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Effect of Nutrient Management through Bio Organic Manures on Quality of Acid Lime (*Citrus aurantifolia* Swingle)

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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

Acid lime (*Citrus aurantifolia* Swingle) is one of the commercial fruit crops which occupies important place in the fruit industry, but yield levels of citrus orchards are still very low. Alternate nutrient management system could help in achieving high yield and quality of acid lime. Thus, an investigation was undertaken on the "Effect of nutrient management through bio-organic manures on quality of acid lime (*Citrus aurantifolia* Swingle)" in the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India during 2016 – 2018. The experiment was laid out in randomized block design with twelve treatments, various organic manures, biofertilizers along with inorganic fertilizers including recommended dose of fertilization @ 100%, 75%, 50%, farm yard manure @ 100%, 50%, Vermicompost @ 100%, 50%, Biofertilizers (25g Azotobacter + 25g phosphate solubilising bacteria + 150g vesicular arbuscular mycorrhizal) were applied. The quality characters of acid lime were studied at different stages. The observations recorded viz., plant height (m), canopy spread east-west (m), canopy spread north-south (m), canopy height (m), no. of leaves per canopy, leaf area (cm^2). The results revealed that plants treated with of T_8 -75% RDF + 50% FYM + 50% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) was observed maximum plant height (m), canopy spread east-west (m), canopy spread north-south (m), canopy height (m), no. of leaves per canopy, leaf area (cm^2).

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1. INTRODUCTION

Acid lime (*Citrus aurantifolia* Swingle) is one of the most commercially grown fruit crops which is widely grown in the tropical and sub-tropical region of India. It belongs to the Rutaceae family, with chromosome number 2n=18. It is a profusely branched thorny shrub or small tree. The leaves are small with narrowly winged petioles. The flowers are small, pure white and are borne in clusters. The fruits are more or less round or oval, smooth and have thin rind (papery) attached tightly. Fruit of acid lime possess great medicinal and nutritional value.It is a rich source of Vitamin-C [1]. They are largely used for garnishing and flavouring several vegetarian and non-vegetarian dishes. Besides, its value-added products like pickle, juice and squash, lime peel oil and peel powder etc., are also in great demand in cosmetic industry. Acid lime is good appetizer, anthelmintic and it checks biliousness and stomach ache. Lime is also used in making candy, chocolate, ice cream and pastries. It is the third most important commercial crop among citrus group of fruits in India next to mandarins (*Citrus reticulate* Blanco*)* and sweet oranges (*Citrus sinensis* Osbeck*).* In India, acid lime is grown in a variety of agro-climates comprising the northern plains and central highlands having hot semi-arid eco-region with black and red soils. In view of this, there is an increasing need of alternate nutrient management system which adjusts the plant nutrient supply to an optimum level for sustaining the desired crop productivity. It involves proper combination of organic manures and biofertilizers with inorganic fertilizers suitable to the system of land use and ecological, social and economic conditions. In current days, organically produced fruits having lot of demand because of high shelf life quality traits which necessitates to increase the use of organic manures in combination with inorganic fertilizers which includes farm yard manure and vermicompost produced by farmers themselves using farm wastes resulting in reducing the cost of cultivation and also reducing the environmental pollution to the maximum extent [2].

Vadak *et al.* [3] reported that VAM converts the unavailable nutrient from rhizosphere soil to available forms resulting increased uptake of nutrient. Besides increased nutrient absorbing area of root, so increase in the chemical quality fruits may be due to beneficial and stimulatory effect of nitrogen and other nutrient.

Hence, the integration of organic manures and biofertilizers with inorganic fertilizers has been found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production.

Keeping the above facts in view, an experiment was conducted to study the effect of nutrient management through bio-organic manures on quality of acid lime (*Citrus aurantifolia* Swingle) in the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar with the following objective:

1. To study the effect of organic manures and biofertilizers with inorganic fertilizers on morpho-physical attributes of acid lime.

