Exploration and Collection of Citrus Germplasm from NEH Region (Meghalaya) of India

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The North-Eastern hills region of India is considered as one of the natural home of many citrus species. Availability of favourable climatic conditions and easy hybridization among different species and genera has resulted in numerous wild/semi-wild forms in North-eastern states of India. Surveys were conducted in Khasi, Jaintia and Garo hills of Meghalaya to collect citrus germplasm from these regions including those from citrus gene sanctuary. A total of 79 accessions belonging to 15 *Citrus* species and 3 new types (probably hybrids) were collected. Five endangered citrus species, namely, *C. indica, C. latipes, C. macroptera, C. assamensis,* and *C. megaloxycarpa* were also collected. The collected materials were regenerated at NRCC, Nagpur and NBPGR, Regional Station, Umiam, Meghalaya and maintained under good conditions. The materials will be planted in field gene bank for evaluation and utilization.

Key Words: Citrus, Exploration, Germplasm, Meghalaya

North-Eastern hill (NEH) region , North-Western (NW) region particularly the foothills of Himalayas and Southern peninsular region of India, are considered the major centres of citrus diversity. A large number of citrus species/progenitors of commercial citrus fruits are believed to have originated in India (Bhattacharya and Dutta, 1951, 1956; Dutta, 1958; Singh, 1967; Singh and Singh 1967, 1968). Many of these species are wild. Hore *et al.*, (1997) reported many citrus species in NEH region. The need to collect and conserve the genetic resources is far greater in present time than ever before because the number of cultivated types has narrowed to only the best available ones with regards to productivity and quality. There is also a need to protect the collected germplasm since many of the field genebanks are under deteriorated condition due to several factors.

Until recently, desired genotypes and landraces, mostly of commercial value, were collected and maintained by individual farmers. National Research Centre for Citrus, Nagpur, which is the main centre for augmentation of Citrus germplasm, has conducted surveys in NEH region and collected citrus genetic resources.

Materials and Methods

An exploration was undertaken in collaboration with NBPGR, Regional Station, Umiam, Meghalaya and total 79 collections were made from Shillong, Cherapunji, Shella area of East Khasi Hills, Jowai, Muktapur and Dawki area of Jaintia Hills, Ribhoi area of Khasi Hills, Kamrup area of Assam, Tura, Rongram, Chandigre and Darichickgre area of West Garo hills and Dalu, Siju and Baghmara area of South Garo Hills and Ranikor area of West Khasi Hills. The habitat covered rocky, undulating mountainous slopes, disturbed, eroded slopes and backyards. Collection sites encompassed a wide altitudinal range *viz.*, 250 m to 1700 m. The soils ranged from shallow to deep soils. The rainfall pattern also varied from 2000-4000 mm per year. Budsticks and mature fruits were collected. Fruits were picked randomly and used for analysis of their physico-chemical properties. Collected seeds were dried in shade and sown in primary nursery for germination.

Table 1. Accessions of *Citrus* spp. collected during the exploration in Meghalaya

No. of accessions	Species	Common name	Occurrence
31	*C. grandis*	Pummelo	Home garden
6	*C. jambhiri*	Sohmyndong	Home garden
1	*C. macroptera*	Satkara	Semi wild
2	*C. reticulata*	Khasi mandarin	Cultivated
2	*C. latipes*	Soh Shyrkhoit	Home garden
1	*C. megaloxycarpa*	Sour Pummelo	Home garden
7	*C. limon*	Jaintia lemon	Cultivated
8	*C. medica*	Citron	Home garden
3	*C. assamensis*	Ada jamir	Home garden
6	*C. pseudolimon*	Galgal/Chinara	Home garden
3	*Probable Hybrid*	Chambil	Home garden
4	*C. indica*	Memon Narang	Wild/semi wild
2	*C. limmetta*	Sharbati lime	Cultivated
1	*C. madurencis*	Calamondin	Home garden
1	*C. aurantium*	Karun jamir	Home garden
1	*C. limettioides*	Sweet lime	Home garden

