

# Growth, Yield and Fruit Quality of Sweet Orange Varieties Under Rainfed Conditions of Chakwal

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## ABSTRACT

Six sweet orange varieties; Musambi, Blood red, Jaffa, Pine apple, Salustiana and Valencia late, grafted on rough lemon rootstock, were evaluated to ascertain their adaptability under rainfed conditions. Irrigations were applied during severe drought/water stress periods (May-June and October-November). Over the first four harvests (from 1991-92 to 1994-95), Musambi proved to be more productive, followed by Blood red and Salustiana. Salustiana fruit was outstanding in circumference (23.49 cm), weight (218.15 g) and juice contents (54.1%). Salustiana and Blood red fruits had minimum rag (<21%), followed by Musambi (24.27%). Salustiana and Valencia late showed superiority in total soluble solids (>10%). Musambi had lower acidity (0.45%) and it resulted in higher TSS/acid ratio (20.33). After eight years, Salustiana plant attained larger canopy volume, followed by Valencia late and Musambi.

**Key Words:** Sweet orange; Growth; Yield; Fruit quality

## INTRODUCTION

Citrus is the most important fruit of the Punjab due to prevailing suitable agro-climatic conditions. It is grown on an area of 180.7 thousand ha, which produce 1847.3 thousand tonnes fruit while Pothwar tract produces only 2163 tonnes from 250 ha (Anonymous, 1995). The meager position of citrus in the tract depicts that little attention had been given on citrus cultivation. All research work on different aspects of citrus production disclosed that those were conducted in central and southern parts of the Punjab (Ahmad & Mazhar, 1962-64; Hussain *et al.*, 1987; Aslam *et al.*, 1989; Ahmad *et al.*, 1990; Chaudhary, 1992).

Climatically, Pothwar tract is comparatively cooler than sub-tropical with 250-750 mm annual rainfall. The soil texture is almost sandy loam. An area of 67 thousand ha have the irrigation facilities (Anonymous, 1993). These facts indicate wide scope of fruit culture in the area.

The fruits produced in a specific environment share a common set of quality characteristics (Hales *et al.*, 1968; Suzuki, 1969; Fucik & Norwine, 1979). These studies were envisaged to test the adaptability of sweet orange varieties and finally for selection of promising ones for commercial cultivation in the area.

## MATERIALS AND METHODS

Six sweet orange varieties, grafted on rough lemon rootstock were planted on sandy loam soil at Barani Agricultural Research Institute, Chakwal in 1987 to test

their adaptability under rainfed conditions. The trial was laid out in RCBD with four replications. Each replication contained one plant of each variety. Inter and intra row spacing was six meters. Experimental site received 592 mm mean annual rainfall during the study period. During first two years, the plants were irrigated by drip system. Then, the plants were irrigated only during severe drought/water stress periods (May-June and October-November). At vegetative stage, nitrogen @ 120-450 g alongwith 10-20 kg FYM per plant per annum was applied. During bearing stage, NPK @ 900-450-450 g alongwith 40 kg FYM per plant/annum were given. Considering maturity time, fruits of different varieties were picked as mentioned against each:

| Varieties                        | Harvesting time |
|----------------------------------|-----------------|
| 1. Musambi                       | Mid December    |
| 2. Jaffa, Pine apple, Salustiana | Mid January     |
| 3. Blood red                     | Mid February    |
| 4. Valencia late                 | Mid March       |

Fruit yield per plant was recorded from 1991-92 to 1994-95. Ten fruits per plant were collected randomly during 1992-93 and 1993-94 to determine fruit circumference (cm), weight (g), peel thickness (cm), rag (%), juice (%), total soluble solids (%), acidity (%), TSS/acid ratio and vitamin C (mg/100 g). The canopy volume was measured in February, 1995. To measure canopy volume, tree was assumed to be one half of prolate spheroid (Jahn, 1979; Morse & Robertson, 1987). Thus volume was calculated by the equation:  $V = 0.524 \times \text{height} \times \text{width}^2$ .

## RESULTS AND DISCUSSION

Low coefficient of variation for all the traits indicated that experimental material was stable and significant differences among varietal characteristics (Table I) were attributed to their specific genetic characteristics. Agro-climatic conditions have striking effect on growth, yield and fruit quality. Thus, these studies would be helpful in finding out better varieties

for commercial cultivation in the specific agro-climatic conditions of the area. Musambi produced higher cumulative yield (for first four harvests) with relatively larger canopy volume followed by Blood red with comparatively lower canopy volume (Table II). Salustiana gave lower yield than Musambi and Blood red, though it ranked first position in canopy volume. Valencia late proved to be least yielder (Table II).

