



Influence of Organic Manures and Foliar Application of Arka Citrus Special on the Growth of Buddlings of Sweet Orange

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In India, citrus fruits rank third in area and production after Mango and Banana. A study was conducted at the Horticultural Research Station (HRS) Konda Mallepally, Nalgonda district during Rabi, November 2022 - April 2023. The study aimed to test the effects of organic manures and foliar application of Arka Citrus Special on the growth of sweet orange cv. Sathgudi buddlings. The

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experiment included fourteen treatments with three replications in RBD. It comprised three types of organic manures (FYM, Vermicompost, Neem cake) and Arka Citrus Special (micronutrient formulation). The application of organic manures and micronutrients showed significant differences in plant height (cm), number of leaves, and leaf area (cm²). During 30, 60, 90 and 120 days of observations, the maximum plant height (26.99 cm), stem diameter (1.23 mm), number of leaves (26.00), girth of the plant (19.5 mm), leaf area (11.70 cm²), internodal length (0.260 cm), absolute growth rate (0.42 cm /day) and relative growth rate (0.10 cm /cm /day).

Keywords: Sweet orange vermicompost; neem cake; organic manures.

1. INTRODUCTION

Citrus is a sub-genus of the Rutaceae family, specifically the Aurantioideae subfamily, identified by Swingle. The sub-genus has three types: Citrus, Fortunella (commonly known as Kumquat) and *Poncirus trifoliata*. There are currently 18 species defined within the three genera, but natural mutations have resulted in numerous hybrids that are spread throughout the world [1]. Nigeria and other tropical and subtropical regions are known for their widespread cultivation of citrus. [2].

Sweet orange (*Citrus sinensis* L. Osbeck) commonly called orange is a member of this family and a major source of vitamins, especially vitamin C, a sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium [3]. Oranges probably originated from south East Asia, and were cultivated in China by 2500 BC (Nicolosi et al, 2008), where it was referred to as "Chinese" apple [4]. Sweet orange is the second important citrus fruit cultivated in the country [5]. Sathgudi is a commercially important sweet orange cultivar known for its medium-sized, spherical fruit with a smooth, orange peel. It has 10-12 segments, flavorful juice, and straw to orange-coloured flesh.

Growing media that are organic in nature play a crucial role in plant growth within limited spaces. Their impact on the growth of plants is achieved through various properties such as water retention, air space, bulk density, pH, aeration, particle size, and soluble salt content. These properties enhance the water capacity, porosity, aeration, and nutrient supply, especially in nitrogen and micronutrients, resulting in the development of robust leaves and the improved growth of seedlings and plants [6]. Micronutrients (Zn, Cu, Mn, B, Fe) play a vital role in plant metabolism. Foliar application of micronutrients, as opposed to soil application, is effective, quick, and avoids toxicity issues. Spraying

micronutrients on sweet orange leaves boosts their nutrient levels [7].

Nutritional diseases impact sweet orange orchards due to micronutrient deficiencies. "Arka Citrus Special," a foliar micronutrient formula, was created by IIHR, Bengaluru to address this issue. An experiment studied the growth of Sathgudi sweet orange buddlings using various organic manures combined with Arka Citrus Special to improve budling quality.

2. MATERIALS AND METHODS

The study took place at Horticulture Research Station (HRS) Konda Mallepally, Nalgonda district, from November 2022 to April 2023. The study was carried out on 120-day-old buddlings (cv. Sathgudi) by adopting randomized block design (RBD) with 14 treatments and 3 replications. It involved three organic manures (FYM, Vermicompost, Neem cake) and a micronutrient spray, Arka Citrus Special. The composition of Arka Citrus Special (Research formulation of IIHR, Bengaluru) is Zinc - 6.1 %, Boron - 0.5 %, Manganese - 0.5 %, Iron - 1 %, Copper - 0.1 %. Treatment involves a foliar spray of Arka Citrus Special and one of the three organic manures. T₁: FYM (100 %), T₂ Vermicompost (100 %), T₃ Neem cake (100 %), T₄ FYM (50 %) + Vermicompost (50 %), T₅ FYM (50 %) + Neem cake (50 %), T₆ Vermicompost (50 %) + Neem cake (50 %), T₇ FYM (100 %) + Arka Citrus Special (5g / l), T₈ Vermicompost (100 %) + Arka Citrus Special (5g / l), T₉ Neem cake (100 %) + Arka Citrus Special (5g / l), T₁₀ FYM (50 %) + Vermicompost (50%) + Arka Citrus Special (5g / l), T₁₁ FYM (50 %) + Neem cake (50%) + Arka Citrus Special (5g / l), T₁₂ FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5g / l), T₁₃ Arka Citrus Special (5g / l), T₁₄ Control.

