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Short communication

Performance of early ripened varieties of 'Sweet Orange' in arid irrigated region of Punjab

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ABSTRACT

Early maturing sweet orange varieties were evaluated during 2014-2018 and the data on leaf nutrient contents, growth, yield and fruit quality were analyzed. Leaf nutrient concentrations varied markedly among different varieties. Early Gold registered significantly higher canopy volume (34.4 m^3) over other varieties (22.5-30.8 m^3). Fruit yield was also significantly higher in Early Gold (42.3 kg/tree). In general, Early Gold showed overall superiority in term of juice content and quality characteristics over other tested sweet orange varieties, and hence has better perspectives in arid irrigated region of Punjab.

Key words: *Citrus sinensis*, yield, granulation.

Citrus is the third important fruit crop of India after mango and banana. During 2015-16, gross citrus production of the country was 11.58 million tonnes (NHB, 6). This crop is being cultivated almost throughout the country. Telangana, Maharashtra, Madhya Pradesh, Andhra Pradesh and Punjab are top citrus growing states, and accounts for about 60 and 70 per cent in the total area and production of the country, respectively. The South-Western regions of Punjab are very conducive for producing high quality citrus fruits. Kinnow is the main fruit crop of this region, and the fresh fruits are available in the market during January-March. Therefore, during November-December, demand for citrus fruits is often very high. Mosambi, however, is one of the available options in early group, but it could not gain much commercial importance due to less juice content. Also, a small delay in harvesting of mature fruits may result in severe granulation. Therefore, the replacement of Mosambi with other early sweet orange variety (s) may prove highly remunerative for citrus growers of this region.

Studies were carried out at PAU Regional Research Station Abohar (Lat. 30.14° N; Long. 74.20° E; Elevation 180 m), India during 2014-2018. The experimental soil (0-15 cm depth) was sandy loam in texture (pH 7.85, electrical conductivity 0.22dS m^{-1} and organic carbon 0.37%). Soil was rated as low in available N, medium in P and high in available K content. In the year 2007, some early maturing sweet orange varieties (Early Gold, Ruby Nucellar, Itaborai, Hamlin and Westin) were budded on rough lemon rootstock (*Citrus jambhiri* Lush). Field plantations were made at 22 × 22 ft distance during 2009. All standard cultural practices were followed as per package and practices, Punjab Agricultural University (PAU), Ludhiana. The experiment was laid out in Randomized Block Design, and replicated thrice.

Leaf samples including petioles (4 months old) were collected for nutrients analysis (Kumar and Sharma, 4). Samples were prepared and analyzed for macro- and micro- nutrients (Jackson, 3). Tree volume was computed as suggested by Westwood (7). Mean fruit weight was determined for randomly selected 15 fruits in each treatment. Total soluble solids (TSS) were determined using 'Hand refractrometer'. Titratable acidity, reducing sugar and ascorbic acid contents of fruit were determined, as per standard method (AOAC, 1). Fruit granulation was noted from October to first week of December. The data were analyzed using statistical package SPSS and Microsoft Excel. Least significance difference was used as post hock method for comparing treatment means at 5% level of significance.

Leaf N content varied between 2.64-2.82% with highest value in Early Gold (Table 1). Itaborai exhibited the lowest value. Leaf P content was statistically comparable in all except in Itaborai which registered the lowest value. Leaf K concentration ranged between 1.29-1.88% with significantly highest value in Ruby Nucellar. Leaf Ca concentration was comparatively higher in Early Gold, Itaborai and Hamlin whereas, higher Mg content was observed in Early Gold, Hamlin and Mosambi than other varieties. Similarly, leaf micro-nutrient nutrient contents also markedly varied among varieties (Table 1). Variations in leaf nutrient content among different varieties even in trees within same species have also been reported

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Table 1. Leaf nutrient content of sweet orange varieties*.

Rootstock	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)
Early Gold	2.82	0.18	1.60	3.80	0.64	3.20	149.40	20.80	10.40
Ruby Nucellar	2.65	0.18	1.88	3.61	0.57	2.97	160.40	23.00	9.56
Itaborai	2.64	0.16	1.64	3.63	0.54	3.32	164.00	20.50	8.61
Hamlin	2.69	0.17	1.70	3.71	0.64	3.05	169.80	18.10	9.90
Westin	2.69	0.19	1.29	3.55	0.62	3.12	165.40	21.50	7.64
Mosambi	2.73	0.18	1.42	3.27	0.67	3.30	173.70	24.60	8.59
$CD_{0.05}$	0.16	0.01	0.07	0.18	0.03	0.17	10.10	1.00	0.47

*average of 2015-2018

by Kumar *et al.* (5).