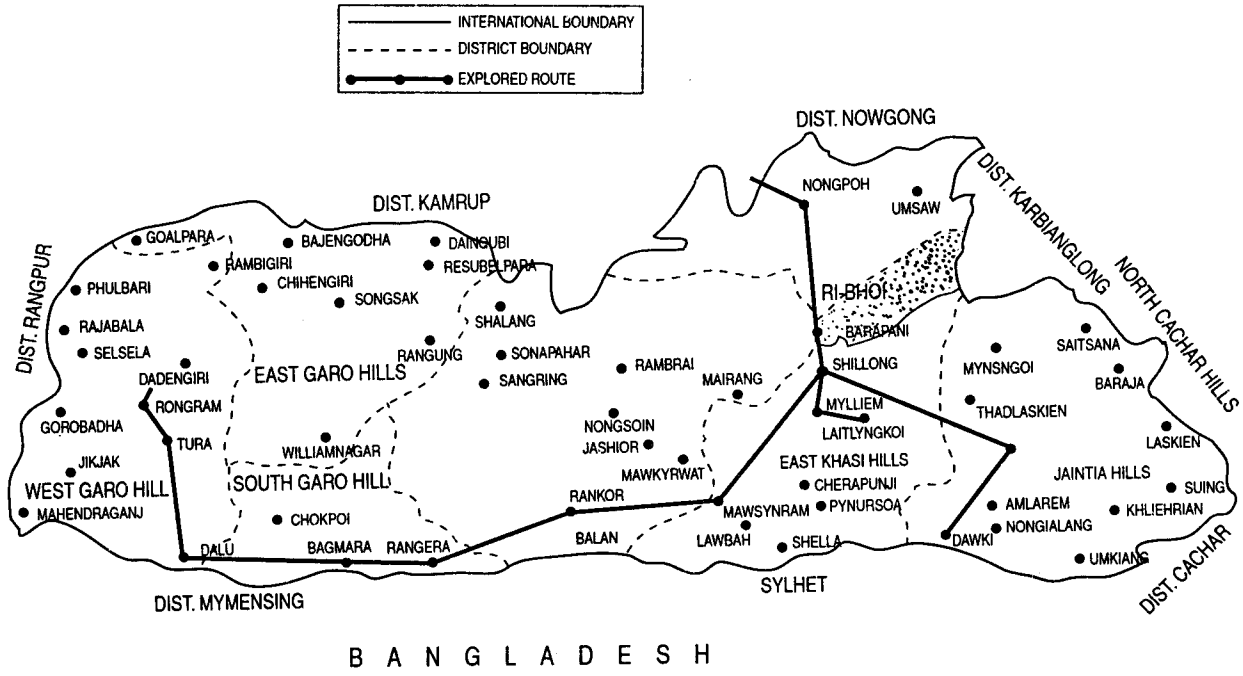

Fig. 1. Route followed during exploration

Results and Discussion

A wide range of variability was observed in collected material. A distinct variation was found in fruit weight, number of segment, fruit length, fruit width, number of seed/fruit and rind thickness (Table 2). Fruit colour was varied from yellow to reddish-deep yellow and greenish yellow. Bearing habit, fruit shape and thorny habit showed distinct variability.

Cherapunji and Shella area of East Khasi Hills and Jowai area of Jaintia Hills were the potential areas for Khasi mandarin and other citrus species. However, due to excess rain and deforestation, these areas are not considered potential area now for citrus except Dawki and Muktapur area in Jaintia Hills. Different types of citrus were collected from Muktapur area including 3 endangered *Citrus* species (*C. latipes, C. assamensis, C. megaloxycarpa*). *C. latipes* grows only at higher altitude above 900 m. around Shillong area whereas Satkara (*C. macroptera)* grows only in lower altitude less than 500 m in semi-wild form. It has good market value in comparison to Khasi mandarin. Area bordering to Bangladesh have greater variability for Pummelo, Satkara and Citron. Ribhoi area of Khasi hills is good for Khasi mandarin, Pummelo, Lemon and Citron, different types were collected from this area. Maximum variability was observed in Pummelo and Citron. In Kamrup area of Assam, different types of Assam lemon and Pummelo occurred.

The Garo Hills of Meghalaya is one of the area that harbours highest citrus genetic diversity. The Citrus gene sanctuary is well protected and plants are less susceptible to infection. The Nokrek Biosphere reserve have maximum genetic diversity of citrus. From here 3 types of Memon Narang (*C. indica*) were collected. Variability was observed in fruit size, colour and shape. Three new types, probably hybrids were also collected from this area. Siju and Baghmara area of West Garo Hills are rich in Pummelo, Khasi mandarin, Sharbati lime, Citron and Chinara germplasm.