The parameters recorded were plant height (cm), stem diameter (mm), number of leaves, girth of the plant (mm), leaf area (cm²), internodal length

(cm), absolute growth rate (cm /day) and relative growth rate (cm /cm /day) at 30, 60, 90 and 120 days after budding.

Organic manures were applied during budding in late October 2022. Micronutrient (Arka Citrus Special) foliar application every 15 days from November to January. Observations are recorded once every 30 days.

2.1 Absolute Growth Rate (cm/day)

AGR for an increase in plant height was calculated by using a formula given by Radford (1967) and expressed as height in cm/day.

$$AGR = (H_2 - H_1) / (t_2 - t_1)$$

Where, H_2 and H_1 represent height per plant and t intervals between two observations, respectively t_2 and t_1 time.

3. RESULTS AND DISCUSSION

Plant height Table 1 results revealed that plant height (cm) was significantly affected in response to the application of different organic manures and Arka Citrus Special. Throughout 30, 60, 90 and 120 (days after budding) DAB of observations, the maximum plant height

(cm) was found in T_{12} - FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) (26.99 cm), which found superior over rest of the treatments and the minimum plant height (cm) was recorded in T_{14} - Control (18.00 cm). Vermicompost in potting soil provides abundant nutrients (nitrates, P, K, Ca, Mg) and humic substances, boosting photosynthate accumulation for improved seedling and juvenile, and leading to increased plant height. A study by Kaur [8] on mango cultivars revealed that the ideal growing media consisted of a 1:1:2 ratio of soil, sand, and vermicompost. similar by Bharadwaj [9] in papaya.

Stem diameter During 30, 60, 90 and 120 (days after budding) DAB the maximum stem diameter (1.230 mm) was observed in T_{12} FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l). On the other hand, T_{14} - Control had a minimum stem diameter (0.55 mm). Aeration and moisture in the growing medium are vital for seedling growth, especially root development. For rough lemon [10], a mix of sand, silt, and leaf manure yielded maximum stem diameter. In jujube [11], canal silt, coconut fibre, and FYM led to the highest stem girth (9.11 mm). Similar results were observed in acid lime by Rakesh et al. [12].

