



## Evaluation of Citrus Germplasm in Venkatagiri, Nellore District

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### ABSTRACT

A total of 117 accessions of citrus germplasm collected from various sources in the country are maintained and evaluated for growth, yield, adoptability at Citrus Research Station Pettur, Venkatagiri dist. Some of the accessions performed very well and some did not perform well. Among the various accessions Pummelo Red., Nicholas Grape fruit, Sunki mandarin., Troyer citrange., CRS-21 performed well in this area. The accessions unfavorable to this climate possessed low average mean for various characters in the present study.

**Key words :** Acidlime, Citrus, Hybrids, Mandarin, Pummelo.

Citrus fruits are the third largest of the fruits grown in India with an estimated production of 4979.11 thousand m.t. from an area of 569.56 thousand ha. The country is the home of many citrus species, namely, *Citrus inchangensis*, *C. latipes*, *C. macroptera*, *C. assamensis*, *C. aurantium*, *C. jambhiri*, *Citrus limonia*, *C. karna*, *C. pennivesiculata* and *C. madera spatana*. The diverse eco geographical distribution and the occurrence of spontaneous mutations and natural hybridization have given rise to a wide range of variability in citrus and related genera. Genetic resources of citrus in India have been well reviewed (Singh and Chadha 1993; Chadha and Singh 1990).

Citrus fruits belong to Rutaceae family which contain more than thousand species possess greater adaptability to different climatic conditions. India is an important centre of origin and diversity of many horticultural crops including fruit crops like mango, citrus and banana. The sub-continent (area 3 276 141 km<sup>2</sup>) extends from 8° 04' - 37° 06' North latitude to 68° 07' - 97° 25' East longitude, and has tropical, subtropical and temperate climate. Therefore, a variety of fruits originating in tropics, subtropics and temperate regions of the world have been introduced in India and many of them are commercially grown in the country.

In India, more than 500 citrus varieties are available of which, mandarin, sweet orange and acid lime are commercially grown with regional preference considering the agro ecological conditions, resulting in their increased area and

production. Increase in production over the base year of 1961 is over 242.59% with an annual growth rate of 7.82%. Citrus fruits thus occupy 11.53% of the total area under fruits in India. However, genetic base of cultivars is very narrow and enrichment of germplasm needs greater attention.

There are three major centres of diversity. The types found include the papeda, pummelo and their hybrids, *Citrus indica* and many types of citron, lemons and mandarins. These include interesting types like Nemerutenga, Soh-Systemg, a sour fruit similar to the sweet lime and Soh-Siem, a sour mandarin. Diversity of this region is well studied and described by Bhattacharya and Dutta (1956).

In South India, the indigenous types include Gajanimma or Baduvapuli, Kichli and some wild mandarin types, viz., Kodakithuli, Billikichili, Nakoor lemon, Mole puli (sour orange type), etc. In western India, at the foot of the Himalaya, the hill lemon (galgal) and Attani are common. Citron, Citron lemon, Karna Khatta, Rough lemon, Rangpur lime, acid lime, hybrid pummelo and various types of mandarins are found all over the country.

Wild types or plants growing without any attention are largely found in the foot hill regions of northwestern India, in the north-east, in south in Malabar hills and in the Western Ghats under varying ecological conditions. Some of the citrus fruits are so localized in certain parts that they are hardly known outside their native homes. Knowledge concerning the performance and its biological studies helps in initiating a hybridization

programme as root stock or in the industries to extract products such as pectin, volatile oils, squashes, jams etc. certain species and genera other than the commercial orcharding, getting extinct and needs their conservation for future.

Several biotic and abiotic factors are known to effect in citrus production. So, it is necessary to collect the different species/varieties from different sources for drought tolerance, suitability as a root stock for different purposes etc. Due to inherent problems in citrus breeding like perennial in nature, juvenility, nucellar embryo and poly embryony citrus improvement programme was not given due attention in our country as in other perennial crops.

Germplasm is maintained under different agro-climatic conditions at central Horticultural Experiment Station, Chethalli, Karnataka; Indian Institute of Horticultural Research' Bangalore, Karnataka; Regional Fruit Research Station, Abohar, Punjab; Horticultural Experiment Station. Bhatinda, Punjab; Division of Fruits and Horticultural Technology IARI, New Delhi; Department of Horticulture Rahuri, Maharashtra; Citrus Improvement Project, Tirupati, Andhra Pradesh; Citrus Experiment station, Katol, Maharashtra; Horticultural Experiment station, Periyakulam, Tamil Nadu; Citrus Experiment Station Tinsukia, Assam and others. At these centres, germplasm is maintained as working collections.

