

## Genetic Variability in Hill Lemon Strains (*Citrus pseudolimon* Tanaka) under Punjab Conditions

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### Abstract

In Punjab (India), preponderance of Hill lemon seedlings are found growing at scattered/isolated areas in the various citrus growing agro climatic zones and chance for the selection of elite strains are high due to wide genetic diversity in the existing germplasm. In order to reveal the genetic variability in Hill lemon (*Citrus pseudolimon* Tanaka) the fruit samples from diverse areas of province were collected and analysed for various physico-chemical attributes. In the present investigation wide range of variability with respect to fruit characters like fruit weight, juice weight, seed number, rind thickness and core diameter have been recorded. This variability can be exploited for the selection of elite genotypes for conservation, evaluation, utilization and a source for crop improvement in future breeding programme.

**Key words:** Hill lemon, genetic diversity, fruit quality, variability

### Introduction

India is the largest producer of lime (*Citrus aurantifolia* Swingle) and lemon (*Citrus limon* Burm. f.) in Asia with the annual production of 1.38 MT. The cultivation is gaining momentum as the fruits are rich source of vitamin C and possess high medicinal values. These are known to have curative value for various diseases of bones and joints, bilious diseases, prevention of capillary bleeding, piles, dysentery, cold, influenza, habitual constipation and scurvy (Dhillon, 1989). Hill lemon (*C. pseudolimon* Tanaka), an indigenous variety of lemon is generally grown in north India especially in the foothills of lower Himalayas due to its wider adaptability, high yield potential, tolerance to citrus canker, hardy to both hot and cold climatic conditions (Singh, 1992). It bears flower during March-April and fruits are harvested in November-December under sub-tropical conditions of Punjab. Fruit is commonly used for the preparation of value added products like citric acid, pectin, lemon powder, pickle, squashes and candy. It is heterozygous in nature and thus exhibits a great variability in seedling population. These elite chance seedlings possess desirable horticultural traits can be selected as variety/strains after their evaluation under particular agro-ecological zone. Hill lemon is found growing naturally in the foothills of Shivalik mountain range and *Kandi* area of Punjab state since no solid plantation has been found. With the advent of high yielding varieties of agronomical crops, the diversity found in minor fruit crops is vanishing or at the verge of extinction due to uprooting of indigenous isolated/ scattered growing citrus species in the natural habitat of the region. Importance of clonal selections in crop improvement is well recognized by several workers (Badge and Patil, 1989; Badiyala et al.,

1992). So, it is imperative to identify superior strains of Hill lemon for their collection, conservation, evaluation and utilization in the future breeding programmes. Hence, the present investigations were carried out to record the extent of genetic diversity and locate the elite genotypes possessing desirable fruit characteristics.

### Materials and methods

In order to harness the genetic variability in the existing germplasm, the fruit samples of Hill lemon strains collected from different zones of Punjab by Horticultural Development Officers of the state, for presentation at state level citrus show, organized by Department of Horticulture (Punjab) during the fruiting year 2005-2006. These fruits were selected on the basis of their external characteristics such as fruit appearance, fruit size, fruit shape, rind texture etc. Fruit samples were analyzed at Fruit Research Station, Gangian (Dasuya) Hoshiarpur, a research centre of Punjab Agricultural University, for evaluation of various fruit quality characteristics. Six fruits per entry were collected to analysis various physico-chemical characters. Physical parameters such as fruit size, core diameter and rind thickness were estimated with the help of digital Vernier Calliper. Juice content was estimated by extracting juice from the pulp by citrus juice extractor and juice percentage was worked out on fresh fruit weight basis. The extracted juice was strained through a muslin cloth and total soluble solids were noted with Bausch and Lomb hand refractometer in term of degree brix (%) and values were corrected at 20°C. Juice acidity was estimated by titrating 10 ml juice against 0.1 N NaOH using phenolphthalein as indicator and ascorbic acid by titration against 2, 6 dichlorophenol

indophenol dye (AOAC, 1980). The data was statistically analyzed by using Statistical Package for Social Sciences (SPSS), a computer software package. Correlation was calculated by using "CORRELATION" sub programme of same package.