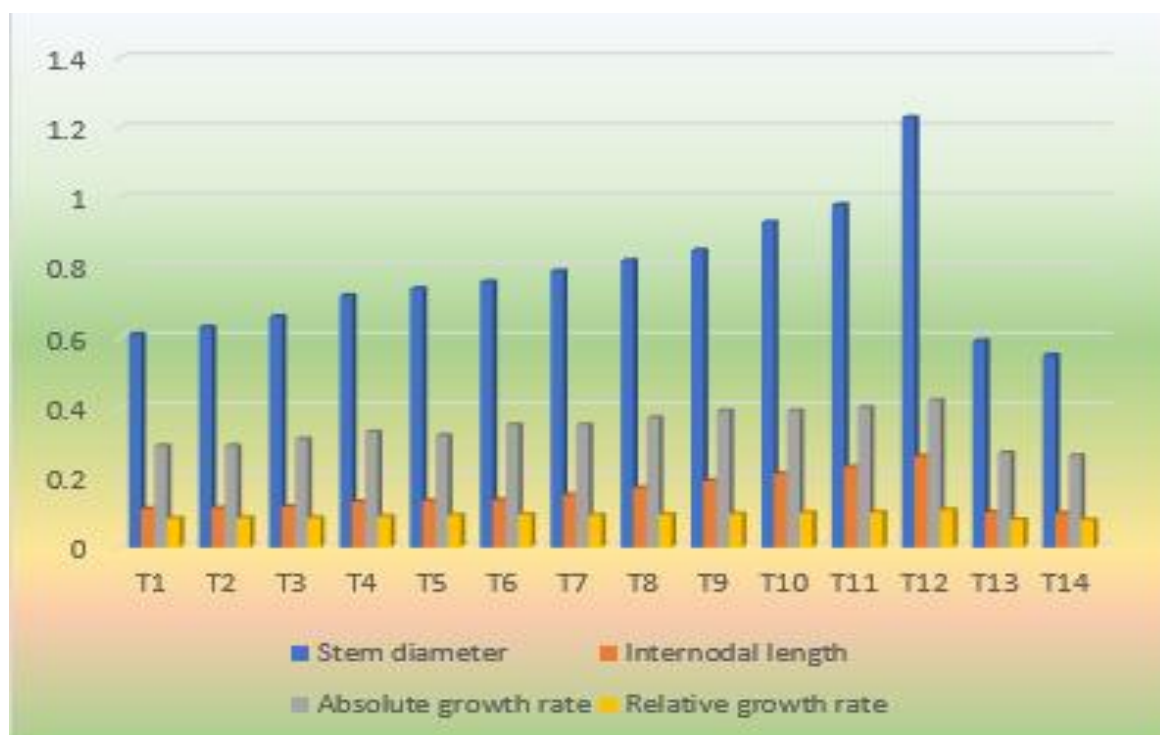


Fig 1. Effect of organic manures

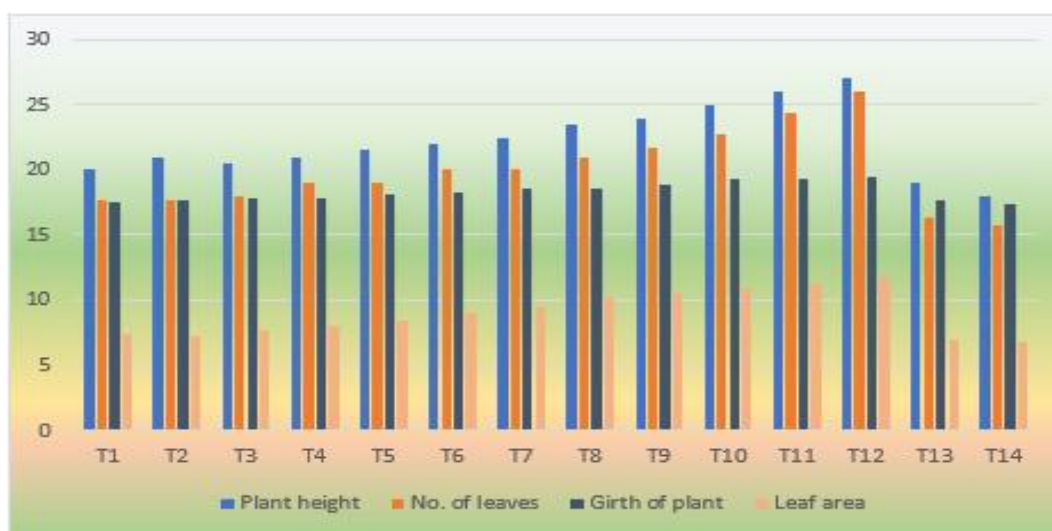


Fig 2. Effect of foliar application



1a. Leaf area meter



1b. Plant Height

Plate 1a and 1b. Leaf area meter and plant height

Table 1. Effect of organic manures and foliar application of micronutrients on plant height and stem diameter of sweet orange (cv. Sathgudi) buddlings

Treatments	Plant height				Stem diameter			
	30	60	90	120	30	60	90	120
T ₁	3.553	12.797	16.000	20.00	0.160	0.270	0.430	0.61
T ₂	3.327	13.020	16.500	21.00	0.160	0.290	0.450	0.63
T ₃	3.700	13.600	16.600	20.50	0.160	0.300	0.470	0.66
T ₄	3.880	12.750	17.000	21.00	0.170	0.310	0.530	0.72
T ₅	3.833	12.900	17.500	21.50	0.170	0.317	0.550	0.74
T ₆	3.633	13.097	17.700	22.00	0.170	0.320	0.580	0.76
T ₇	3.267	12.300	18.000	22.50	0.180	0.330	0.610	0.79
T ₈	4.067	12.400	18.500	23.50	0.180	0.370	0.630	0.82
T ₉	3.767	13.200	19.000	23.97	0.180	0.370	0.650	0.85
T ₁₀	3.967	14.600	20.000	25.00	0.190	0.380	0.660	0.93
T ₁₁	4.633	15.500	21.000	26.00	0.190	0.390	0.670	0.98
T ₁₂	5.980*	16.203*	22.000*	26.97	0.210*	0.410*	0.720*	1.23
T ₁₃	2.940	11.000	15.000	19.00	0.150	0.250	0.4100	0.59
T ₁₄	2.800	10.333	14.500	18.03	0.150	0.240	0.400	0.55
Sem ±	0.897	0.2356	0.3326	0.540	0.0024	0.0045	0.0099	0.010
CD at (5%)	0.2606	0.6849	0.9688	1.465	0.0071	0.0130	0.0289	0.030

Table 2. Effect of organic manures and foliar application of micronutrients on number of leaves, girth of the plant and absolute growth rate of sweet orange (cv. Sathgudi) buddlings.