Citrus germplasm is conserved in field gene banks at different locations (Srivastava and Singh 1977; Iyer and Dinesh 1987; Singh and Uma 1995). Though substantial diversity is conserved in field gene banks, it does not contain total representation of the variability available in citrus. Most of the germplasm collected by Bhattacharya and Dutta (1956) from North-eastern India are currently not available in any of the collections. At the same time, Most of the germplasm were safely duplicated at few centers owing to the fact that germplasm of one region behaves differently at other region.

South East Asia, Australia the intervening island areas between Asia and Australia and Central Africa are recognized as important centers of origin for citrus and related genera (Swingle and Reece, 1967). Most of the important species grown in India have originated in India and china (Mcphee, 1967). In India north eastern Himalayas region and foot hills of central and western Himalayas tracts

are rich sources of citrus diversity. As many as 17 Citrus species their 52 cultivars and 7 probable natural hybrids are reported to have originated from northeast tern region (Bhattacharya and Dutta, 1956). It is interesting to note out of 30 citrus species available in India (Singh and Chadha, 1993) at least 9 species are available throughout India whereas fifteen species are confined to northeastern India, nine species to South India six species to northwestern India and one species to central India.

Trees on Rangapur lime root stock are reported to have more life and are heavy yielders (Chadha and Singh 1990). Cleopatra mandarin has also shown good promise as root stock (Iyer and Dinesh 1987) (Chakrawar et al. 1988) identified two promising clones of acid lime Vikram and Pramalini in Maharashtra. (Chadha and Singh, 1990) collected a thornless and seedless acid lime from central Maharashtra at Nagpur, seedless Santra has been selected which has commercial potentiality.

At Periakulam PKM-1 acid lime was selected which gives high yield of quality fruits- Short juvenile Poncirus was also spotted during a survey. At Rahuri, 150 accessions of acid lime were collected with desirable traits of yield, resistance to canker and leaf miner and higher summer yield. Five of these accessions have potential for commercial exploitation. One of the accessions has been selected and released as Sai Sarbati for its cultivation in Maharashtra region. Similarly, exploration of citrus orchards have also resulted in selection of superior clones of acid lime and sweet oranges at Tirupati and Rahuri.

Although documentation of genetic resources of Citrus has been done (Bhattacharya and Dutta 1956; Singh and Singh, 2003; Srivastava and Singh 1977; Iyer and Dinesh 1987; Singh and Uma 1995) for better accessibility of information, database with central monitoring system is still lacking.

Citrus Research Station Petlur being the nodal agency for citrus research in Andhra Pradesh was started in 1991 at Petlur, Venkatagiri Nellore dist to develop superior scion cultivars with excellent fruit quality, early / late bearing and seedless cultivars and rootstocks having Rough lemon/ Rangapur lime seedling growth habit with tolerance to biotic stress. A large pool of citrus germplasm indigenous as well as exotic were collected and

Table 1. Citrus Germplasm at C.R.S., Petlur.

Name of the Citrus group	Number of accessions maintained					
	Planted during 1993	Planted during 1998	Planted during 1999	Planted during 2001	Planted during 2003	Collected during 2011
Sweet orange	8	6	1	5		
Sour orange	4	1				2
Pummelo	1	2				
Grape fruit	5	-		2		1
Rough lemon	8	-		7	10	3
Rangapur lime	2	1		4		2
Mandarin group	6	1		1		
Miscellaneous	6					12
Hybrids	4	-		2	5	10
Other species	2	6		3	2	
Acid lime		3		6		
Lemon		1		1		
Total	46	21	1	32	17	30

Table 2. Biometric observations of different Accessions of pumello.

S.No	Pumello ( <i>Citrus grandis</i> )	Plant height (m)	Spread E-W(m)	Spread N-S (m)	Stem girth (cm)	Canopy volume(m <sup>3</sup> )	Yeild
1	Pummelo Red	4.8	7.8	8.2	100	522	213
2	Rabab Tanga Assam	4.7	3.8	3.8	90.3	99.3	199
3	Pummelo 31-1-13	4.8	3.9	4.0	42.6	124.4	184
	Sed	0.02	0.04	0.02	0.74	31.36	3.31
	CD 5%	0.11	0.15	0.11	3.20	134.9	14.2

conserved with main objective to utilize under improvement programme., The characterization of germplasm therefore assumes great significance not only for streamlining breeding strategy but also for economic reasons and development of collections with high genetic diversity. This station has the mandate of ex situ conservation of genetic variability of both indigenous and exotic germplasm of citrus crops.

#### MATERIAL AND METHODS

A total of 117 accessions in the Rutaceae family are maintained Citrus Research Station Petlur. Venkatagiri, Nellore dist.. It comprised of Sour oranges, Rough lemons, Grape fruits, Pumello, Rangapur lime, Acid lime, Lemons, Mandarin types, 15 miscellaneous species, genera other than citrus and 10 hybrids (Table 1).