Conclusions

The threat of genetic erosion of citrus diversity is not there but farmers preferences play a vital role in species survival. Due to this reason the genetic diversity in sour pummelo, white fleshed pummelo, *C. latipes* are fast eroding. Citrus plants in citrus gene sanctuary are well protected in healthy condition than plants found outside. Satkara (*C. macroptera*) that grows in semi-wild form in Shella area of Cherrapunji, now faces problem due

Table 2. Variation in physico-chemical characteristics of fruits in collected germplasm

S. No.	Collector No.	Species/Landraces	Fruit wt (g)	Fruit length (mm)	Fruit breadth (mm)	Peel thickness (mm)	No. of segment	Seeds/ fruit	TSS	Acidity (%)
1.	NRCC-241	Pummelo (*C. grandis*)	445.38	87.45	99.75	8.95	16.84	71.34	9.56	1.36
2.	NRCC-242	Sohmyndong (*C. jambhiri*)	75.00	52.66	48.60	2.74	9.00	12.60	6.70	4.35
3.	NRCC-243	Pummelo (*C. grandis*)	567.45	98.56	112.54	10.43	15.80	45.77	9.56	1.45
4.	NRCC-244	Sohmyndong (*C. jambhiri*)	69.35	50.42	49.33	2.56	8.5	16.00	7.00	4.80
5.	NRCC-245	Satkara (*C. macroptera*)	192.5	71.77	81.28	4.2		11.2	8.40	8.07
6.	NRCC-246	Khasi mandarin (*C. reticulata*)	–	–	–	–	–	–	–	–
7.	NRCC-247	Pummelo (*C. grandis*)	567.45	82.34	97.65	8.45	15.43	82.34	9.78	1.56
8.	NRCC-248	Pummelo (*C. grandis*)	487.46	79.569	90.35	10.56	16.45	69.86	10.00	1.34
9.	NRCC-249	Pummelo (*C. grandis*)	623.76	86.53	102.25	11.54	15.00	65.34	11.00	2.10
10.	NRCC-250	Soh Shyrkhoit (*C. latipes*)	342.45	81.24	90.34	12.45	12.00	29.67	9.00	6.69
11.	NRCC-251	Pummelo (*C. grandis*)	398.00	95.00	111.00	14.00	16.00	120.00	9.67	1.38
12.	NRCC-252	Soh Shyrkhoit (*C. latipes*)	424.00	86.50	105.60	14.80	11.00	61.00	7.6	8.6
13.	NRCC-253	Sour Pummelo (*C. megaloxycarpa*)	378.00	91.60	98.30	13.00	15.00	54.00	8.6	6.8
14.	NRCC-254	Jaintia lemon (*C. limon*)	120.00	80.30	58.75	5.00	11.00	58.00	6.7	5.6
15.	NRCC-255	Citron (*C. medica*)	106.24	86.75	65.45	4.60	13.00	36.78	7.00	6.95
16.	NRCC-256	Citron (*C. medica*)	54.66	72.33	41.83	3.00	14.00	56.66	6.50	7.80
17.	NRCC-257	Citron (*C. medica*)	79.56	68.67	64.23	4.85	14.00	35.54	7.00	6.34
18.	NRCC-258	Pummelo (*C. grandis*)	628.00	101.30	123.70	11.20	20.00	89.00	9.4	1.70
19.	NRCC-259	Pummelo (*C. grandis*)	478.00	110.40	111.70	14.40	15.00	161.00	10.2	2.0
20.	NRCC-260	Pummelo (*C. grandis*)	596.00	97.00	104.70	6.70	16.00	73.00	10.20	1.80
21.	NRCC-261	Pummelo (*C. grandis*)	882.00	122.80	133.00	12.00	19.00	162.00	10.00	2.20
22.	NRCC-262	Nimbu (*C. jambhiri*)	22.40	38.54	35.25	1.00	8.00	16.40	8.08	7.20
