Research Article

Effect of Different Organic Sources of Nutrients on Growth, Yield and Quality of Sweet Orange (*Citrus sinensis*)

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Abstract

Sweet orange is an important fruit crop and the information on the effect of various organic sources of nutrients and bio fertilizers on growth, yield and quality is lacking. Keeping this in view, the present investigation on "Effect of different organic sources of nutrients on growth, yield and quality of Sweet orange (*Citrus sinensis*)" was carried out under RBD design during 2018-19 at Horticultural Research Station, Darsi (Prakasam District), Andhra Pradesh, India with ten treatments and three replications to find out the effect of organic manures and bio fertilizers on growth, yield and quality of Sweet orange (*Citrus sinensis*). Among all the treatments, (T_1-RDF (1500-350-400g.NPK/Plant)) recorded highest yield of 3.96 t/ha as compared to other treatments. Among organic treatments T_9(FYM@46Kg/plant + Neemcake@22Kg /Plant + *Azospirillum*@200g/Plant+PSB@200g/ Plant) recorded highest yield of 3.39 t/ha(0.41 B:c ratio). Considering the yield as well as benefit : cost ratio in view among organic treatments, it can be concluded that application of T_9(FYM@46Kg/plant + Neem cake@22Kg/Plant + *Azospirillum* @ 200g/ Plant +PSB@200g/ Plant) recorded highest yield of 3.39 t/ha(0.41 B:c ratio) was found promising and can be recommended for obtaining higher yield among organic treatments.

Keywords: Farm yard manure (FYM), Randamized block design(RBD)

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Introduction

In India, the citrus, holds a prominent place among the major commercial fruits covering an area of about 8.46 lakh ha with an annual production of 74.64 lakh tonnes and productivity of 8.8t/ha [1]. Andhra Pradesh is one of the major citrus producing states in the country with a total area of abour 1.28 lakh ha (24.2%) and an annual production of 18.05 lakh tonnes and ranks first in sweet orange (0.4 lakh ha) and acid lime production (0.46 lakh ha). Sweet orange (*Citrus sinensis*) and Acidlime (*Citrus aurantifolia*) are the two chief commercial citrus fruits grown in the state. Of late, there is good market for organic produce of sweet orange both in the domestic and international market. To maintain and sustain a higher level of soil fertility and crop productivity, organic manures are very important in the present day system of crop production. The conjunctive use of organic manures will not only improve the soil health but also helps to increase fruit yield and quality of sweet orange in long run.

Citrus requires 16 essential elements for normal growth, production, and quality, irrespective of the source [2]. Renewed and intensified efforts are in progress during the past 10-15 years to grow citrus organically ever since the depleting soil fertility attained a serious concern with the practice of high density orchards coupled with heavy use of chemical fertilizers [3, 4]. Organic citrus cultivation is often considered amongst one of the sustainable agricultural practices; if used appropriately, it promises to offer rich dividends on a long-term basis. Opinions vary greatly about organic farming being perceived as a part of sustainable agriculture [5]. Concerns about improving nitrogen use efficiency, reducing nitrate pollution, contamination due to byproducts of various chemical pesticides in use, and continued gradual loss of soil organic matter have always been the major core issues in organic citrus cultivation [6]. But the organic cultivation of citrus has yet not received the priority it deserves; as a result, soil physical, chemical, and microbiological health have deteriorated irrecoverably [7]. In addition to changes in land use pattern, unfavorable climatic conditions have further enhanced the rate of decomposition of soil organic matter and its further depletion [8]. These problems warrant revision of ongoing agricultural practices, and adaptation of some alternative strategies whose origin is presumed to be age old, popularly known as organic farming or natural farming.

Market demand is established according to the scale and value of production. A precise estimate of acreage under citrus production is still not available. However, only 0.3 percent (286 acres) of the commercial citrus acreage

reported in 1992 (791,290 acres) is currently certified as organic according to the Florida Department of Agriculture and Consumer Services [6]. According to another estimate, 2,500 to 3,000 acres are claimed to be under organic citrus production [9]. The Florida Department of Agriculture and Consumer Services has listed 22 certified citrus growers among a total of 69 organic farmers [10].

Chemical fertilizers constitute the major component of inputs. Expenditure on this component is ever increasing and making the cultivation economically not viable besides, the continuous use of chemical fertilizers is posing new problems because of depletion of soil health.

Keeping this in view, the present investigation on "Effect of different organic sources of nutrients on growth, yield and quality of Sweet orange (*Citrus sinensis*)" was carried out to find out the effect of organic manures on growth, yield and quality of Sweet orange.