The plants are planted during the year 1993 and 1998 at 6 x 6 mt spacing in the farm . The

soil is red loamy type and the temperatures are very hot which reaches up to 47 degrees during summer months and dry weather persists for almost nine months in a year. Six plants in each variety at a distance of 6x6 mt were planted and-maintained. The irrigation is carried out through drip with 16 mm lateral pipes.

The performance in term of vegetative growth charac-ters, yield efficiency and fruit quality characters were studied . The data for all the parameters was recorded during 2011 and 2013 and was pooled. Collapsible PVC pole, calibrated in feet and inches was used to measure the height of each sam-ple plant. Height was measured from the bud union to the top of plant. Tree size was derived in term of Canopy Volume (CV) with the help of calculation,  $CV = 0.524hd^2$  which is one-half of a prolate spheroid with h denoting as tree height while d denotes average of N-S and E-W diam-eters. Scion and stock circumference were measured with

Table 3. Biometric observations of different Accessions of Grape Fruit.

S.No	Grape Fruit ( <i>Citrus paradisii</i> )	Plant height (m)	Spread E-W(m)	Spread N-S (m)	Stem girth (cm)	Canopy volume(m <sup>3</sup> )	Yeild
1	Grape fruit (Attari small)	3.8	7.9	7.9	102	400	97
2	Grape Fruit (Punjab)	4.8	8.2	7.4	92.3	480	379
3	Nicholos Roy Grape fruit	4.4	8.0	7.6	119.3	655	318
4	Zamabowk	4.5	8.1	8.3	92.6	711	110
	Sed	1.80	0.08	0.23	6.47	84.6	8.63
	CD 5%	1.74	0.38	0.99	27.8	364.1	7.1

Table 4. Biometric observations of different Accessions of Mandarin.

S.No	Mandarin group <i>Citrus maderaspatna</i>	Plant height (m)	Spread E-W(m)	Spread N-S (m)	Stem girth (cm)	Canopy volume(m <sup>3</sup> )	Yeild
1	Sunki mandarin	4.5	8.3	8.2	104	526	1076
2	Cleoptramandarin	4.6	7.8	8.0	106	404	1247
3	Unshui Mandarin <i>Citrus unshiu</i>	3.7	7.0	6.6	93	330	718
4	Cleoptramandarin 8738	3.5	6.3	6.3	100	253	846
	Sed	0.10	0.04	0.25	2.32	1.96	87.4
	CD 5%	0.46	0.19	0.059	10.02	8.46	376.1

the help of measuring tape, just above and below the bud union. Yield Efficiency (YE) was computed from the relationship between fruit yield and canopy volume.

## RESULTS AND DISCUSSION

**Pumello** There is significant difference between the Pumello varieties (Table 2) with respect to plant height, plant spread, stem girth, canopy volume and yield. Among the Pumello varieties, Pumello Red recorded maximum height of (7.8 mt) followed by Pumello 31-1-13 (6.8 mt). Pumello Red exhibited maximum values in terms of spread, volume, girth and yield and minimum in Rabab Tanga assam. Similar results were reported by Mohar et al 2011 and Tripathi *et al*, 2013).

There is significant difference between the Grape fruit varieties (Table 3) with respect to plant height, plant spread, stem girth, canopy volume and yield. Among the Grape fruit varieties, Grape Fruit Punjab recorded maximum height of (4.8 mt) followed by Zamabowk (4.5 mt). Nicholos Roy Grape fruit exhibited maximum values in terms of spread, volume, girth and minimum in Attari small. As far as yield maximum was recorded in Grape fruit Punjab. Similar results were reported by (Aiyappa *et al*. 1976) and Tripathi *et al*, 2013).

There is significant difference between the mandarin varieties (Table 4) with respect to plant height, plant spread, stem girth, canopy volume and yield. Among the mandarin varieties Cleoptramandarin recorded maximum height of (4.6 mt) followed by Sunki mandarin (4.5 mt). Sunki mandarin exhibited maximum values in terms of spread, volume, girth and minimum in Cleoptramandarin 8738. As far as yield maximum was recorded in Cleoptramandarin (1247) Similar results were reported by (Tripathi *et al* 2013).

There is significant difference between the Rough lemon varieties (Table 5) with respect to plant height, plant spread, stem girth, canopy volume and yield. Among varieties Rough lemon 8778 recorded maximum height of (4.9 mt) followed by Rough lemon 8781 (4.7 mt). Rough lemon 8778 exhibited maximum values in terms of spread, volume, girth and minimum in Rough lemon 14-9-13 As far as yield maximum was recorded in Rough lemon 8779 (826) Similar results were reported by (Singh and Chadha 1993, Qureshi et al., Tripathi *et al* 2013).