23.	NRCC-263	Pummelo (*C. grandis*)	840.00	114.40	123.70	6.00	21.00	114.00	9.80	2.00
24.	NRCC-264	Ada jamir (*C. assamensis*)	265.00	83.40	61.60	4.30	9.00	11.00	6.30	6.20
25.	NRCC-265	Jaintia lemon (*C. limon*)	36.00	43.70	40.60	9.00	9.00	18.00	9.00	7.50
26.	NRCC-266	Pummelo (*C. grandis*)	516.00	150.00	105.00	8.90	14.00	102.00	8.20	2.40
27.	NRCC-267	Citron (*C. medica*)	71.33	65.93	47.06	1.60	9.66	17.00	9.20	8.20
28.	NRCC-268	Ada Jamir (*C. assamensis*)	152.00	67.20	63.10	2.35	12.00	41.50	6.10	6.80
29.	NRCC-269	Pummelo (*C. grandis*)	830.00	127.00	135.00	13.00	16.00	106.00	10.00	2.3
30.	NRCC-270	Soh Jhalia (*C. jambhiri*)	90.00	56.00	53.75	2.30	9.50	28.50	6.60	7.68
31.	NRCC-271	Pummelo (*C. grandis*)	716.00	110.70	114.00	9.40	12.00	43.00	9.40	2.60
32.	NRCC-272	Pummelo (*C. grandis*)	420.00	88.00	119.00	8.30	10.00	12.00	8.00	5.5
33.	NRCC-273	Pummelo (*C. grandis*)	890.00	133.00	156.00	24.80	18.00	110.00	9.20	2.90
34.	NRCC-274	Pummelo (*C. grandis*)	418.00	95.60	101.00	10.6	13.00	76.00	8.4	1.50
35.	NRCC-275	Pummelo (*C. grandis*)	638.00	105.70	121.40	18.60	16.00	35.00	8.90	2.27
36.	NRCC-276	Lemon Umroi (*C. limon*)	244.00	125.30	61.60	4.30	9.00	11.00	6.3	6.80
37.	NRCC-277	Rootstock (*C. jambhiri*)	34.00	42.80	38.00	3.20	8.00	1.25	9.25	4.50
38.	NRCC-278	Pummelo (*C. grandis*)	890.00	14.50	145.00	18.40	16.00	72.00	9.20	1.22
39.	NRCC-279	Galgal (*C. peudolimon*)	225.00	94.80	70.40	5.50	11.00	12.50	6.90	7.20
40.	NRCC-280	Assam lemon (*C. limon*)	81.33	77.70	44.93	1.73	10.67	1.00	7.33	7.90
41.	NRCC-281	Pummelo (*C. grandis*)	584.00	111.00	115.00	16.00	14.00	153.00	9.20	2.70
42.	NRCC-282	Assam Lemon (*C. limon*)	92.00	81.76	46.33	1.20	8.33	14.00	6.56	5.25
43.	NRCC-283	Pummelo (*C. grandis*)	822.00	121.30	129.40	11.60	16.00	80.00	9.0	1.4
44.	NRCC-284	Pummelo (*C. grandis*)	1002.00	155.00	128.00	18.20	14.00	28.00	8.40	1.90
45.	NRCC-285	Chambil (*Probable Hybrid*)	81.60	47.92	55.20	3.60	9.60	4.00	8.2	7.04
46.	NRCC-286	Chinara (*C. peudolimon*)	126.67	79.30	57.03	3.30	10.00	3.20	9.90	4.20
47.	NRCC-287	Pummelo (*C. grandis*)	557.58	98.76	120.65	15.2	16.8	56.8	9.50	2.13
48.	NRCC-288	Memon Narang (*C. indica*)	22.00	30.50	40.60	2.05	10.00	10.50	9.98	2.11
49.	NRCC-289	Chinara (*C. peudolimon*)	190.66	84.60	71.03	6.73	11.33	22.20	7.93	3.40
50.	NRCC-290	Memon Narang (*C. indica*)	18.34	23.45	34.24	1.24	10.12	15.46	10.00	2.05
51.	NRCC-291	Pummelo (*C. grandis*)	666.00	101.20	131.00	20.00	18.00	72.00	9.10	1.50
52.	NRCC-292	Khasi Mandarin (*C. reticulata*)	–	–	–	–	–	–	–	–
53.	NRCC-293	Chinara (*C. peudolimon*)	142.00	77.30	61.00	3.167	10.00	3.00	7.6	4.48

