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Rootstock evaluation for sweet orange cv. Early Gold in arid irrigated region of Punjab

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ABSTRACT

The performance of sweet orange cv. Early Gold on different rootstocks was evaluated at Regional Research Station Abohar, Punjab during 2013-16. The plants budded on different rootstocks were supplied by Punjab Agri Export Corp. Ltd., imported from USA. The data was analyzed in a randomized block design, replicated four times. Fruit yield was significantly higher and comparable in trees raised on Carrizo citrange (39.1 kg/tree) and *Jatti khatti* rootstock (37.7 kg/tree) than other rootstocks. Fruits on Carrizo rootstock registered maximum juice content (48.47%), which was statistically same as observed on *Jatti khatti* and Volkamer lemon. Total soluble solids were also highest on Carrizo. Fruit quality index (TSS:acid ratio) was comparable in Volkamer lemon, *Jatti khatti* and Carrizo citrange rootstocks. The trees raised on commercial *Jatti khatti* rootstock were quite younger but resulted comparable yield and fruit quality to that of Carrizo. Hence, *Jatti khatti* seem to be the most suitable rootstock for raising 'Early Gold' sweet orange in arid irrigated regions of Punjab.

Key words: Leaf nutrient, fruit quality, yield.

INTRODUCTION

Citrus is one of the important crops of tropical, subtropical and Mediterranean regions. In India, Gross annual citrus fruit production during 2014-15 was 11655, 000 MT and hold sixth position among top ten citrus players of world (NHB, 9). At national level, 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 contribution of Punjab alone in country's total area and production of citrus fruit is about 6 and 10 per cent (NHB, 9). Climatic conditions of Southwest regions of Punjab are most suitable for producing high quality citrus fruits.

Kinnow is the most preferred citrus crop of Punjab. Besides being a remunerative crop, its bright coloured citrus fruits are very attractive, rich in vitamin-C and contain high juice content. But, fresh fruits of Kinnow are available in the market during January-March. Hence, there is always a high demand for citrus fruits in the market especially during November and December. In early group, Mosambi is one of the options; however, it could not gain much commercial importance, since a small delay in harvesting may result in occurrence of granulation which drastically affects the fruit quality. Therefore, the replacement of Mosambi with other flawless early sweet orange varieties like 'Early Gold' may prove highly remunerative for citrus growers of this region.

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The use of rootstock plays an important role in profitable orchard management. Tree vigour, yield and physico-chemical characteristics of fruits are markedly influenced by rootstocks (Wutscher, 16). US-1213 and US-1210 rootstocks produced fruits with higher soluble solids than US-1203 and US-1205 (Bowman and McCollum, 4). Al-Jaleel *et al.* (2) also reported variable fruit yield and quality of 'Allen Eureka' lemons grafted on different rootstocks. The findings from earlier rootstock trials have, however, revealed different results owing to local climatic conditions and edaphic factors (Rouphaela *et al.,* 13). Therefore, the outcomes of these trials cannot be replicated as such from one part of the world to another without a thorough local evaluation of rootstocks. With these considerations, performance of 'Early Gold' sweet orange was evaluated on locally most accepted *Jatti khatti* rootstock as well as on some exotic rootstocks.

MATERIALS AND METHODS

A sweet orange cultivar 'Early Gold', budded on Carrizo, C-35, Benton, Volkamer Lemon and 852 rootstocks was supplied by Punjab Agri Export Corporation Limited (PAGREXCO), imported from USA. These stock/scion combinations were planted in the demonstration block of Punjab Agricultural University (PAU) Regional Research Station Abohar, Punjab, India during the year 2005. The plantation was made in pits of size 3 × 3 × 3ft at a spacing 25 × 15 ft. cultivar 'Early Gold' was also budded on local *Jatti Khatti* rootstock and planted in the experimental

field of Regional Research Station Abohar during 2009. All cultural practices were followed as per standard package of practices, Punjab Agricultural University (PAU), Ludhiana.

The study area was located at an altitude of 180 m above mean sea level with a latitude and longitude of 30.14° and 74.20°, respectively. Climate of area has been assigned a nation 'BWh' by Köppen-Geiger system of classification. The experimental soil was sandy loam with 7.85 pH, 0.22 dS/m EC and 0.37% organic carbon. The soil was low in available N, medium in P and high in K content.