There is significant difference between the citrus hybrids (Table 6) with respect to plant height, plant spread, stem girth, canopy volume and yield. Among hybrids Troyer citrange recorded

Table 5. Biometric observations of different Accessions of Rough lemon.

S.No	Rough Lemon <i>Citrus jambheri</i>	Plant height (m)	Spread E-W(m)	Spread N-S (m)	Stem girth (cm)	Canopy volume(m <sup>3</sup> )	Yeild
1	Soh Myndong	3.2	8.3	9.2	103.3	470.5	426.6
2	Rough lemon 8779	3.9	8.5	8.0	106.3	589.3	826.3
3	Brazilian Rough Lemon	3.5	8.1	8.3	101.6	527.1	803.6
4	Rough lemon 8778	4.9	7.8	8.2	127.3	617.5	733.3
5	Rough lemon 8780	4.3	8.5	8.2	116	632.7	789.6
6	Rough lemon 8781	4.7	7.8	8.1	109.6	495.4	771.0
7	Florida Rough lemon	3.0	7.7	8.0	118.6	478.6	331.3
8	Rough lemon 14-9-13	3.0	7.3	7.3	118	446.2	342.6
9	Chage Rough lemon	3.3	7.6	7.4	124	415.9	358.3
	Sed	0.212	0.067	0.086	4.474	3758	15.85
	CD 5%	0.449	0.142	0.182	9.485	2.96.7	33.06

Table 6. Biometric observations of different Accessions of Citrus hybrids.

S.No	Other species	Plant height (m)	Spread E-W(m)	Spread N-S (m)	Stem girth (cm)	Canopy volume(m <sup>3</sup> )	Yeild
1	<i>C. depressa</i>	3.8	7.4	7.3	78.3	121	636
2	Calamandrin hybrid	4.3	9	9.2	88.3	124	780
3	Citrus china	4.4	7.7	6.3	81	106.6	946
4	Kichili	4.2	7.5	6.3	80	95.6	192
5	C madraspatna	4.4	6.3	5.2	79.6	97.6	239
6	<i>C. Macrophylla</i>	3.2	6.6	7	83.6	111.6	217
7	<i>C. Moi</i>	3.3	6.2	5.9	89.6	111.3	260
8	<i>Citrus karma</i>	4.3	5.7	5.6	78.6	98.3	192
9	Citrumello - 4475	4.0	7.3	7.2	67.3	109.3	440
10	Troyer citrange	4.8	7.6	7.2	50.6	20	200
11	31-1-3	3.5	5.8	5.6	53.6	86	204
12	Gajanimma	3.8	5.4	5	41	89.6	58
13	<i>C.pennivesiculata</i>	4.6	3.7	3.46	49.6	27.3	93
14	Satsuma niku	4.3	4.4	4.4	48.6	48.3	79
15	Rangapur lime	3.6	5.1	5	80.6	88.3	1458
	Sed	0.10	0.04	0.01	0.36	8.3	61.3
	CD % %	0.20	0.90	0.02	0.75	17.0	125.04

maximum height of (4.8 mt) followed by *C.pennivesiculata* (4.6 mt). *C. macrophylla* exhibited maximum values in terms of spread, volume, girth and minimum in Satsuma niku. As far as yield maximum was recorded in Rangapur lime (1458). Similar results were reported by (Singh and Chadha 1993, Qureshi et al., Tripathi et al 2014).

There is significant difference between the acid lime varieties with respect to plant height, plant

spread, stem girth, canopy volume and yield. Among varieties CRS-21 recorded maximum height of (5.4 mt) followed by TAL94-13 (5.0 mt). CRS-21 exhibited maximum values in terms of spread, volume, girth, and minimum in Vikram. As far as yield maximum was recorded in TAL 94-14.(2603). Similar results were reported by (Aiyappa et al. 1976), Singh and Chadha 1993 and Tripathi et al (2013).

Table 7. Biometric observations of different Acid lime varieties.

S.No	Acid lime varieties	Plant height (m)	Plant spread (E W)	Plant spread (N-S)	Plant volume (cu.m)	Yield
1	Vikram	4.3	4.7	5.0	109.7	821
2	Pramalini	4.7	7.6	4.9	127.9	1423
3	Balaji	4.4	5.0	5.2	118.5	1643
4	TAL 94-14	3.9	7.1	6.6	96.6	2603
5	TAL 94-3	5.0	7.1	5.2	74.2	1015
6	CRS 21	5.4	7.2	7.5	141.8	2317
	Sed	0.08	0.30	12.6	5.99	236.75
	CD 5%	0.18	0.69	28.0	13.3	527.4

**Summary.**

Accessions of citrus belonging to different species were collected and maintained in Citrus research station, Petlur. There is clear range of variability in terms of height, yield, volume and girth is existing in the germplasm collections.

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(Received on 08.09.2016 and revised on 14.10.2016)