Influenceof organic manures and foliar application of Arka Citrus Special on the growth ofbuddlings of sweet orange

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. Sathgudibuddlings. The experiment included fourteen treatments with three replications in RBD. It comprised three types of organic manures (FYM, Vermicompost, Neemcake) and Arka Citrus Special (micronutrient formulation).The applicationof organic manures and micronutrients showed significant differences in plant height (cm), number of leaves, and leaf area (cm^2).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 cm^2), 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

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 (Guo and Deng2001). Nigeria and other tropical and subtropical regions are known for their widespread cultivation of citrus. (Piccinelli*et al*, 2008).

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 (Angew, 2007).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 (Ehler, 2011). Sweet orange is the second important citrus fruit cultivated in the country.(National Horticulture Database, 2021). 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 (Patel *et al.* 2019).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 (Obreza *et al.*, 2010).

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.

Material 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) byadoptingrandomizedblockdesign (RBD) with 14 treatmentsand 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. T_1: FYM (100 %), T_2 Vermicompost (100 %), T_3 Neem cake (100 %), T_4 FYM (50 %) + Vermicompost (50 %), T_5 FYM (50 %) + Neem cake (50 %), T_6 Vermicompost (50 %) + Neem cake (50 %), T_7 FYM (100 %) + Arka Citrus Special (5g / l), T_8 Vermicompost (100 %) + Arka Citrus Special (5g / l), T_9 Neem cake (100 %) + Arka Citrus Special (5g / l), T_{10} FYM (50 %) + Vermicompost (50%) + Arka Citrus Special (5g / l), T_{11} FYM (50 %) + Neem cake

(50%) + Arka Citrus Special (5g / l), T_{12} FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5g / l), T_{13} Arka Citrus Special (5g / l), T_{14} Control.

The parameters recorded were plant height (cm), stem diameter (mm), number of leaves, girth of the plant (mm), leaf area (cm^2), 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.

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.

$$AGR = \frac{(H_2-H_1)}{(t_2-t_1)}$$

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

Results and Discussions

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 and120 (days after budding) DABof 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 seedlingand juvenile, andleading to increased plant height. A study by **Kaur (2017)**on mango cultivarsrevealed thatthe ideal growing media consisted of a 1:1:2 ratio of soil, sand, and vermicompost.similar by Bharadwaj (2014) 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 (**Qadri *et al.* 2021),** a mix of sand, silt, and leaf manure yielded maximum stem diameter. In jujube (Sharif *et al.*, 2014), 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.* (2012).

Number of leaves Observations over 30, 60, 90 and 120 (days after budding) DAB showed that the combination of T_{12} - 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 2017)***et al.* (2017) for Cebiapentandra, Ali *et al.* (2016) for Mango, and Raval *et al*. (2016) for Mango indicate that soil mixtures with farmyard manure increase leaf count.

Plant girth Observations over 30, 60, 90 and120 (days after budding) DAB significantly highest increase in plant girth was found in treatmentT_{12} - FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) (19.5mm). Thelowestincreaseinplantgirthwasfoundintreatment T_{14}–Control(17.30 mm). Organic manures promote faster growth in grafts by enhancing photosynthesis activity (Ragaji, 2017). 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 120DAB revealed that the treatment comprising T_{12} - FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) had the highest leaf area (11.700 cm^2) and T_{14} - Control had the lowest leaf area

of (6.80 cm^2).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. **Gebregiorgs*et al***. (2021) 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 over30, 60, 90 and 120 DAB T_{12} - FYM (33 %) + Vermicompost (33 %) + Neem cake (33 %) + Arka Citrus Special (5 g / l) (0.260 cm)had the greatest internodal length, and T_1 - 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 (2016) and Bade *et al.* (2017).

Absolute growth rate After observing over the specified period of 120 DAB, the absolutegrowthrate (AGR) ona height basis was highest in treatment T_{12} - 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 T_{14} - Control (0.262 cm/day). Organic manures in potting media enhance soil fertility (Karbauskiene 2000) and stimulate plant growth and development (Aranco*net al*. 2004). Vermicompost, with its worm mucus, prevents nutrient runoff, improves moisture retention, and promotes plant growth (Singh *et al.* 2004). Similar results were seen by Khan and Ishaq (2011) in their experiment with Peas using Vermicompost.

Relative growth rate Over the observation period of 120 DAB, the highest relative growth rate (cm /cm /day) was found in T_{12} - 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 T_{14} - 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). These findings align with research by Ragaji (2017) in Alphonso mango grafts and Lad (2018) using cocopeat + leaf manure + compost (1:1:1).

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.

Fig 1.

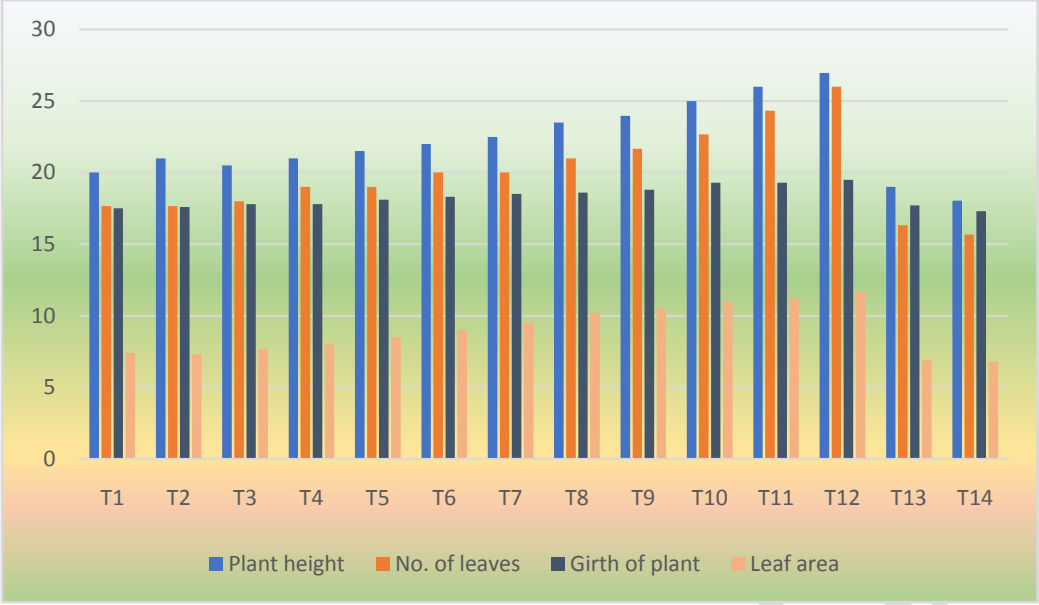

Fig 2

Fig 1 and Fig 2. effect of organic manures and 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**
CDat(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**
CDat(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**
CDat(5%)	**0.2595**	**0.2009**	**0.3995**	**0.513**	**0.0003**	**0.0011**	**0.0039**	**0.0064**	**0.0042**

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