2. MATERIALS AND METHODS

The studies on " Effect of nutrient management through bio organic manures on quality of acid lime (*Citrus aurantifolia*)'' was carried out in the orchard, Department of Horticulture, Annamalai University, Annamalainagar, Tamil Nadu during 2018. Five years old uniform trees of acid lime (*Citrus aurantifolia* Swingle) were selected for the study. Using randomized block design with twelve treatments and three replications. The quality parameters viz., plant height (m), canopy spread east-west (m), canopy spread north-south (m), canopy height (m), no. of leaves per canopy, leaf area (cm^2).There were twelve treatment solutions which are used to increase growth and yield and the treatment details are T_{1-} Control, T_{2-}100% RDF (400:200:220g NPK/plant), T_{3-} 75% RDF, T_{4-}50% RDF, T_{5-}75% RDF + 100% FYM (20 kg/plant), T_{6-}75% RDF + 100% Vermicompost (10 kg/plant), T_{7-}75% RDF + 50%FYM + 50% Vermicompost, T_{8-} 75% RDF + 50% FYM + 50%Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM), T_{9-} 50% RDF + 100% FYM, T_{10-}50% RDF + 100% Vermicompost, T_{11-}50% RDF + 75%FYM + 75% Vermicompost , T_{12-}50% RDF +75% FYM +75% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB +150g VAM).

3. RESULTS AND DISCUSSION

3.1 Plant Height (m)

A significant differences was observed among the treatments when compared with control (Table 1).The maximum plant height (0.67m) was

recorded in the treatment T_8 - 75 % RDF + 50% FYM + 50% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM). It was followed by the treatment T_{12}-50% RDF + 75% FYM + 75% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) (0.63m) whereas, the minimum plant height (0.28m) was found under control.

Ram *et al.* [4] reported that maximum increases in plant height (0.45 m) and spread (0.34m in E-W & 0.57m in N-S) with the dose of 250 g N, 100 g P_2O_5, 250 g K_2O, 10 kg FYM and 250 g Azotobacter. Number of fruits (1200/tree), yield (150.25 kg/tree) and fruit quality parameters such as TSS (13.5^o Brix) and reducing sugars (3.50%) were also higher with same treatments in 7 years old trees of guava cv. Sardar.

3.2 Canopy Spread East-West (m)

Significant difference was stimulated among all the treatments with the control for this trait (Table 1).The soil placement of 75% RDF + 50% FYM + 50% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) T_8 existed maximum canopy spread in E-W direction (0.76m). It was followed by T_{12}-50% RDF + 75% FYM + 75% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) (0.71m) whereas,the control exhibited minimum canopy spread in E-W direction (0.30m).

Mandal *et al.* [5] found that the highest plant height (323.00cm), were recorded in aonla cv. NA-7 trees supplied with 100:25:150g NPK+10 Kg FYM + 50 g PSB/ plant and highest plant spread (N-S 300.63 cm and plant spread E-W 297.33 cm) under 100: 25:150 g NPK + 50g PSB + 40g Azotobacter/plant and fruit weight (24.80 g), fruit length (3.60 cm) under 100: 25:150 g NPK + 50g PSB plant^{-1}+ 10 kg FYM.

3.3 Canopy Spread North-South (m)

The maximum canopy spread in N-S direction was (0.71m) expressed by the treatment T_8- 75% RDF + 50%FYM + 50% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) which was significantly superior to other treatments. It was followed by T_{12}-50% RDF + 75% FYM + 75% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) (0.66m) whereas, the minimum canopy spread in N-S direction (0.29m) was indicated under control.

kumar *et al.*[6] revealed that the maximum plant height (2.81 m), plant spread (N-S direction) (2.74 m), plant spread (E-W direction) (2.67 m), canopy volume (11.71 m^3), leaf area (59.12 m^2) and total chlorophyll content (2.53 mg 100 g-1 FW) were maximum in guava (*Psidium guajava L.*) cv. Lalit with (T_{10}) Azotobacter @20g + PSB @20g + vermicompost @10 kg + 50% recommended NPK.

