

Research Article



Suitability of Different Rootstocks to Overcome the Reduction of Size Problem in the Feuter's Early (*Citrus reticulata*) Mandarin

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Abstract | Performance of different exotic citrus root stock was studied at Citrus Research Institute Sargodha from 2013-18. The trail was conducted according to RCB design with three replications. The Five Treatments four exotic and one local root stock (T_0 Rough lemon, T_1 Troyer citrange, T_2 Cox mandarin, T_3 C-35, T_4 Carrizo citrange) were budded with Feutrells early in 2013. The statistical analysis of vegetative data from trial site shown good compatibility in term of scion/root stock ratio. Maximum plant height attained in T_0 (Rough lemon) with max. canopy volume. All the exotic root stocks are compatible with Feutrell's early. Objectively maximum fruit weight, fruit size, juice percentage and yield obtained in T_1 Troyer citrange and T_2 Cox mandarin as compared to local root stock rough lemon. Results depict that exotic citrus root stock Troyer citrange and Cox mandarin performed well with Feutrell's early in the local climatic conditions of Sargodha Punjab, can be used to overcome the smaller size of Feutrells early along with added edge of better results in various other parameters like tree yield, fruit weight, juice percentages etc.

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Keywords | Exotic root stocks, Plant height, Canopy volume, Rough lemon, Troyer citrange, Cox Mandarin, fruit size, Scion/stock ratio

1. Introduction

All citrus varieties are very popular due to their nutritional value and thrust quenching properties. Pakistan citrus industry is well dominated by mandarin group. More than 95% of the citrus is produced in the Punjab among which only Kinnow mandarin contributes 70% of total produce (Niaz et al., 2004). There is dire need to improve and diversify the Pakistan citrus industry by using different root stock and to exploit the potential of commercial cultivars. Feutrell's early an early second largest maturing mandarin variety of citrus in terms of production at Punjab after Kinnow. It represents mandarin group in the market in November. Feutrells early has a problem of size, as it is observed that with period of time its fruit size is on the decreasing

trend. Role of rootstocks in affecting the various fruit characteristics is authenticated in the citrus industry. It is believed that more than 20 plant characteristics can be affected by rootstocks like plant health, Physico-chemical composition and including fruit size, fruit weight, yield and other quality parameters (Castle et al., 1995). Lima (1992) explained budded/grafted on Rangpur lime were vigorous in vegetative growth as compare to Rough lemon. Niaz et al. (1994) reveal that Kinnow and Feutrell's early budded with have vigorous growth but it is more susceptible to Phytophthora disease. Most of the citrus commercial varieties are propagated by asexual propagation using budding or grafting methods. Most of the citrus crop experts are convinced about the importance of the root stock for good crop production. Root stock significantly affects the canopy volume and

functioning such as photosynthesis (Richardson et al., 2003). Root stock have difference in adoption to soils type and root dispersion manner, mycorrhiza dependence and this lead to difference leaf mineral concentration or in the leaves of grafted cultivars budded/grafted on them and finally affects vegetative and reproductive physiology of fruit (Basal, 2009). The leaf nutrient composition of scion cultivars was significantly affected by different root stocks (Jaskani et al., 2016). Pestana et al. (2005) reported that root stock show significant difference in Iron absorption.

The main factor that limits the growth of citrus plant include Citrus Tristeza Virus (CTV) and Phytophthora spp., which are present in all orchards in Pakistan. Some abiotic stresses such as quick decline, root rot salinity and flooding, also reduces citrus growth in certain areas. Currently used citrus root stock in Punjab is rough lemon and which is susceptible to these problems. Thus, attempt have been made to solve abiotic issues by changing root stock.

Choice of root stock is among the most important decision a grower makes and implication for yield and quality are enormous. Drivers of root stock adoption are wide ranging with most important being tolerance to Citrus Tristeza virus, Phytophthora, Nematodes and salts, but water use efficiency and drought tolerance are increasingly are important to achieve better performance. Although the metabolic functions in a grafted plant are divided between two plant fraction, it is well known that root stock greatly influence variety behavior as it ensures provision of mineral and water for total plant. Campeanu et al. (2009) suggested that for better quality fruit, mineral nutrient contents of scion cultivar should be taken in consideration. Various studies have shown that tree growth, flower development, yield and fruit quality of scion cultivar of mandarin (Smith et al., 2004).