Leaf samples were collected as per standard procedure (Kumar and Sharma, 7) and analysed for N, P and K content (Jackson, 6).Trunk girth, tree height and spread were measured during February. Fruit yield was recorded by counting the number of fruits per tree multiplied by fruit weight. Physico-chemical characteristics of fruit were determined only for 2015 and 2016. The fruit weight was determined by calculating mean weight of randomly selected 20 fruits in each combination. The observations on fruit size and peel thickness were recorded with the help of by 'vernier calliper'. 'Hand refractrometer' was used for the estimation of total soluble solid (TSS) content of fruits. Total titratable acidity, ascorbic acid and reducing content of fruits were determined following standard methods as outlined in A.O.A.C. (1).

The data were subjected to analysis using the statistical package SPSS and Microsoft Excel. Treatment means were compared considering least square difference at 5% level of significance.

RESULTS AND DISCUSSION

The data (Table 1) revealed maximum leaf N content in trees budded on Carrizo rootstock (2.90%). The values were statistically at par with Jatti Khatti (2.73%). Benton and Volkamer Lemon exhibited almost similar leaf N content. Higher P was noted on Benton, *Jatti Khatti* and Volkamer rootstocks. Leaf K was higher on Benton (1.8%) which was statistically similar to Carrizo citrange (1.7%). Higher leaf calcium was noticed on Benton, *Jatti Khatti* and Carrizo whereas; magnesium was recorded significantly higher on Carrizo rootstock. Furthermore, trees on Benton registered maximum value for leaf Cu (4.4 ppm), followed by Carrizo (3.8 ppm). Iron content was notably higher on Volkamer lemon (282 ppm). Zinc content was maximum on *Jatti khatti* whereas, higher leaf Mn content was observed on Volkamer Lemon and Benton rootstocks. It is clear from the data that different rootstocks behave differently in terms of nutrient uptake from the soil. These results may be attributable to rootstock/scion combinations which have been supposed to govern water and nutrient uptake by the plants (Lee and Oda, 8; Ruiz *et al.*, 14; Pulgar *et al.*, 11 and Rouphael *et al.*, 12).

The data presented in Table 2 indicate significantly higher tree spread in trees budded on Carrizo rootstock (4.72 m). Minimum spread was observed in trees raised on C-35 (3.63 m). Maximum tree height was achieved on *Jatti khatti* (3.52 m), which was statistically at par with other rootstocks except C-35. Tree canopy volume was significantly highest on Carrizo rootstock (29.1 m^3) followed by *Jatti khatti* (25.4 m^3).

It is also evident from data (Table 2) that trees on Carrizo rootstock asserted maximum fruit number (244) followed by Benton (243) while, lesser number of fruits was noted in C-35 rootstock (201). Heavier fruits were observed in trees budded on *Jatti khatti* (164 g), and Carrizo (160 g). Comparatively, lower fruits weight was noticed in trees raised on Volkamer lemon and C-35 rootstocks. Fruit size (length and breadth), however, was better in Carrizo and C-35 rootstocks but the values were statistically non-significant over other rootstocks. Maximum fruit yield on Carrizo (39.1 kg/tree) which was 3.7% higher than trees raised on *Jatti Khatti* (Table 3). Minimum fruit yield was noted on C-35 rootstock. Seed number was significantly higher in C-35 and Volkamer Lemon rootstocks (Table 2).

Higher tree vigour, fruit weight and more number of fruits in Carrizo and Jatti Khatti rootstocks may

Table 1. Effect of different rootstock on leaf nutrient content*.

Rootstock	N(%)	P(%)	K(%)	Ca(%)	Mg(%)	Cu(ppm)	Fe(ppm)	Zn(ppm)	Mn(ppm)
Benton	2.47	0.18	1.8	3.93	0.59	4.4	242.4	21.0	9.5
Jatti khatti	2.73	0.18	1.4	3.88	0.64	3.2	149.4	24.6	8.6
Carrizo	2.90	0.15	1.7	3.82	0.70	3.8	182.0	22.2	8.4
V. lemon	2.59	0.18	1.4	3.62	0.64	3.0	200.0	21.6	9.8
C-35	2.21	0.16	1.2	3.14	0.54	3.0	166.4	21.5	8.6
$LSD_{0.05}$	0.17	0.01	0.1	0.28	0.04	0.2	16.3	2.0	0.7

*Av. data of 2015 ad 2016

Table 2. Effect of rootstocks tree growth* and physical characteristics of fruits**.