Materials and Methods

The investigation on " Effect of different organic sources on growth, yield and quality of Sweet orange (*Citrus sinensis*)" was carried out in randomized block design during 2018-19 at Horticultural Research Station, Darsi (Prakasam District), Andhra Pradesh, India with ten treatments and three replications *viz*; T_1-RDF(1500-350-400g.NPK/plant), T_2- FYM@93kg/Plant, T_3- Vermicompost@62kg/Plant, T_4- Neemcake@44kg/Plant, T_5-FYM@93kg/Plant + *Azospirillum*@200g/Plant + PSB@200g/Plant, T_6-Vermicompost@62kg/Plant + *Azospirillum*@200g/ Plant + PSB@200g/Plant, T_7-Neemcake@44kg/ Plant +*Azospirillum*@200g/Plant +PSB@200g/ Plant, T_8-FYM@46kg/Plant + Vermicompost@31kg/ Plant + *Azospirillum*@200g/Plant + PSB@200g/ Plant, T_9-FYM@46kg/Plant+Neemcake@22kg/Plant+*Azospirillum*@200g/Plant+PSB@200g/Plant, T_{10}-Vermicompost@31kg/ Plant + Neemcake@22kg/ Plant + *Azospirillum*@200g/ Plant + PSB @200g/ Plant. Data on Plant height (m), Stem girth, Canopy Spread (EW & NS), Fruit yield/tree (Kgs), Fruit no./tree, Fruit Weight (g), Fruit diameter(cm), Yield kgs/plant, Yield t/ha, Juice Content ml/fruit, TSS and C:B ratio were recorded. The experimental data were statistically analyzed following the standard procedures and significance was tested by 'F' value at 5 per cent level of probability.

Results and Discussion

Effect of organic manures and bio fertilizers on growth

Growth is an irreversible increase in size and shape of the plant and it is affected by the complex interaction between environmental factors and physiological processes which are influenced by the external inputs like water and nutrients. It can be observed that in the present field experiment, application of different organic sources of manures and their combinations and recommended dose of fertilizer exerted a significant influence on vegetative growth of the crop in terms of plant height, stem girth and canopy spread.

Application of Neemcake@44kg/ Plant +*Azospirillum*@200g/ Plant +PSB@200g/ Plant (T_7) has shown significant effect on vegetative characters and recorded highest plant height of 2.94mts and it was on par with T_1(2.86mts), T_3(2.79mts), T_2(2.77mts) and T_9(2.77mts) and the above organic treatments recorded comparable plant height with inorganic treatment (T_1) which recorded 2.86mts. The lowest plant height has been recorded in T_6(2.49mts). Similarly, highest stem girth was recorded in T_2(49.89cm) followed by (T_1) inorganic treatment (45.15cm) where as the canopy spread (EW) is more in T_9(4.03mts) followed by T_2(3.85mts). The treatment T_2 recorded highest (3.88mts) canopy spread (NS) followed by inorganic treatment T_1(3.71mts). Among organic treatments, T_2 recorded highest stem girth (49.89cm) and canopy spread (NS) 3.88mts which is closely followed by(T_1) 100% RDF through chemical fertilizers (**Table 1**).

Vegetative growth in plants treated with organic manures was found to be rather slow initially and improved gradually. It is reasonable to state that the organic manures might have taken longer time to undergo mineralization process in the soil and to provide the plants with usable nutrient forms [11]. The vegetative growth was promoted by certain organic treatments *viz*., T_7, T_2, T_9 *etc.* The increase in the growth parameters may be attributed to improved nutrient availability through organic manures such as neem cake and farm yard manure applied in a combined form which would have exerted a complimentary effect on growth parameters.

Similarly, vermicompost is reported to be a good source of macro and micro elements, growth hormones, vitamins and microflora. Vermicompost also contains plant growth promoters and group 'B' vitamins and their effect on growth was similar to the effect of IAA [12]. Further, other organic manures, especially farm yard manure and

Vermicompost (Treatments; T_6 and T_8) might have improved the rhizosphere leading to an improvement in nutrient availability to the plants.