The data presented in Table 2 revealed significantly higher canopy volume in Early Gold (34.4 m^3). Higher canopy volume in Early Gold may be attributed to its excellent compatibility with rough lemon rootstock as compared to other tested varieties. This might have resulted in higher water and nutrient uptake and consequently higher canopy volume in Early Gold than rest of the cultivars (Table 1). Fruit yield also varied significantly among different varieties. In overall, Early Gold consistently performed better over other varieties during 2014-2018, and registered significantly higher average fruit yield over other cultivars (42.3 kg/tree). Higher fruit yield in Early Gold may be correlated with its higher canopy volume. Canopy volume is a measure of source size, which directly influences certain bio-chemical processes like photosynthesis and respiration. A pioneer worker, Duncan (2) also advocated that tree volume determines light interception and hence, is an important parameter in determining tree growth and productivity. Furthermore, average fruit weight was highest in Westin (185 g). However, yield is a function of fruit weight and number of fruits, therefore, allocation of plant material (photosynthates) is also an important consideration. Therefore, it seems that the allocation of photosynthates in terms of fruit weight and fruit number was the most optimum in Early Gold over other varieties under similar set of conditions.

Further, fruit granulation was observed only in case of Hamlin (33%) and Mosambi (5%). The

Table 2. Tree growth, yield and fruit quality characteristics of sweet orange varieties*.

Rootstock	Tree height (m)	Average tree spread (m)	Canopy volume (m^3)	Fruit yield (kg/ tree)	Fruit weight (g)	Granulation (%)	Juice (%)	TSS (°B)	Acidity (%)	TSS-acid ratio	Reducing Sugars (%)	Ascorbic acid**
Early Gold	3.10	4.60	34.40	42.30	168.00	0	47.70	9.60	0.58	16.60	2.32	43.40
Ruby Nucellar	3.00	4.21	29.40	39.10	158.00	0	47.40	9.50	0.56	16.90	2.28	42.80
Itaborai	3.40	3.55	22.50	34.10	146.00	0	45.90	9.50	0.62	15.30	2.34	41.00
Hamlin	3.00	4.07	25.70	32.10	145.00	33	34.70	8.10	0.54	15.00	2.36	42.30
Westin	3.30	3.90	26.30	38.10	185.00	0	46.00	9.20	0.57	16.20	2.31	41.50
Mosambi	3.22	3.83	30.80	36.50	154.00	5	42.50	9.80	0.58	16.90	2.38	43.60
$CD_{0.05}$	0.30	0.36	1.80	2.80	15.20	-	1.80	0.30	0.03	0.70	NS	NS
Early Gold	3.10	4.60	34.40	42.30	168.00	0	47.70	9.60	0.58	16.60	2.32	43.40
Ruby Nucellar	3.00	4.21	29.40	39.10	158.00	0	47.40	9.50	0.56	16.90	2.28	42.80
Itaborai	3.40	3.55	22.50	34.10	146.00	0	45.90	9.50	0.62	15.30	2.34	41.00
Hamlin	3.00	4.07	25.70	32.10	145.00	33	34.70	8.10	0.54	15.00	2.36	42.30
Westin	3.30	3.90	26.30	38.10	185.00	0	46.00	9.20	0.57	16.20	2.31	41.50
Mosambi	3.22	3.83	30.80	36.50	154.00	5	42.50	9.80	0.58	16.90	2.38	43.60
$CD_{0.05}$	0.30	0.36	1.80	2.80	15.20	-	1.80	0.30	0.03	0.70	NS	NS

*average of 2014-2018; **mg/100 ml juice

titratable acidity was markedly higher in Itaborai (0.62%). Cultivar Early Gold registered maximum juice content (47.7%) which was, however, statistically similar to Ruby Nucellar and Itaborai. The TSS content was recorded highest in Mosambi (9.8%), but was statistically comparable with Early Gold, Ruby Nucellar and Itaborai. The TSS-acid ratio was higher in Mosambi, Early Gold, Ruby Nucellar and Westin over other cultivars. Ascorbic acid content was noted comparable in all cultivars except in Itaborai and Westin which registered lower values. It seems that in addition to inherent characteristics, this variation may also be due to differential water and nutrient uptake from the soil.

Based on the findings of study, Early Gold and Mosambi exhibited greater production potential with reasonable fruit quality as compared to other tested varieties. However, a comparison of data between Early Gold and Mosambi indicate overall superiority of Early Gold in terms of negligible granulation problem. Hence, it may be concluded that Early Gold could have better perspectives in arid irrigated region of Punjab.

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