Treatments	Number of leaves				Girth of the plant				Absolute growth rate
	30	60	90	120	30	60	90	120	120
T ₁	3.333	6.333	11.333	17.66	16.6	16.9	17.1	17.5	0.290
T ₂	3.333	6.333	11.667	17.66	16.5	16.8	17.2	17.6	0.290
T ₃	3.333	6.333	11.333	18.00	16.8	17.1	17.5	17.8	0.310
T ₄	3.333	7.000	13.33	19.00	16.7	17.2	17.5	17.8	0.330
T ₅	4.000	6.333	13.333	19.00	16.9	17.5	17.6	18.1	0.320
T ₆	3.667	6.333	13.000	20.00	17.0	17.5	17.9	18.3	0.350
T ₇	3.333	6.000	12.667	20.00	17.1	17.6	18.1	18.5	0.350
T ₈	4.333	6.667	13.667	21.00	17.5	17.8	18.2	18.6	0.370
T ₉	4.333	8.000	14.000	21.66	17.7	17.9	18.4	18.8	0.390
T ₁₀	5.000	8.333	15.000	22.66	18.2	18.5	18.8	19.3	0.390
T ₁₁	5.667	9.667	15.667	24.33	18.3	18.8	19.1	19.3	0.400
T ₁₂	6.333*	10.667*	17.000*	26.00	18.5	18.9	19.3	19.5	0.420
T ₁₃	3.000	5.000	10.333	16.33	16.7	17.0	17.3	17.7	0.270
T ₁₄	3.000	5.000	9.667	15.66	16.2	16.7	16.9	17.3	0.262
Sem ±	0.2892	0.3828	0.3673	0.540	0.2174	0.2220	0.2781	0.240	0.0048
CD at (5%)	0.8407	1.1127	1.0678	1.572	0.6318	0.6453	0.8085	0.699	0.0138

Table 3. Effect of organic manures and foliar application of micronutrients on leaf area, internodal length and relative growth rate of sweet orange (cv. Sathgudi) buddlings.

Treatments	Leaf area				Internodal length				Relative growth rate
	30	60	90	120	30	60	90	120	120
T ₁	4.187	5.200	6.400	7.40	0.007	0.037	0.070	0.110	0.082
T ₂	4.297	5.297	6.300	7.30	0.007	0.033	0.072	0.112	0.084
T ₃	4.373	5.400	6.600	7.70	0.007	0.034	0.075	0.116	0.084
T ₄	4.670	6.003	7.000	8.00	0.008	0.030	0.080	0.130	0.088
T ₅	4.997	6.503	7.500	8.50	0.008	0.039	0.085	0.132	0.092
T ₆	5.200	7.000	8.000	9.00	0.008	0.036	0.087	0.135	0.093
T ₇	4.997	7.477	8.500	9.50	0.009	0.038	0.092	0.150	0.092
T ₈	5.533	8.003	9.200	10.20	0.009	0.039	0.095	0.170	0.093
T ₉	5.800	8.170	9.500	10.50	0.011	0.040	0.098	0.190	0.095
T ₁₀	6.300	8.777	10.000	11.00	0.013	0.040	0.098	0.210	0.099
T ₁₁	6.808	9.380	10.200	11.20	0.016	0.050	0.120	0.230	0.100
T ₁₂	7.497*	9.830*	10.700*	11.70	0.018*	0.060*	0.170*	0.260	0.106
T ₁₃	4.000	5.903	6.313	6.91	0.006	0.027	0.070	0.100	0.079
T ₁₄	3.900	5.867	6.267	6.80	0.002	0.020	0.060	0.097	0.078
Sem ±	0.0893	0.0691	0.1374	0.176	0.0001	0.0004	0.0013	0.0022	0.0015
CD at (5%)	0.2595	0.2009	0.3995	0.513	0.0003	0.0011	0.0039	0.0064	0.0042

Number of leaves Observations over 30, 60, 90 and 120 (days after budding) DAB showed that the combination of T₁₂ - FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) (26.00) had the highest number of leaves. These outcomes might be the consequence of improved nutrient availability in potting medium combinations, which would increase the growth of

photosynthesis functional leaves. Results in line with Kaur et al. [8] for Cebiapentandra, Ali et al. [13] for Mango, and Raval et al. [14] for Mango indicate that soil mixtures with farmyard manure increase leaf count.