The work overviews the response in term of plant growth, fruit quality and yield parameters of Feutrel's early grafted on different root stocks under agro ecological conditions of Punjab Pakistan.

2. Materials and Methods

Mature fruits from rough lemon rootstock were collected from the citrus foundation block at Citrus Research Institute Sargodha in August 2010.

Seeds were extracted and sown in the nursery beds. The seedling were transplanted in nursery area in September 2011. Rough lemon and four other rootstock seedlings namely Troyer, Cox mandarin, C-35 and Carrizo Citrange were imported from Australia under ASLP project were budded employing T-budding method with Feutrell's' early in October 2012. The prepared uniform plants were planted at square No. 15 at Citrus Research Institute Sargodha in September 2013. The plants were arranged in randomized complete block design (RCBD), with three replication and one plant per treatment. The plants were irrigated every 5-7 days interval received 200gm nitrogen 200gm phosphorus and 200gm potash and 10 kg farm yard manure first two year, then during third and fourth year 1 kg Urea 1kg phosphorus and 12 kg FYM yearly. The initial readings of scion girth, stock girth, stem diameter and canopy volumes were measured by measuring tape. The height of the plant was measured in meter from ground level to tip of the plant by measuring Rod. The spread of the tree was recorded by measuring maximum spread in north-south and east-west direction in meters with the help of measuring Rod calculating mean spread of the plant. The canopy volume of selected plants were computing using formula (Albrigo et al., 1975).

$$PScv = \frac{\pi D^2}{4} \left[2 \left(\frac{Ht - Hc}{3} \right) + (Hc - Hs) \right]$$

PScv= Canopy Volume(m³); Ht= Overall canopy height above ground level(m); D1= Canopy diameter parallel to the row(m); Hc= Height to the point of maximum canopy diameter(m); Hs=Height from ground to canopy skirt(m); H= height of plant.

$$R = \frac{\text{Sum of E - W and S - N direction (m)}}{4}$$

E-W= East-West; N-S= North-South.

The TSS was measured by digital Refractometer and the percentage of acidity was determined by dilute juice against 0.1 sodium hydroxide by using phenolphthalein indicator (AOAC, 1985).

Formula: 1 ml of 0.1 N NaOH = 0.0064 g of citric acid was employed.

The layout of the orchard was designed according to complete block design (CRBD) with three replication and each replication with one plant. Five average

growth data was statistically analyzed by using statistix 8.1 software. Difference among the means were tested by LSD.

3. Results and Discussion

3.1 Scion/Stock ratio

Five years average data of scion and stock ratio shows that all the five root stock has good compatibility with Feutrell's early.

3.2 Plant height (m)

Feutrell's early budded on different root stock attained maximum plant height on Cox mandarin root stock followed by Troyer citrange and Rough lemon (Figure 1A) average of plant height for consecutive five years. These three root stocks are significantly different. Dubey *et al.* (2016) observed highest plant height in rough lemon followed by Troyer and no significant difference which is contrary to present study. The remaining root stock has lower plant height. Dwarfing effect was observed in C-35 root stock as its character.

3.3 Canopy volume (m³)

Figure 1A shows that max. canopy volume attained in Feutrell's early budded with Rough lemon followed by Cox mandarin and Troyer. These three are significantly different. The same behavior was observed by Dubey *et al.* (2016) in which canopy volume was found maximum followed by Cox mandarin and Troyer but difference was not significant.

3.4 Fruit weight (g)

Data regarding influence of rootstock on fruit weight (Figure 1B) reveal that Feutrell's early budded with Troyer produced heaviest fruit followed by Carrizo and Cox mandarin. Both have no significant difference. The lowest fruit weight was recorded in C-35. Al-Hosni *et al.* (2011) found heavy fruit weight in Hamlin budded with Troyer in Oman.

3.5 Fruit size (dia, mm)

Maximum fruit size in term of diameter was registered in Troyer budded with Feutrell's early (Figure 1B). Statistically Feutrell's early fruit size remained at par with respect to Musambi budded on Troyer Citrange. and Cox mandarin which are significantly different to remaining three root stock whom have no significant difference. However larger fruits earn more than smaller ones in the market. Fruit size in term of diameter ranged from 50mm to 80mm. The same

has been observed in the literature such as Lucena-Cavalcante *et al.* (2006); Al-Hosni *et al.* (2011).

3.6 Juice (%)

Highest juice percentage was recorded in fruits of Feutrell's early budded on Troyer. Juice percentage from all the five root stock was statistically at par and no significant difference observed (Figure 1B).

