

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 volume	Cumu. yield	Fruit circum.	Fruit weight	Peel thickness	Juice	Rag	TSS	Acidity	TSS/acid 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 (m³)

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. (cm)	Fresh weight (g)	Peel thickness (cm)	Rag (%)	Juice (%)	TSS (%)	Acidity (%)	TSS/acid ratio	Vit. C (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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(Received 03 May 1999; Accepted 12 June 1999)