Plant girth Observations over 30, 60, 90 and 120 (days after budding) DAB significantly highest increase in plant girth was found in treatment T₁₂

- FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) (19.5mm). The lowest increase in plant girth was found in treatment T₁₄ – Control (17.30 mm). Organic manures promote faster growth in grafts by enhancing photosynthesis activity [15]. The presence of sand and vermicompost in their potting mix was essential for plant performance and survival in external conditions. Vermicompost provides necessary nutrition, defence, and root potential. When combined with sand, it prevented the soil from becoming clayey and compact, improving soil texture and drainage and facilitating root growth. This strong foundation led to better nutrient absorption, increased survival, and higher yields in field conditions. Similar findings were observed by Lad (2018) using cocopeat + leaf manure + compost (1:1:2), followed by soil + cocopeat (1:1).

Leaf area Observations made over 30, 60, 90 and 120 DAB revealed that the treatment comprising T₁₂ - FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) had the highest leaf area (11.700 cm²) and T₁₄ - Control had the lowest leaf area of (6.80 cm²). The improved plant growth can be attributed to the nutrient availability in the soil potting media combinations. These combinations likely improved the physico-chemical properties of the root zone soil, enhancing nutrient absorption, differentiation, and availability. This, in turn, increased the production of photosynthates and functional leaves. Gebregiorgis et al. [16] experimented on various mango cultivars and found that the maximum leaf area (86.68 cm) was achieved with a soil media composition of topsoil, FYM, and sand in a 3:2:1 ratio.

Internodal length: Observations made over 30, 60, 90 and 120 DAB T₁₂ - FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) (0.260 cm) had the greatest internodal length, and T₁ - FYM (100 %) (0.09 cm) had the lowest. The improvement in internodal length may result from nutrient application, heightened photosynthetic activity, chlorophyll formation, and enhanced nitrogen metabolism in the plants. These findings align with Jenny and Malliga [17] and Bade et al. [18].

Absolute growth rate After observing over the specified period of 120 DAB, the absolute growth rate (AGR) on a height basis was highest in treatment T₁₂ - FYM (33 %) + Vermicompost

(33%) + Neem cake (33%) + Arka Citrus Special (5 g / l) (0.42 cm/day). Conversely, the lowest absolute growth rate (cm /day) was found in T₁₄ - Control (0.262 cm/day). Organic manures in potting media enhance soil fertility [19] and stimulate plant growth and development [20]. Vermicompost, with its worm mucus, prevents nutrient runoff, improves moisture retention, and promotes plant growth [21]. Similar results were seen by Khan and Ishaq [22] in their experiment with Peas using Vermicompost [23-25].

Relative growth rate Over the observation period of 120 DAB, the highest relative growth rate (cm /cm /day) was found in T₁₂ - FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) (0.10 cm/cm/day). In contrast, the minimum was found in T₁₄ - Control (0.078 cm /cm /day). Organic media positively impact plant growth, especially in height, by improving textural and structural properties that enhance nutrient availability. This leads to increased plant height and growth, resulting in a higher relative growth rate (RGR) [26-27]. These findings align with research by Ragaji [15] in Alphonso mango grafts and Lad (2018) using cocopeat + leaf manure + compost (1:1:1).

4. CONCLUSION

In brief, combining organic manures (FYM, Vermicompost, Neem cake) with foliar micronutrient application (Arka Citrus Special) significantly improved various growth parameters in sweet orange plants. The best results were observed with a combination of 33% each of FYM, Vermicompost, and Neem cake, along with Arka Citrus Special (5 g/l), while minimal growth occurred with no organic manure or separate application.

COMPETING INTERESTS

Future line of work

- Effect of organic manures and foliar application of micronutrients on the flowering of sweet orange (cv. Sathgudi) buddlings.
- Effect of organic manures and foliar application of micronutrients on the yield of sweet orange (cv. Sathgudi) buddlings.
- Effect of organic manures and foliar application of micronutrients on the quality of sweet orange (cv. Sathgudi) buddlings.

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