## Results and discussion

The data pertaining to physico-chemical attributes of Hill lemon depicted a high degree of variability with respect to fruit morphology and quality characters (Tab. 1 and 2). The highest variability (38.6 %) was recorded for core diameter followed by fruit weight (31.2 %), juice weight (26.14 %), seeds number/fruit (26.7 %) and rind thickness (22.26 %). In different selected strains, fruit weight ranged from 143.5 g to 623.4 g, fruit length 7.07 cm to 14.55 cm and fruit diameter 6.03 cm to 10.78 cm, rind thickness 0.41 to 0.85 cm, number of articulation 8 to 13, juice weight 67.9 to 237.8 g and juice per cent 33.4 to 59.6 and number of seeds/fruit 12 to 34. Variability in chemical attributes was found among different elite selected Hill lemon strains and total soluble solids varied from 5.4 to 8.7 per cent, juice citric acid content 5.2 to 6.7 per cent and vitamin C 14.7 to 32.3 mg/100 ml of juice. This indicates that elite strains may be selected directly from seedling population on the basis of fruit weight, juice content and rind thickness for diverse purposes. Similar variations in fruit characters of Hill lemon was reported by Sandhu *et al.*, (1999) The results also showed that fruits with higher rind thickness and lesser juice content may be suitable for the preparation of pickles. Likewise, fruits with large fruit size and weight, higher juice content per cent may be used for the preparation of value added products like juices and squashes (Badiyala and Sharma, 2004). Earlier, Punjab Agricultural University has released 'Punjab Galgal' a variety of hill lemon for general cultivation in the region. This variety was selected from farmers' field on the basis of various external and physico-chemical attributes and their further evaluated (Anonymous, 2008). Fruit rind thickness exhibited significant positive correlation with fruit length (0.60), fruit diameter (0.47), fruit weight (0.39) and fruit length/diameter ratio (0.42), however, it showed negative significant correlation with per cent juice content (-0.75) (Tab. 3). In the present study, number of seeds/fruit, juice acidity, total soluble solids and vitamin C content of the selected strains showed non significant correlation with fruit size. The relationship of fruit weight with juice content and rind thickness indicated that larger fruits have lower juice content having thicker peels, indicating the preference of larger fruits for pickle industry (Fig.1 and 2). The plants of Hill lemon having desired fruiting attributes have been raised after the collection of bud sticks/hard wood cuttings from the identified entries. These are being evaluated further for various vegetative, flowering and fruiting characteristics in future.

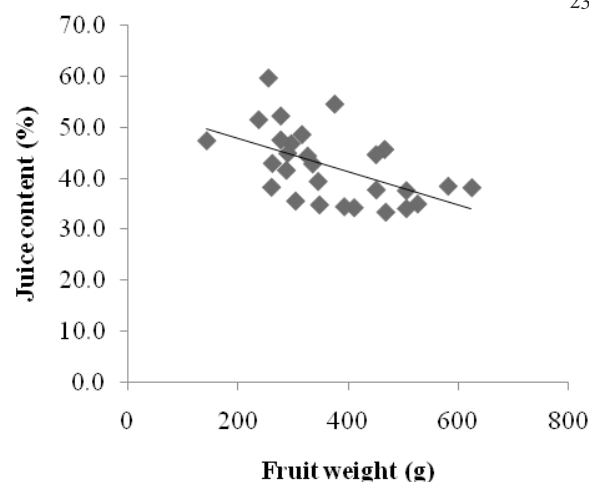


Fig. 1 Relationship between fruit weight and juice content.