Table 1 Effect of organic sources on growth parameters of sweet orange

Treatments	Plant height (mts)	stem girth (cm)	Canopy spread	
			EW (mts)	NS (mts)
T_1	2.86	45.15	3.60	3.71
T_2	2.77	49.89	3.85	3.88
T_3	2.79	41.17	3.67	3.47
T_4	2.61	36.35	3.79	3.58
T_5	2.58	35.61	3.46	3.44
T_6	2.49	41.25	3.50	3.60
T_7	2.94	38.74	3.47	3.55
T_8	2.72	38.80	3.50	3.36
T_9	2.77	40.24	4.03	3.39
T_{10}	2.68	35.27	3.48	3.39
SEm+/-	0.07	0.85	0.04	0.04
CD (P=0.05)	0.21	2.56	0.12	0.13

Effect of organic manures on yield and yield attributes

The application of 100 % RDF (T_1) recorded higher values for no. of fruits per plant (92), fruit weight (194g), juice content (68ml) and yield/ha (3.96t/ha). The no. of fruits are significantly highest in inorganic treatment followed by T_9(80.66), T_{10}(79.66) and T_8(78.50) and similar trend also observed in fruit weight. The inorganic treatment recorded highest per plant (17.85kg) and per ha fruit yield (3.96t/ha) followed by T_9(3.39t/ha), T_8(3.26t/ha) and T_{10}(3.37t/ha) where as the lowest (1.76t/ha) yield has been recorded in T_4 (**Table 2** and **Figure 1**).

In sweet orange under sustainable organic culture, availability of major nutrients such as NPK is very important. A significantly higher fruit yield in sweet orange particularly in (100%RDF) T_1 comprising only inorganic fertilizers as noticed here may be attributed to the direct addition of nitrogen in readily available form. Nitrogen was applied in the form of urea which contains the nutrient in amide form. Urea is readily converted to ammonical form by urease catalyzed urea hydrolysis and then promptly oxidized to nitrate form by nitrification. Next to inorganic treatment, the higher fruit yield in treatments with combination of organic manures ie; farmyard manure, neem cake and vermi compost with bio fertilizers (T_9,T_8&T_{10}) may be attributed to slow and sustained release of nutrient from farmyard manure, neem cake and vermicompost. These sources contain nitrogen in complex organic form which requires the mineralization process to be executed for bringing nitrogen in available form. This process is essentially a soil microbiological process carried out by the soil heterotrophic microflora and is a slow process. As a result the entire nitrogen becomes available to the plant over an extended period of time.

Table 2 Effect of organic sources on fruit characters and yield of sweet orange

Treatment	No. of fruits/ plant	Fruit Weight (g)	Fruit diameter (cm)	Juice content/ fruit (ml)	TSS (^{0} Brix)	Yield kg/plant	Yield t/ha	B : C Ratio
T_1	92.00	194.00	7.15	68.00	9.60	17.85	3.96	0.97
T_2	61.00	158.50	6.10	57.11	10.30	9.66	2.14	-0.05
T_3	51.33	164.06	6.46	59.16	9.56	8.42	1.86	-0.42
T_4	45.33	175.16	6.60	61.66	9.66	7.94	1.76	-0.22
T_5	69.00	180.33	6.76	63.96	10.10	12.43	2.75	0.13
T_6	72.83	170.83	6.53	59.16	9.76	12.44	2.76	-0.08
T_7	63.66	181.50	6.80	65.96	9.66	11.55	2.56	0.09
T_8	78.50	187.50	6.86	66.50	10.06	14.71	3.26	0.39
T_9	80.66	189.50	6.96	67.83	9.88	15.31	3.39	0.42
T_{10}	79.66	191.16	7.03	65.66	9.98	15.19	3.37	0.35
SEm+/-	2.09	2.09	0.04	0.04	0.06	0.31	0.06	-
CD (P=0.05)	6.26	6.27	0.13	1.21	0.19	0.92	0.20	-

A point of equal significance in context is that nitrogen supply from organic sources depends upon their chemical nature and nitrogen content too. Further, synchronicity between crop demand and nitrogen supply is also very

important for successful nutrient uptake. It can be reasoned that in the above treatments the combination of farmyard manure, neem cake and vermicompost might have developed good synchronicity between nitrogen supply from organic manures and crop demand preventing higher loss of nitrogen through leaching or de nitrification [13]. As a result, greater part of the nutrient could be utilized by the plant. The lowest yield was noticed (T_4) with application of neem cake which might be due its transient inhibitory effect on soil nitrifying bacteria. Similarly in 100 % RDF (T_1) the direct addition of phosphorus in the form of chemical fertilizers which provide the nutrient to the soil solution in readily available orthophosphate form might have contributed to higher yield. Next to 100% RDF, combination of organic manures ie; farmyard manure, neem cake and vermicompost with bio fertilizers (T_9,T_8&T_{10}) also performed better as compared to other treatments which may be attributed to applied organic matter in the manures which might have led to the formation of coating on the sequioxides, because of which phosphate fixing capacity of the soil might have been reduced in organic manures applied plots. This might have reduced the bounded phosphorous in the soil duly increasing the available nutrient pool of the element in discussion [14]. The reason for comparable better performance in respect of fruit yield with application of organic manures may be attributed to the beneficial effect of organic manures on reduction of potassium fixation capacity of the soil and interaction of organic manures with clay micelles to release potassium ions from the non exchangeable fraction to the available pool [14].

