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INFLUENCE OF NUTRIENT MANAGEMENT THROUGH BIO-ORGANIC MANURES ON BIO-CHEMICAL ATTRIBUTES OF ACID LIME (*CITRUS AURANTIFOLIA* SWINGLE)

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Abstract

An investigation was undertaken on the "Influence of nutrient management through bio-organic manures on Bio-Chemical Attributes 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 conducted with organic manures and biofertilizers along with inorganic fertilizers which were applied with different treatment combinations *viz.*, T_1 – Control, T_2- 100% RDF (400 : 200 : 220g/plant), T_3 - 75% RDF, T_4 - 50% RDF, T_5 - 75% RDF + 100% FYM (20kg/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). There were twelve treatments replicated thrice in Randomized block design (RBD). Application of inorganic fertilizers along with organic manures and biofertilizers significantly improved the bio-chemical characters of the fruit. The maximum TSS (7.99 ^{o}Brix), acidity (6.09 %), TSS : acidity (1.42), reducing sugar (0.98%), non-reducing sugar (1.08 %), ascorbic acid content (35.41 mg/100 ml juice) and chlorophyll content (81.61) were recorded in the application of T_{12} - 50% RDF + 75% FYM + 75 % Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM). The least values were obtained under control due to lack of nutrients supply.

Key words : Nutrient management, Bio-Chemical attributes, *Citrus aurantifolia* Swingle

Introduction

Acid lime (*Citrus aurantifolia* Swingle) is an important fruit crop in citrus group which belongs to the family Rutaceae. It occupies a vital place in the fruit industry, but yield level of citrus orchards is still very low. There are several factors responsible for low yield in acid lime and among these the inadequate supply of inorganic fertilizers and organic manures are the major one. Being a high yielding perennial crop, the nutritional requirements of lime is quite high (Banker *et al.,* 2009) but the prices of inorganic fertilizers are ever increasing which forced the farmers to look for the alternative low cost input technology. It was observed that nutrients applied at higher doses without organic manures where less effective in improving the fruit production but more effective when applied with organic manures. Apart from this, the use of biofertilizers to maintain and improve the soil quality and productivity levels are at low input costs. Hence, the concept of alternate nutrient management system came into picture which lays emphasis on continuous improvement in soil productivity on long term basis through appropriate use of organic manures and biofertilizers with inorganic fertilizers for optimum growth and development of acid lime fruits in reference to particular agro ecological situations. The present investigation was carried out to assess the efficacy of organic manure (Farm yard manure and vermicompost) and biofertilizers (Azotobacter, Phosphate Solubilizing Bacteria and Vesicular Arbuscular Mycorrhizae) with inorganic fertilizers on bio chemical characters of acid lime.

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Materials and methods

The experiment was conducted in the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India during 2016 - 2018. The treatment consisted with organic manures and biofertilizers along with inorganic fertilizers which were applied with different treatment combinations viz., T_1 – Control, T_2-100% RDF (400 : 200 : 220g/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). There were twelve treatments replicated thrice in Randomized block design (RBD). The observations were recorded on bio chemical parameters *viz*., The maximum TSS (^{o}Brix), acidity (%), TSS: acidity, reducing sugar (%), non-reducing sugar (%), ascorbic acid content (mg/100ml juice) and chlorophyll content. The data generated through this investigation was analyzed by the statistical method of Panse and Sukhatme (1985).

Results and Discussion

Application of inorganic fertilizers along with organic manures and biofertilizers significantly improved the bio-chemical characters of the fruit. The maximum TSS (7.99 ^{o}Brix), acidity (6.09%), TSS : acidity (1.42), reducing sugar (0.98%), non-reducing sugar (1.08%), ascorbic acid content (35.41 mg/100ml juice) and chlorophyll content (81.61) were recorded in the application of T_{12} - 50% RDF + 75% FYM + 75 % Vermicompost + Biofertilizers (25g Azotobacter + 25g PSB + 150g VAM). The least value were obtained under control due to lack of nutrients supply.

