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Effect of nutrients level on growth of sweet orange under Western Maharashtra conditions

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Abstract
An investigation was carried out to study the effect of nutrients level on growth of sweet orange under Western Maharashtra conditions. The effect of different combined doses of N, P and K nutrients on plant growth of sweet orange. Experimental plants were supplied with different levels of N (600, 800 and 1000 g N/plant), P (200, 300 and 400 g P_2O_5/plant) and K (400, 600 and 800 g K_2O/plant) in the form of Urea, SSP and MOP fertilizers. From the results, it was found that nitrogen, phosphorus and potassium application improve growth parameters like plant height and canopy volume. $N_3P_1K_2$ *i.e.* N_3-1000 g N/plant, P_1-200 g P_2O_5/plant and K_2-600 g K_2O/plant and $N_3P_2K_3$ *i.e.* N_3-1000 g N/plant, P_2-300 g P_2O5/plant and K_3-800 g K_2O/plant recorded maximum plant height and canopy volume.

Keywords: N, P, K, Urea, SSP, MOP, plant height and canopy volume

Introduction
Citrus is one of the most widely grown fruits on the planet. *Citrus* is gaining popularity due to its numerous health benefits, as well as its refreshing flavor, aroma and taste (Baldwin *et al*., 2014) [5]. *Citrus* fruits are rich in vitamin C as well as a host of other health-promoting compounds including flavonoids and carotenoids (Lv *et al*., 2015) [12]. *Citrus* and its relatives (Fortunella, Poncirus, Eremocitrus and Micro-*citrus*) are angiosperms that belong to the Rutaceae family and the Aurantioideae subfamily. *Citrus* is thought to have originated in Southeast Asia, particularly in the Himalayan foothills. According to a recent genomics study published in "Nature" by Wu *et al*. (2018), *Citrus* originated in Southeast Asia and thrived under the favorable monsoon climate. *Citrus* migrated to different parts of Asia and Australia as the monsoon impact weakened in the late Miocene period. *Citrus* evolved into different species as it moved to different geographical locations and climates.

In India, sweet orange is grown in 190 ha of area and produced in 3401 MT. Andhra Pradesh rank first in production 2700.57 tons and percent share 69.35 per cent and Maharashtra rank second with 515.19 tons production and 69.35 percent share followed by Telangana, Madhya Pradesh and Punjab (Anon., 2022a) [2]. In the world, Brazil stands first in production, followed by the United States of America, China, India and Mexico (Anon. 2013) [1]. In terms of export of sweet orange from India, Bangladesh (63,152.54 tons) rank first in export followed by Nepal (9,634.50 tons), Bhutan (209.91 tons), UAE (137.60 tons) and Baharian (7.95 tons) (Anon., 2022b) [3].

Sweet orange (*Citrus sinensis* L. Osbeck) is a small evergreen tree 7.5 m height and in some cases up to 15 m also. It began from southern China where it has been cultivated for numerous times, but at present grown commercially worldwide in tropical, semi-tropical and some warm temperate regions to come the most extensively planted fruit tree in the world (Nicolosi *et al*., 2000 and Ehler, 2011) [14, 8]. Orange fruit is spherical to oblong in shape, with few seeds and high sugar content. Round oranges, navel oranges, blood oranges and acid less orange are the four styles of oranges. Round oranges are typically used for preparation of juice (Richa *et al*., 2023) [18].

Sweet oranges need a well-drained medium or soft loam soil with a 2-3 cm depth of slightly heavier subsoil. Cultivation generally avoided in shallow soils. It grows in a wide variety of soil types, from clay to light sandy and is salt tolerant (Radha and Mathew, 2007) [17]. Sweet Orange grows well in medium dark, red, alluvial river bank loamy soils of Maharashtra. Well-drained, heavy soils provide strong crops but are difficult to cultivate.

The pH of the soil should be between 6.5 and 7.5 and the EC of the water should not exceed 1.0 dSm^{-1}. The plant is very vulnerable to wet soils (Srivastava and Singh 2008) [19]. Sweet orange has a high nutrient demand around the year because it is an evergreen, perennial tree with a long fruiting period. Both of the necessary macro and micronutrients must be supplied to the sweet orange plant. Multiple nutrient deficiencies are common in *Citrus* orchards the world over. In advance husbandry, soil health has entered due attention because of the fact that, vacuity of plant nutrients depends upon colourful physical and chemical characteristics of the soil. Multi-nutritional scarcities in horticultural crops are really common far and wide in the world and their operation has been noted to impact plant growth and productivity in a variety of way. Deficient nutrient not only reduces the productivity of the crops, but also reduces the use effectiveness of applied nutrients. Still, information on the optimum range of nutrients in soil and factory for maintaining yield eventuality and quality of fruit in sweet orange for Western Maharashtra conditions is demanded.

Materials and Methods

An experiment was conducted on 15 years old plants of sweet orange at All India Co-ordinated Research Project on Fruits, Department of Horticulture, MPKV., Rahuri, Ahmednagar, Sub centre Shrirampur, during 2021-2022. There were three levels of nitrogen (N_1-600, N_2-800, N_3-1000 g N/plant), three levels of phosphorus (P_1-200. P_2-300, P_3-400 g P_2O_5/plant) and three levels of potassium (K_1-400, K_2-600, K_3-800 g K_2O/plant). All the nutrient doses were arranged in a factorial combination and laid out in randomized block design with two replications. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash, respectively in two years, during February to September. Plant height was recorded by placing long bamboo pole on the soil surface near the trunk base to the top of the plant and the height was measured in meters with the help of metallic tape. Canopy volume was calculated before and after start of an experiment by using the following formula given by Castle (1983).

