 2. Physico-chemical characteristics of citrus germplasm at Umiam, Meghalaya (Av. 4yrs).**

| No. | Name of Cultivars | Fruit Wt. (g) | Fruit size (cm) Length | Breadth | No of Segment/ Fruit | Rind Thickness ness (mm) | Number of seed/ fruit | Juice/ Fruit (ml) | TSS % | Acidity % | Ascorbic acid mg/100ml Fruit juice |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sweet orange** | | | | | | | | | | | |
| *(C. sinensis)* | | | | | | | | | | | |
| 1 | Kamla Australia | 123.6 | 5.75 | 6.12 | 11.2 | 4.50 | 11.8 | 41.2 | 10.1 | 0.90 | 66.0 |
| 2 | Sohbitara | 155.2 | 6.02 | 7.15 | 11.3 | 4.82 | 10.2 | 44.0 | 8.6 | 2.4 | 37.0 |
| 3 | Sohnairiang | 140.5 | 5.57 | 7.02 | 11.1 | 6.20 | 8.5 | 34.2 | 8.4 | 1.7 | 41.0 |
| 4 | Dulcis malta | 128.0 | 5.82 | 6.19 | 11.0 | 2.38 | 15.8 | 40.8 | 9.2 | 1.1 | 52.2 |
| **Sour Orange** | | | | | | | | | | | |
| *(C. aurantium)* | | | | | | | | | | | |
| 5 | Karun Jamir | 146.1 | 6.44 | 6.82 | 8.7 | 5.82 | 7.0 | 19.2 | 8.0 | 5.1 | 35.2 |
| **Mandarins** | | | | | | | | | | | |
| 6 | Cleopatra mandarin *(C. redhni)* | 36.3 | 3.34 | 4.12 | 11.4 | 1.55 | 8.2 | 17.5 | 8.4 | 2.7 | 32.5 |
| 7 | Kinnow (Hybrid) | 105.4 | 4.15 | 5.58 | 12.2 | 3.30 | 35.5 | 37.0 | 10.0 | 1.1 | 37.5 |
| 8 | Calamondin | 26.4 | 3.44 | 3.88 | 8.2 | 1.30 | 6.5 | 12.4 | 6.0 | 4.5 | 35.0 |
| **Lemon/rough lemon** | | | | | | | | | | | |
| 9 | Lemon Meyor *(C. meyerii* Y. Tan) | 260.5 | 11.08 | 6.53 | 10.2 | 6.50 | 42.0 | 34.5 | 6.5 | 5.7 | 31.5 |
| 10 | Volkamer lemon *(C. Volkameriana)* | 144.2 | 7.11 | 6.48 | 8.6 | 4.20 | 19.1 | 45.2 | 7.2 | 4.0 | 21.5 |
| 11 | Galgal *(C. pseudlimon)* | 360.5 | 9.98 | 8.85 | 8.4 | 6.00 | 5.2 | 110.0 | 6.4 | 4.1 | 30.0 |
| 12 | Estes rough lemon *(C. jambhgiri)* | 106.3 | 6.48 | 5.89 | 6.2 | 5.50 | 19.0 | 20.2 | 6.5 | 4.4 | 33.4 |
| **Trifoliate orange and its Hytbrids** | | | | | | | | | | | |
| 13 | Troyer citrange | 85.6 | 5.33 | 5.25 | 8.2 | 2.50 | 12.5 | 30.2 | 8.3 | 5.6 | 68.0 |
| 14 | Citrangequate | 125.6 | 5.84 | 5.76 | 10.8 | 3.72 | 8.5 | 40.3 | 7.0 | 1.5 | 52.2 |
| 15 | Yuma citrange | 71.5 | 4.62 | 5.54 | 9.2 | 3.51 | 18.5 | 27.4 | 6.5 | 4.1 | 52.2 |
| 16 | Carrizo Citrange | 80.2 | 5.54 | 5.32 | 9.0 | 2.62 | 14.2 | 25.4 | 7.0 | 4.6 | 55.0 |
| 17 | Trifoliate orange *(P.trifoliata)* | 35.4 | 3.94 | 4.12 | 6.4 | 2.48 | 22.8 | 16.4 | 7.1 | 5.28 | 47.6 |
| 18 | Citremon | 43.4 | 4.15 | 4.52 | 7.4 | 3.00 | 6.0 | 15.2 | 8.1 | 5.4 | 44.5 |
| **Papeda Group** | | | | | | | | | | | |
| 19 | Satkara *(C. mucrioetera)* | 169.5 | 6.09 | 7.12 | 14.0 | 6.40 | 10.5 | 35.2 | 7.9 | 8.2 | 27.0 |
| 20 | Soh Shykhoit *(C. latipes)* | 388.9 | 8.84 | 9.20 | 12.1 | 16.80 | 26.5 | 40.5 | 8.9 | 5.4 | 55.5 |
| **Others Group** | | | | | | | | | | | |
| 21 | Grapefruit *(C. paradisi)* | 362.5 | 8.25 | 9.13 | 12.0 | 6.62 | 56.5 | 95.20 | 7.2 | 2.0 | 41.2 |
| 22 | Sweet lime *(C. limiettiodies)* | 105.2 | 5.62 | 5.85 | 11.0 | 3.10 | 2.4 | 33.0 | 6.0 | 0.23 | 40.0 |
| 23 | Adajamir | 260.4 | 8.02 | 7.79 | 12.1 | 6.4 | 27.2 | 30.0 | 6.1 | 5.2 | 50.0 |

physico-chemical characters was observed. Single fruit weight (388.9 g), fruit size, rind thickness (16.8 mm) and ascorbic acid content (55.5 mg/100 ml juice) was recorded more in Soh Shyrkhoit than Satkara which contain maximum number of segments (14.4) and acidity. Similar observations were made by Verma and Ghosh (1979). In other three species viz. *C. paradisi*, *C. limettioides* and an indigenous species *C. assamensis*, the fruits of *C. paradisi* was recorded heavier in weight and bigger in size with thicker rind containing maximum juice and seeds followed by Adajamir. The TSS content was found in a range of 0.23 to 5.20% and 40 to 50 mg/ 100 ml juice with minimum in sweet lime and maximum in Adajamir respectively.

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