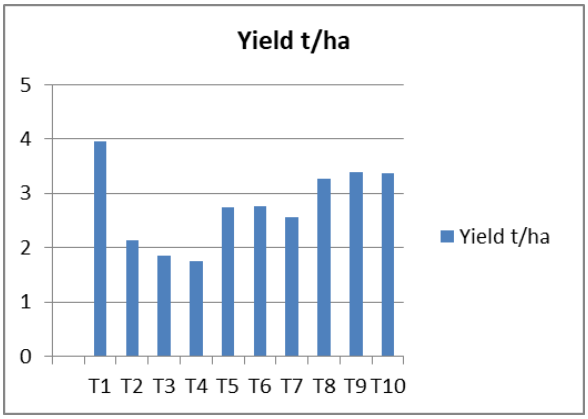

Figure 1 Effect of different Organic Sources of Nutrients on Yield of Sweet orange (*Citrus sinensi*)

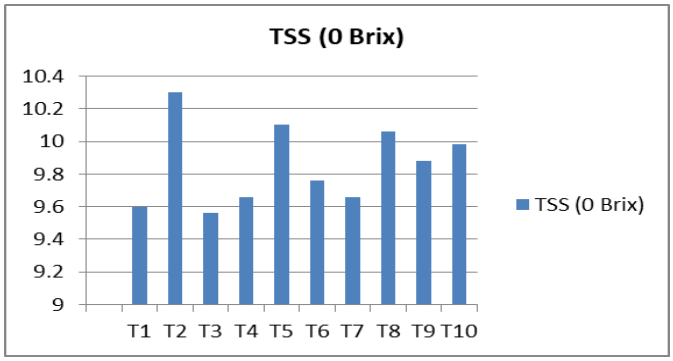

Figure 2 Effect of different Organic Sources of Nutrients on TSS (^{0}Brix) of Sweet orange (*Citrus sinensis*)

Substantial and irrefutable evidence is on record that organic manures in comparison to inorganics are superior and beneficial on four counts [15]. These include: (i) decreased storage losses and high starch content after storage due to low moisture content in organically grown crops; (ii) higher ascorbic acid content, better taste, flavour, resistance to insect pests, and disease in addition to higher biological value of protein; (iii) introduction of beneficial microorganism due to suppression of soil borne plant pathogens by organic amendments; and (iv) build up and stability in soil structure, leading to better air-water relation, and retention and regulation of the supply of nutrients. Shelf life and quality of organic citrus is claimed to be arguably better than in conventionally grown citrus [16]. Similarly, In the above experiment, among organic treatments T_9(FYM@46Kg/plant + Neemcake@22Kg /Plant + *Azospirillum*@200g/ Plant + PSB@200g/ Plant) recorded highest yield of 3.39 t/ha(0.41 B:c ratio). A perusal of the results in this study indicated that the quality in sweet orange in terms of TSS (^{0}Brix) was found to be highest in T_2(10.30) with application of FYM@93kg/plant followed by T_5 (10.10) with application of FYM@93kg/ Plant +

Azospirillum@200g/ Plant + PSB@200g/ Plant (**Figure 2**). Therefore, application of organic manures may lead to improved quality in sweet orange. However, further research is required to arrive at a definite conclusion.

Conclusion

Advent of high density planting, and increased productivity per unit area and time coupled with heavy use of inorganic inputs, necessitated the adoption of organic citrus cultivation as a viable technology. Accordingly, the effect of organic manures and bio fertilizers on fruit yield in sweet orange has been studied. Considering the yield as well as benefit : cost ratio in view among organic treatments, it can be concluded that application of T_9(FYM@46Kg/plant + Neem cake@22Kg/Plant + *Azospirillum* @ 200g/ Plant +PSB@200g/ Plant) recorded highest yield of 3.39 t/ha(0.41 B:c ratio) was found promising and can be recommended for obtaining higher yield among organic treatments.

Thus, under sustainable agriculture the application of organic manures in long run will ensure positive relationship between soil, plant, water, fauna and soil microflora resulting in healthy soil and result in proper energy flow in soil-crop-water environment system and keep biological life cycle alive resulting in sustainable yield in horticultural crops.

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