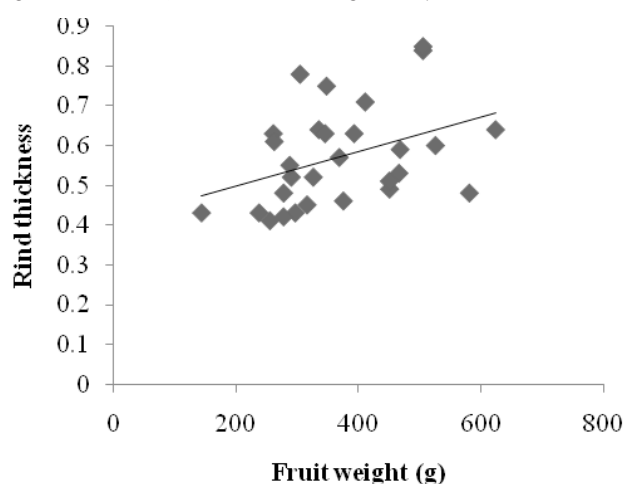


Fig. 3 Relationship between rind thickness and juice content

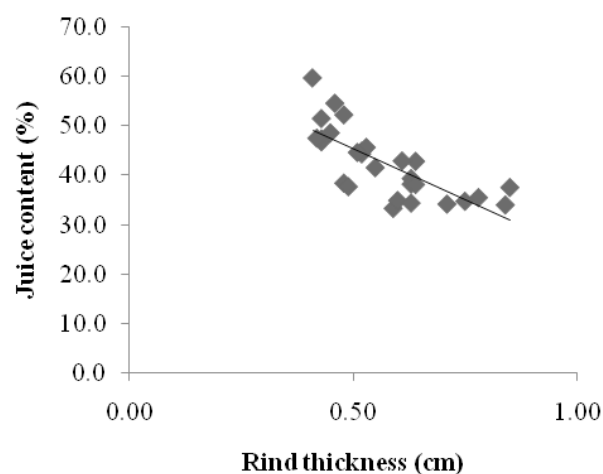


Fig. 2 Relationship between fruit weight and rind thickness

## Conclusions

There is a significant variability in the present Hill lemon population of the Punjab state. This variability can be exploited for the selection of elite genotypes for conservation, evaluation, utilization and a source for crop improvement in future breeding programme.

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Tab. 1. Physico-chemical characteristics of various Hill Lemon (*Citrus pseudolimon* T) strains

Entry No.	Shape	Rind texture	Fruit diameter (D) (cm)	Fruit length (L) (cm)	Fruit weight (g)	L/D ratio	Core diameter (cm)	No. of articulation
3712	Spherical	Smooth	6.03	7.07	143.5	1.17	0.9	12
883	Spherical	Smooth	8.31	10.54	375.0	1.27	1.1	9
494	Spherical	Rough	9.51	11.30	304.2	1.19	1.1	11
894	Spherical	Rough	8.02	9.53	296.4	1.19	2.1	12
1852	Spherical	Smooth	9.30	12.82	467.5	1.38	1.5	11
368	Oblong	Semi smooth	8.17	10.43	335.0	1.28	0.8	10
574	Oblong	Smooth	8.08	10.09	315.7	1.25	0.9	11
4787	Pyriform	Smooth	8.80	11.11	410.5	1.26	1.1	11
1880	Pyriform	Smooth	9.52	12.93	525.3	1.36	0.8	10
1851	Hemi spherical	Rough	10.43	13.06	580.6	1.25	2.4	12
490	Spherical	Very Smooth	7.44	8.82	237.5	1.19	1.1	11
572	Spherical	Smooth	7.86	9.37	290.0	1.19	1.1	13
573	Oblong	Rough	8.02	9.83	287.5	1.23	0.9	10
1885	Oblong	Rough	9.90	14.55	504.8	1.46	1.5	8
895	Spherical	Rough	9.10	10.87	450.4	1.19	1.5	10
1514	Spherical	Very Smooth	8.33	9.82	325.9	1.18	0.6	10
1299	Oblong	Rough	9.80	12.84	505.0	1.31	2.0	9
1509	Spherical	Smooth	9.09	10.81	392.5	1.20	0.8	8
3706	Spherical	Rough	7.65	8.88	255.0	1.16	1.1	12
892	Oblong	Smooth	7.16	9.57	277.5	1.33	0.9	10
1513	Spherical	Very Smooth	9.39	11.68	465.6	1.24	1.5	12
491	Spherical	Smooth	8.32	10.25	345.1	1.24	1.1	10
888	Spherical	Smooth	9.04	11.46	450.1	1.28	1.7	12
1516	Oblong	Rough	8.00	11.67	347.5	1.46	1.0	11
1512	Oblong	Very Smooth	7.54	10.36	277.3	1.37	1.1	10
1298	Oblong	Rough	7.11	10.32	260.7	1.45	1.0	11
575	Spherical	Semi Smooth	7.50	8.74	262.2	1.16	0.8	11
1854	Spherical	Rough	10.78	12.77	623.4	1.19	2.3	12
		Average	8.51	10.77	368.28	1.27	1.24	10.68
		S.D	1.09	1.64	114.14	0.09	0.48	1.25
		C.V. (%)	12.85	15.21	31.17	7.29	38.63	11.69