Rootstock	Stock / scion	Tree spread (m)	Tree height (m)	Canopy volume (m^3)	No. of fruits/ tree	Fruit wt. (g)	Fruit length (cm)	Fruit breadth (cm)	Peel thickness (cm)	No. of seed
Benton	1.06	3.76	3.39	22.9	243	150	6.1	6.5	0.52	3.1
Jatti Khatti	1.04	3.87	3.52	25.4	230	164	6.3	6.5	0.56	2.4
Carrizo	1.08	4.72	3.42	29.1	244	160	6.5	6.7	0.53	2.3
V. Lemon	1.10	3.79	3.33	22.2	236	147	6.1	6.6	0.57	3.4
C-35	1.15	3.63	3.19	19.5	201	131	6.3	6.4	0.52	3.4
$LSD_{0.05}$	NS	0.33	0.31	2.3	17.2	12	NS	NS	NS	0.2

*avg. data of 2013-2016, **avg. data of 2015 and 2016

Table 3. Effect of rootstocks on fruit yield.

Rootstock	Fruit yield (kg/tree)				Av.
	2013	2014	2015	2016	
Benton	39.8	28.5	34.3	43.4	36.5
Jatti khatti	31.7	38.1	36.8	44.1	37.7
Carrizo	39.1	43.4	31.7	42.2	39.1
V. lemon	29.3	31.9	34.7	43.0	34.7
C-35	26.3	26.3	23.4	29.2	26.3
$LSD_{0.05}$	2.4	2.5	2.6	2.5	2.5

be ascribed to better absorption of nutrients from the soil (Table 1). Enhanced nutrient uptake and assimilation may have resulted in higher tree growth as reflected by canopy volume. Canopy volume is a measure of source size which directly influences certain critical plant processes like photosynthesis and consequently-the tree response. Anderson (3), Obreza and Rouse (10) and Syvertsen and Lloyd (15) also co-related positively the tree canopy volume with number of fruits, fruit weight and yields in citrus. Furthermore, fruit yield is a function of fruit weight and number of fruits. Better allocation of photosynthates in terms of fruit size and numbers on Benton, C-35 and Carrizo rootstocks may therefore be assumed.

Rootstocks significantly influenced the fruit quality of Early Gold (Fig. 1-2). Fruits juice content was higher and comparable in *Jatti Khatti*, Carrizo and Volkamer Lemon than other rootstocks tried (Fig. 1). Trees raised on Carrizo rootstocks exhibited minimum juice content which was statistically at par with *Jatti Khatti* and Volkamer Lemon. Total soluble solids were also highest on Carrizo which was statistically similar to Volkamer Lemon. The data in Fig. 2 revealed highest fruit quality index (TSS-acidity ratio) in Volkamer Lemon which was statistically at par with *Jatti Khatti* and Carrizo rootstocks. Ascorbic acid content in fruits was found to be significantly

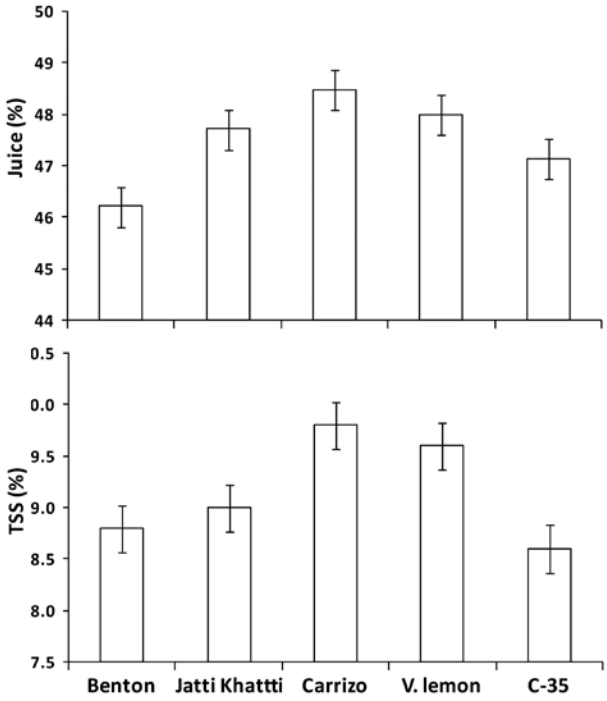

Fig. 1. Juice and TSS content of fruits as influenced by different rootstocks.

higher and comparable between *Jatti Khatti* and Volkamer Lemon rootstocks as compared to other rootstocks (Fig. 2). Reducing sugar and titratable acidity was significantly higher in Carrizo and C-35 rootstocks, respectively (Fig. 3).