Canopy volume (m3) = 0.5236 x canopy height (m) x mean of EW and NS spread m^2)

Where, canopy height was calculated by subtracting stem height from plant height.

Result and Discussion

The $N_3P_2K_3$ combination with N_3-1000 g N/plant, P_2-300 g P_2O_5/plant and K_3-800 g K_2O/plant recorded maximum canopy volume (11.52 m^3) in 2021 while The $N_3P_3K_1$ combination recorded maximum canopy volume (17.56 m^3) which was at par with $N_3P_1K_1$, $N_3P_2K_3$ and $N_3P_3K_2$ in 2022. The $N_3P_2K_3$ was found to be at par with $N_3P_1K_2$, $N_3P_3K_1$ in 2021. Whereas, the $N_1P_2K_3$ combination with N_1-600 g N/plant, P_2-300 g P_2O_5/plant and K_3-800 g K_2O/plant recorded minimum canopy volume during 2021, 2022, respectively. However, other growth parameter *i.e.* plant height did not vary much between treatments (Table 1).

The data on the effect of nitrogen revealed that the application of organic and inorganic fertilizer increased the plant growth. Application of nitrogen resulted in better vegetative growth of the plant and gave dark green colour of the foliage. This favoured the photosynthetic activity of the plants and greater synthesis of carbohydrate, which led to the formation of amino acids, nucleo-proteins, chlorophyll, alkaloids and amides. These complex compounds were responsible for building up of new tissues and were associated, which in turn favoured better development of plants (Kaul and Bhatnagar, 2006) [11]. Similarly, increase in canopy volume of fruit plants by the application of nitrogen has also been reported earlier by Dhillon *et al.* (2011) [6] in Pomegranate cv. Kandhari, Pawar *et al.* (2022) [15] in Acid lime cv. Phule Sharbati, Dhomane *et al.* (2011) [7] in guava, Garhwal *et al.* (2014) [10] in Kinnow mandarin, Priya *et al.* (2022) [16] in custard apple cv. Balanagar, Ennab (2023) [9] in pumello, Mirji *et al.* (2023) [13] in sapota cv. Kalipatti and Asim *et al.* (2024) [4] in Kinnow mandarin.

Table 1: Effect of nutrients level on growth of sweet orange

Sr. No.	Treatment combination	Plant height (m)		Canopy volume (m^3)	
		2021	2022	2021	2022
1.	$N_1P_1K_1$	3.48	3.58	7.21	8.69
2.	$N_1P_1K_2$	3.56	3.68	8.09	9.84
3.	$N_1P_1K_3$	3.37	3.51	6.98	7.95
4.	$N_1P_2K_1$	3.54	3.68	8.09	9.14
5.	$N_1P_2K_2$	3.09	3.28	5.95	7.09
6.	$N_1P_2K_3$	2.92	3.13	4.41	5.51
7.	$N_1P_3K_1$	3.76	3.96	10.64	12.28
8.	$N_1P_3K_2$	3.73	3.94	10.55	12.48
9.	$N_1P_3K_3$	3.24	3.46	5.81	7.39
10.	$N_2P_1K_1$	3.60	3.84	9.15	11.46
11.	$N_2P_1K_2$	3.13	3.41	5.08	6.10
12.	$N_2P_1K_3$	3.67	3.93	9.87	12.06
13.	$N_2P_2K_1$	3.52	3.80	7.98	10.65
14.	$N_2P_2K_2$	3.72	4.03	10.13	12.92
15.	$N_2P_2K_3$	3.65	3.97	9.21	12.63
16.	$N_2P_3K_1$	3.30	3.62	6.03	9.15
17.	$N_2P_3K_2$	3.27	3.56	6.01	8.56
18.	$N_2P_3K_3$	3.78	4.14	10.63	14.51
19.	$N_3P_1K_1$	3.80	4.13	10.68	17.48
20.	$N_3P_1K_2$	3.96	4.31	11.49	16.42
21.	$N_3P_1K_3$	3.26	3.64	5.74	8.92

22.	$N_3P_2K_1$	3.62	4.01	9.31	13.39
23.	$N_3P_2K_2$	3.61	4.02	8.78	13.17
24.	$N_3P_2K_3$	3.84	4.27	11.52	17.30
25.	$N_3P_3K_1$	3.85	4.24	10.97	17.56
26.	$N_3P_3K_2$	3.78	4.22	10.11	17.35
27.	$N_3P_3K_3$	3.54	3.98	7.91	13.37
S.Em.(±)		0.17	0.23	0.28	0.34
CD at 5%		NS	NS	0.81	0.99

Conclusion

Maximum canopy volume (14.41 m^3) was recorded with the treatment $N_3P_2K_3$ with N_3-1000 g N/plant, P_2-300 g P_2O_5/plant and K_3-800 g K_2O/plant. Plant growth increased with the increasing level of nitrogen and phosphorus in sweet orange under Western Maharashtra conditions.

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