Contd.

Table 2. contd.

S. No.	Collector No.	Species/Landraces	Fruit wt (g)	Fruit length (mm)	Fruit breadth (mm)	Peel thickness (mm)	No. of segment	Seeds/ fruit	TSS	Acidity (%)
54.	NRCC-294	Pummelo *(C. grandis)*	588.00	122.00	111.40	10.20	13.00	59.00	9.40	1.22
55.	NRCC-295	Pummelo *(C. grandis)*	682.00	112.20	129.20	14.00	15.00	102.00	8.2	1.50
56.	NRCC-296	Pummelo*(C. grandis)*	790.00	130.00	115.00	9.00	14.00	70.00	9.60	2.30
57.	NRCC-297	Chinara *(C. peudolimon)*	248.00	91.46	72.06	2.43	9.33	31.00	7.40	2.69
58.	NRCC-298	Citron *(C. medica)*	157.33	83.00	60.10	2.80	10.00	55.00	7.60	8.62
59.	NRCC-299	Sharbati lime *(C. limmetta)*	45.50	52.00	39.16	2.125	9.00	23.75	6.65	7.92
60.	NRCC-300	Lemon *(C. limon)*	28.67	42.00	36.03	1.10	8.67	6.00	8.06	8.20
61.	NRCC-301	Citron *(C. medica)*	176.66	98.06	59.36	2.90	10.00	15.00	6.40	8.49
62.	NRCC-302	Pummelo *(C. grandis)*	1204.00	140.00	150.00	11.60	19.00	108.00	9.40	1.50
63.	NRCC-303	Sharbati lime *(C. limmetta)*	32.66	48.45	34.98	0.81	9.83	20.83	6.96	8.45
64.	NRCC-304	Pummelo *(C. grandis)*	114.00	121.80	125.60	14.00	15.00	98.00	9.20	1.80
65.	NRCC-305	Lemon *(C. limon)*	101.50	71.25	50.20	0.925	10.50	32.00	6.85	7.70
66	NRCC-306	Chinara *(C. peudolimon)*	17.70	82.45	71.60	1.75	10.50	27.00	7.10	2.40
67.	NRCC-307	Memon Narang *(C. indica)*	–	–	–	–	–	–	–	–
68.	NRCC-308	Lemon *(C. limon)*	17.60	41.34	29.58	1.36	9.40	15.60	8.48	8.20
69.	NRCC-309	Memon Narang *(C. indica)*	10.50	22.55	29.62	1.60	10.50	9.75	9.40	2.10
70.	NRCC-310	Salonga *(Probable Hybrid)*	563.00	125.00	110.00	4.70	12.00	76.00	6.20	8.94
71.	NRCC-311	Citron *(C. medica)*	64.50	90.50	62.22	4.60	10.50	73.25	6.85	7.50
72.	NRCC-312	Calamondin *(C. madurencis)*	32.32	34.54	39.74	1.56	8.50	6.25	6.50	4.20
73.	NRCC-313	Salonga *(Probable Hybrbid)*	586.00	115.40	105.00	8.70	11.00	10.20	7.0	8.60
74.	NRCC-314	Pummelo *(C. grandis)*	534.00	109.40	117.00	11.20	16.00	13.00	9.2	1.90
75.	NRCC-315	Citron *(C. medica)*	133.33	85.70	53.60	3.63	8.67	23.67	5.27	7.40
76.	NRCC-316	Rough lemon *C. jambhiri*	62.50	51.85	48.90	1.425	9.28	16.25	8.40	5.80
77.	NRCC-317	Pummelo *(C. grandis)*	620.00	112.00	126.00	11.00	15.00	60.00	9.40	2.70
78.	NRCC-318	Karun jamir *(C. aurantium)*	150.24	63.34	68.00	6.25	8.60	6.00	8.00	5.00
79.	NRCC-319	Sweet lime *(C. limettioides)*	98.50	56.20	59.25	3.12	11.00	2.00	6.50	0.34

to deforestation in these area and we observed even farmers cut the trees without any use for fuel etc. It was observed that in Meghalaya most of the citrus species are well maintained in home garden. Therefore, to conserve genetic resources of citrus, emphasis should be given to conserve these species in home garden.

References

Bhattacharya SC and S Dutta (1951) Citrus varieties of Assam. *Indian J. Genet* **11**: 57-62.

Bhattacharya SC and S Dutta (1956) Classification of citrus fruits of Assam. Government of India Press, Delhi, Sci. Monog. No. **20**: 110.

Dutta S (1958) Origin and history of citrus fruits of Assam. *Indian J. Hortic.* **15**: 146-153.

Hore DK, S Govind and IP Singh (1997) Collecting of citrus germplasm from the Mizoram and Tripura hills of India. *Plant Genet. Resor. Newslett.* (IPGRI/FAO) **110**: 57-59.

Singh D (1967) Nakoor lime - a new citrus. *Indian J. Hortic.* **24**: 84-86.

Singh D and R Singh (1967) Taxonomic status of Indian Citrus rootstock. *Proc. Intl. Symp. Subtrop. Trop. Hortic.* 424.

Singh D and R Singh (1968) Taxonomy of Indian rough lemon. *Indian J. Agric. Sci.* **38**: 25-37.