Tab. 2. Physico-chemical characteristics of various Hill Lemon (*Citrus pseudolimon* T) strains

Entry No.	Rind thickness (cm)	Juice (%)	Juice weight (ml)	Seed number	Vitamin C mg/100 g juice	TSS (%)	Acidity (%)
3712	0.43	47.3	67.9	15.0	30.6	8.4	5.2
883	0.46	54.5	204.3	20.0	23.5	8.7	6.4
494	0.78	35.5	108.1	20.0	23.5	8.6	6.5
894	0.43	46.8	138.6	31.0	23.5	8.4	6.4
1852	0.59	33.4	156.0	29.0	22.9	7.5	5.4
368	0.64	42.8	143.4	12.0	23.5	8.0	6.5
574	0.45	48.5	153.2	15.0	20.6	8.4	6.3
4787	0.71	34.2	140.5	24.0	14.7	7.8	5.5
1880	0.60	35.0	183.6	24.0	32.3	7.4	5.4
1851	0.48	38.5	223.2	22.0	17.6	8.0	5.5
490	0.43	51.4	122.1	25.0	24.7	8.2	5.7
572	0.52	44.9	130.1	22.0	18.8	8.5	6.7
573	0.55	41.6	119.5	22.0	21.8	8.0	6.1
1885	0.84	34.1	171.9	16.0	21.8	7.5	5.6
895	0.49	37.7	169.9	13.0	31.2	7.2	6.3
1514	0.52	44.3	144.5	24.0	23.5	8.1	5.6
1299	0.85	37.6	189.7	22.0	31.8	8.1	5.6
1509	0.63	34.4	135.2	16.0	24.5	8.1	5.8
3706	0.41	59.6	151.9	14.0	22.3	8.7	5.8
892	0.48	52.2	144.8	14.0	25.9	7.4	6.5
1513	0.53	45.6	212.5	34.0	22.3	7.5	5.7
491	0.63	39.4	135.9	22.0	23.5	7.0	6.5
888	0.51	44.6	200.8	28.0	28.2	7.6	6.7
1516	0.75	34.8	120.9	20.0	19.9	8.4	6.5
1512	0.42	47.5	131.7	18.0	14.7	5.4	6.1
1298	0.63	38.2	99.7	18.0	21.7	7.8	6.3
575	0.61	42.9	112.5	20.0	19.9	7.8	6.7
1854	0.64	38.2	237.8	18.0	19.4	7.4	6.4
Average	0.57	42.34	151.80	20.64	23.18	7.85	6.06
S.D.	0.13	6.93	39.68	5.52	4.54	0.67	0.47
C.V. (%)	22.26	16.38	26.14	26.74	19.58	8.56	7.77

Tab. 3. Correlation studies between various physico-chemical attributes of Hill Lemon (*Citrus pseudolimon* T) strains

	Fruit diameter	Fruit Length	Fruit weight	L/D ratio	Core diameter	Peel thickness	Juice percent	Seed no	Vitamin C	TSS	Acidity	Juice content
Fruit diameter	1.00	0.88**	0.94**	0.09	0.63**	0.47*	-0.57**	0.25	0.003	-0.12	-0.18	0.78**
Fruit length		1.00	0.89**	0.55**	0.52**	0.60**	-0.65**	0.19	-0.02	-0.25	-0.22	0.67**
Fruit weight			1.00	0.23	0.65**	0.39*	-0.54**	0.23	0.05	-0.23	-0.22	0.86**
L/D ratio				1.00	-0.01	0.42*	-0.38*	-0.03	-0.08	-0.34	-0.08	0.05
Core diameter					1.00	0.07	-0.17	0.33	-0.03	-0.08	-0.06	0.65**
Rind thickness						1.00	-0.75**	-0.04	0.01	0.03	-0.02	-0.02
juice %							1.00	-0.11	0.00	0.19	0.18	-0.05
seed No.								1.00	-0.04	-0.01	-0.17	0.25
Vitamin C									1.00	0.15	-0.18	0.04
TSS										1.00	0.02	-0.15
Acidity											1.00	-0.19
												1.00

\*\* Significant at 0.01 level

\* Significant at 0.05 level