More juicy fruit is not only better accepted in the juice market but also in the fresh market. All the root stock under trial had juice percentage above the minimum accepted for most citrus varieties for consumption as fresh fruit (35%).

3.7 Peel weight, peel thickness, rag percentage and seed weight

These three parameters were not significantly affected by the different root stock. Although more peel contents could be a disadvantage when the ratio between peel and pulp decreases mean less edible portion. Literally the relation between peel thickness and root stock has been reported and confirmed such as Sharma *et al.* (2004) and Al-Jaleel *et al.* (2005). Large number of seeds in the pulp of the fruit is negative character. Fruit harvested from all root stock contain almost equal no of seed having average weight 14-15g.

3.8 Total soluble solids, acidity and TSS/Acid ratio

Total soluble solids in all four root stock were significantly different from Rough lemon local root stock (Figure 1C). Fruit harvested from Feutrell's early budded on Troyer root stock have the highest TSS contents as compared to other exotic root stock but all the four exotic root stocks found at par statistically. Lowest TSS contents were recorded in Rough lemon root stock budded Feutrell's early fruits. Feutrell's early fruits on Rough lemon were found more acidic and less acidic in Cox mandarin were registered. Sweetness is important quality parameter for fruits; it is actually considered the sum of sucrose glucose and fructose contents, which are the indication of ripeness (Gomes *et al.*, 2002). Sweetness of the fruit is judged on the basis of sugar to acid ratio. For pleasant fruit taste this ratio is very important. Fruits collected from Cox mandarin budded root stock had the highest sugar to acid ratio followed by Troyer. Lowest ratio was observed in fruits of scion on Rough lemon which mean poor quality fruit. This could be the drawback of the Rough lemon root stock, in spite of the fact that widely adopted root stock in Punjab Pakistan

due to its positive growth characters.

(Agriculture Sector Linkage Program) for Pakistan.

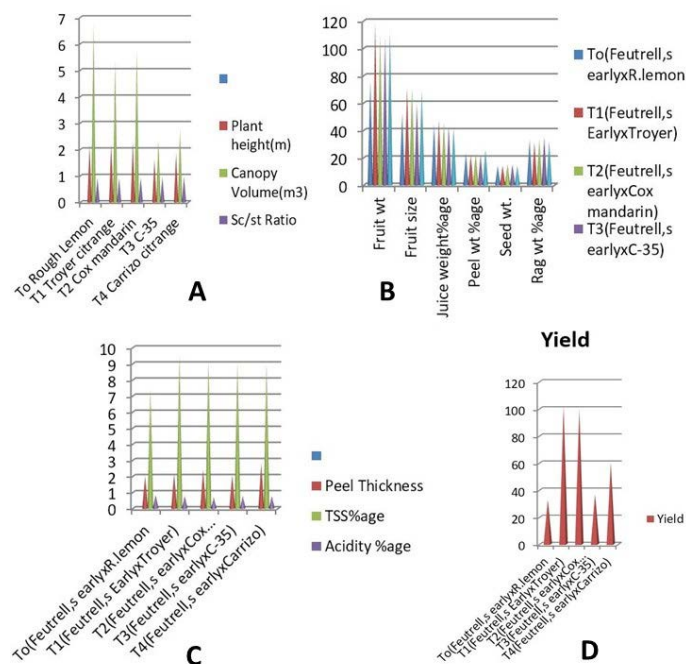


Figure 1: A: Maximum canopy volume attained in Feutrell's early budded with Rough lemon followed by Cox mandarin and Troyer; B: Maximum fruit size in term of diameter was registered in Troyer budded with Feutrell's early; C: Total soluble solids in all four root stock were significantly different from Rough lemon local root stock; D: Troyer citrange and Cox mandarin exceeded all the other root stocks followed by Carrizo.

(yield fruit tree⁻¹). The statistical analysis of the data indicates highly significant difference amongst root stocks; Troyer citrange and Cox mandarin exceeded all the other root stocks followed by Carrizo (Figure 1D).

Conclusions and Recommendations

Present study conclude that better fruit size could be attained in Feutrell's early budded with Troyer Citrange and Cox mandarin without limiting any other qualitative and quantitative character. These root stock can replace Rough lemon root stock which have certain problem of serious nature. Furthermore, studies are required to prove the bearing length of the plants.

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Authors Contribution

All authors have equally contributed to this research work.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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