Rouphaela *et al.* (13) concluded that rootstock and scion compatibility may induce undergrowth or overgrowth of the scion. This varying growth behaviour may lead to differential water and nutrient flow through the grafted union and consequently variable fruit quality of produce. Castle (5) also reported that in citrus, fruit and juice quality are closely related to rootstock effects on plant water relations. Rootstock also supposed to have bearings

on translocation of photosynthates and synthesis of plant hormones which affect the fruit quality (Lee and Oda, 8).

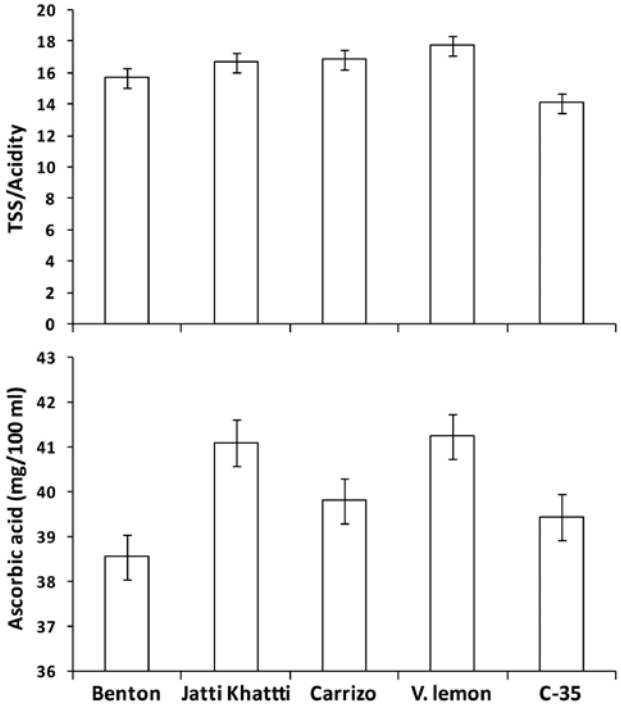

Fig. 2. Chemical fruit quality characteristics of 'Early Gold' on different rootstocks

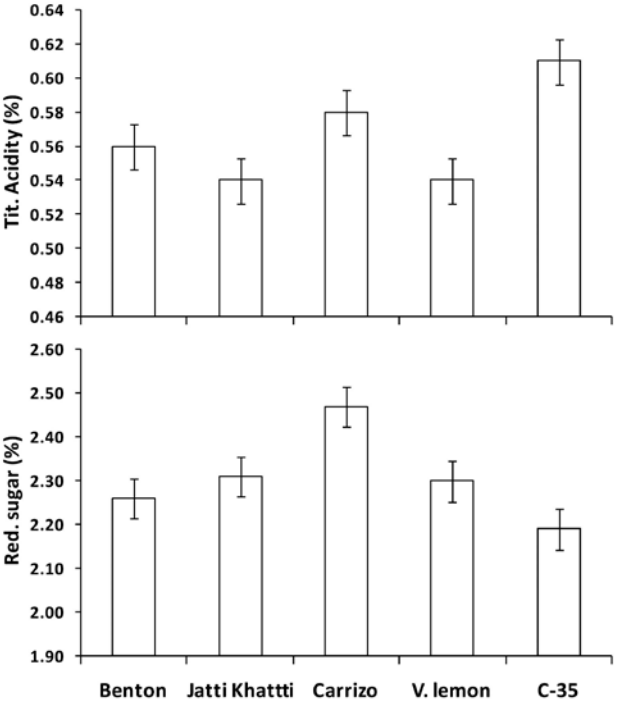

Fig. 3. Influence of rootstock on reducing sugar and titratable acidity of 'Early Gold'.

The results of study clearly demonstrated that a given scion can only perform better on a particular rootstock. Hence, selection of a suitable rootstock seems very crucial for maintaining higher productivity as well as quality of fruits. Carrizo and *Jatti Khatti* maintained higher tree vigour and productivity of sweet orange var. 'Early Gold' with the assurance of good quality fruit. Also, it is worthwhile to mention that trees raised on commercial Jatti Khatti rootstock were quite younger than trees budded on Carrizo rootstock, however, both resulted in comparable yields. This proved the superiority of Jatti Khatti over Carrizo both in terms of tree vigour and productivity of 'Early Gold. Hence, *Jatti Khatti* is considered most suitable rootstock for raising 'Early Gold' sweet orange in arid irrigated regions of Punjab.

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