**Table I. Mean squares of quality traits of sweet orange varieties**

|         | Canopy<br>volume | Cumu.<br>yield | Fruit<br>circum. | Fruit<br>weight | Peel<br>thickness | Juice   | Rag   | TSS    | Acidity  | TSS/acid<br>ratio | Vit. C  |
|---------|------------------|----------------|------------------|-----------------|-------------------|---------|-------|--------|----------|-------------------|---------|
| Rep.    | 1.03             | 48.10          | 1.28             | 4.24            | 0.0012            | 2.29    | 0.92  | 0.12   | 0.0027   | 0.11              | 1.47    |
| Variety | 62.57            | 2301.90**      | 2.51*            | 1090.31***      | 0.0074**          | 44.69** | 60.14 | 1.42** | 0.1651** | 64.04**           | 95.56** |
| Error   | 0.92             | 13.20          | 0.85             | 26.18           | 0.0002            | 1.36    | 2.07  | 0.18   | 0.0002   | 0.48              | 1.94    |
| X       | 18.72            | 103.15         | 22.48            | 185.27          | 0.40              | 48.80   | 24.32 | 9.44   | 0.41     | 12.41             | 53.99   |
| C.V.%   | 5.11             | 3.52           | 4.09             | 2.76            | 3.88              | 2.39    | 5.92  | 4.49   | 1.66     | 5.58              | 2.58    |

\*Significant; \*\*Highly significant; Cumu. = Cumulative; Circum. = Circumference; TSS = Total soluble solids

**Table II. Mean cumulative fruit yield (kg/plant) and plant canopy volume (m<sup>3</sup>)**

| Varieties     | Fruit Yield |         |         |         |                  | Plant CV |
|---------------|-------------|---------|---------|---------|------------------|----------|
|               | 1991-92     | 1992-93 | 1993-94 | 1994-95 | Cumulative yield |          |
| Musambi       | 15.38       | 27.83   | 38.30   | 51.38   | 132.89a          | 20.05b   |
| Blood red     | 15.69       | 30.70   | 35.38   | 47.89   | 125.56b          | 15.65d   |
| Jaffa         | 11.50       | 17.57   | 27.83   | 41.81   | 98.71cd          | 13.53e   |
| Pine apple    | 10.70       | 21.67   | 21.76   | 40.09   | 94.22d           | 18.21c   |
| Salustiana    | 12.89       | 22.20   | 28.19   | 38.33   | 101.61c          | 24.83a   |
| Valencia late | 8.84        | 12.84   | 16.03   | 29.03   | 65.89e           | 20.31b   |

Any two means having same letter (s) do not differ significantly at 0.05 probability level (DMRT); CV = Canopy volume

It is evident from Table III that Salustiana fruit was outstanding in circumference (23.49 cm), weight (218.15 g) and juice contents (54.10%). The results are in conformity with Aslam *et al.* (1989), but higher juice contents recorded in the current study may be due to moderate summer. Blood red attained second position in juice contents (51.72%) with smaller size and medium weight. The rag percentage was minimum (less than 21%) in Salustiana and Blood red followed by Musambi (24.27%) in ascending order. Blood red and Jaffa had

thinner (0.35 cm) and thicker (0.47 cm) peel, respectively. Other varieties contained peel of medium thickness. Salustiana and Valencia late had superiority in TSS (more than 10%). Other varieties ranged from 8.87 to 9.25% in TSS showing non-significant differences. As regards acidity, Valencia late possessed more acidity (1.07%) followed by Blood red (0.90%). Musambi had lower acidity (0.45%) and it resulted in higher TSS/acid ratio (20.33). Pine apple secured top position in vitamin C (63.13 mg/100 g) followed by Blood red, Musambi and Salustiana.

**Table III. Means of fruit characteristics of sweet orange varieties**

| Varieties     | Circum.<br>(cm) | Fresh weight<br>(g) | Peel thickness (cm) | Rag<br>(%) | Juice<br>(%) | TSS<br>(%) | Acidity (%) | TSS/acid<br>ratio | Vit. C<br>(mg/100g) |
|---------------|-----------------|---------------------|---------------------|------------|--------------|------------|-------------|-------------------|---------------------|
| Musambi       | 21.88bc         | 174.18c             | 0.39b               | 24.27c     | 45.85d       | 9.25b      | 0.45e       | 20.33a            | 53.78b              |
| Blood red     | 21.49c          | 181.92bc            | 0.35c               | 20.75d     | 51.72b       | 9.00b      | 0.90b       | 9.95c             | 54.45b              |
| Jaffa         | 22.39abc        | 184.02b             | 0.47a               | 25.85bc    | 47.82c       | 9.12b      | 0.82c       | 11.16b            | 50.53c              |
| Pine apple    | 23.33ab         | 177.60bc            | 0.40b               | 28.70a     | 47.05cd      | 8.87b      | 0.79d       | 11.23b            | 63.13a              |
| Salustiana    | 23.49a          | 218.15a             | 0.41b               | 18.80d     | 54.10a       | 10.25a     | 0.84c       | 12.24b            | 52.78b              |
| Valencia late | 22.31abc        | 175.25c             | 0.39b               | 27.55ab    | 46.25cd      | 10.12a     | 1.07a       | 9.54c             | 49.20c              |

Any two means having same letter (s) do not differ significantly at 0.05 probability level (DMRT); Circum = Circumference

## CONCLUSION

It is concluded that Musambi, Blood red and Salustiana have satisfactory performance in their yield and physico-chemical characteristics of fruit. Therefore, these three varieties are suggested for commercial cultivation in Pothwar region of Pakistan.

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