3.4 Canopy Volume (m^2)

The maximum canopy volume (84.93m^3) was obtained in the treatment T_8-75% RDF + 50% FYM + 50% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) which was superior to other treatments. It was followed by T_{12}- 50% RDF + 75% FYM + 75% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) (80.61m^3) whereas, the minimum canopy volume (41.27m^3) was registered with control (T_1). Bhandari *et al.* [1] found that the application of 75% RDF + 3 kg vermicompost + 10kg FYM + 150g VAM + 25g Azotobactor (T_{11}) significantly influence the vegetative growth and quality parameters of acid lime. Maximum plant height (3.93 m), canopy spread in E-W direction (4.74 m), canopy spread in N-S direction (4.66 m), canopy volume (75.75 m^3) leaf area (39.61 cm^2), maximum TSS (7.93^{o}Brix), minimum acidity (6.11%), maximum TSS/acid ratio (1.29), ascorbic acid (32.27 mg/100g pulp) and chlorophyll content in leaves (64.40) were recorded with T_{11}. Application of 50% RDF + 7kg vermicompost + 15kg FYM + 150g VAM + 25g Azotobacter (T_{12}) had been found the most appropriate for physical and yield characteristics of the acid lime fruit..

3.5 Number of Leaves Per Canopy

The application of 75% RDF + 50% FYM + 50% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) T_8 reported maximum leaves per canopy (33.89). It was followed by T_{12}- 50% RDF + 75% FYM + 75% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) (31.80) whereas, control resulted the minimum number of leaves per canopy (17.06).

verma *et al.*[7] registered that the application of 50% vermincompost+50% recommended dose of fertilizers (T_6) was better for improvement of plant height (34.55 cm), stem diameter (8.4 cm), number of leaves per plant (49.5), number of branches per plant (13.5), leaf length (8.7 cm) and leaf width (6.5 cm).

Table 1. Effect of nutrient management through bio organic manures on quality of acid lime

Treatment Details	Plant height (m)	Canopy Spread E-W (m)	Canopy Spread N-S (m)	Canopy height (m)	No. of leaves per canopy
T_1 Control	0.28	0.30	0.29	0.25	17.06
T_2 100% RDF (400:200:220 NPK g /plant)	0.39	0.45	0.41	0.36	21.38
T_3 75% RDF	0.36	0.40	0.37	0.33	19.99
T_4 50% RDF	0.32	0.34	0.33	0.29	18.51
T_5 75% RDF + 100% FYM (20kg/plant)	0.47	0.56	0.51	0.45	25.40
T_6 75% RDF + 100% Vermicompost (10kg/plant)	0.51	0.60	0.55	0.49	27.12
T_7 75% RDF + 50% FYM + 50% Vermicompost	0.61	0.69	0.64	0.58	30.54
T_8 75% RDF + 50% FYM + 50% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM)	0.67	0.76	0.71	0.64	33.89
T_9 50% RDF + 100% FYM	0.42	0.49	0.45	0.40	22.80
T_{10} 50% RDF + 100% Vermicompost	0.45	0.53	0.49	0.43	24.27
T_{11} 50% RDF + 75% FYM + 75%Vermicompost	0.56	0.64	0.60	0.53	28.76
T_{12} 50% RDF + 75% FYM + 75% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM)	0.63	0.71	0.66	0.60	31.80
S.Ed	0.012	0.017	0.17	0.013	0.64
CD(P=0.05)	0.026	0.035	0.032	0.028	1.31

RDF: Recommended dose of fertilization; FYM: Farm yard manure; PSB: Phosphate solubilising bacteria; VAM: Vesicular Arbuscular Mycorrhizal

4. CONCLUSION

In this study T_8 (75% RDF + 50% FYM + 50% Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM) treatment combination had the maximum plant height (m), canopy spread east-west (m), canopy spread north-south (m), canopy height (m), and no. of leaves per canopy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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