The improvement in various biochemical characteristics by application of optimum dose of NPK may be explained by the fact that phosphorus enters into the composition of phospholipids and nucleic acids, the latter combines with proteins and result in the formation of nucleo-proteins which are important constituents of the nuclei of the cells. Potassium acts as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity. These carbohydrates and coenzymes are beneficial in the improvement of fruit quality and nitrogen enhances the uptake of phosphorus and potassium. The chain reactions in these components and beneficial effect of worms which is brought about by mucoses deposit of epidermal cells and coelomic fluids of earthworms, rich in plant growth substances and through rapid mineralization and transformation of plant nutrients in soil and also through the exertion of plant promoting substances, vitamins and amino acid content produced by microorganism of biofertilizers might have possibly been reason of the improvement in quality of the fruit. Similar findings were also reported by Sharma *et al*., (2008) in ber, Yadav *et al*., (2011) in mango and Binepal *et al.,* (2013) in guava.

The higher ascorbic acid content with increased N application in form of organic and inorganic nutrient sources might be due to the catalytic activity of several enzymes, which participate in biosynthesis of ascorbic acid and its precursor. These results are in line with the findings of Ingle *et al.,* (2001) in acid lime and Savreet Khehra and Bal (2014) in lemon.

Whereas FYM increased TSS and total sugars due to gradual supply of nutrients and organic manures throughout the growth period which increased the metabolites in improvement in soil moisture availability, soil pH, organic carbon and nutrient status of the soil and decrease acidity of fruits may be attributed to their conversion into sugars and their derivatives by the reactions involving reversal of glycolytic pathway or might be used in respiration or both. Similar findings were also reported by Verma and Chauhan (2012) in apple, Katiyar *et al.,* (2012) in ber and Dwivedi (2013) in guava.

Increase in fruit quality under application of vermicompost treatment may be due to beneficial effect of worms which is brought about by mucoses deposit of epidermal cells and coelomic fluids of earthworms, rich in plant growth substances. Improvement in fruit quality by continuous supply of nutrients, higher concentration of soil enzymes, soil microorganism, more friable and porous soils made by vermicompost may be attributed to better vegetative growth of the treated plants and which resulted in higher quantities of photosynthates (starch, carbohydrates, etc.) and the translocation to the fruits, thus increasing the various contents of fruit hence quality improvement reflected in fruit chemical character. Similar findings were also reported by Khan and Hameedunnisa (2007) in acid lime, Yadav *et al*., (2011) in mango, Singh *et al*., (2012) in aonla and Ghosh *et al.,* (2012) in pomegranate 98.

Azotobacter and PSB inoculation resulted in overall increase in plant growth, fruit yield and quality which can be explained in a way that *Azotobacter* and PSB contribute up to 20-30% N and 25-50% P_2O_5 in soil

Table 1: Effect of nutrient management through bio-organic manures on bio-chemical attributes of Acid lime (*Citrus aurantifolia* Swingle).

Tr. No.	TSS (°Brix)	Acidity (%)	TSS:Acid ratio	Reducing sugar(%)	Non- reducing sugar(%)	Ascorbic acid content(mg/100mljuice)	Chlorophy llcontent
T_1	6.63	7.18	0.97	0.43	0.25	22.58	42.02
T_2	7.04	6.89	1.09	0.58	0.49	25.70	52.15
T_3	6.92	6.99	1.05	0.53	0.41	24.56	48.37
T_4	6.77	7.09	1.01	0.48	0.33	23.54	45.04
T_5	7.33	6.66	1.18	0.70	0.67	28.25	60.01
T_6	7.50	6.52	1.24	0.78	0.79	30.35	66.46
T_7	7.63	6.39	1.29	0.84	0.88	31.76	70.75
T_8	7.82	6.23	1.36	0.92	0.99	33.89	77.23
T_9	7.17	6.77	1.14	0.64	0.58	27.03	56.20
T_{10}	7.39	6.63	1.20	0.72	0.69	29.06	62.54
T_{11}	7.77	6.27	1.34	0.90	0.97	33.14	74.91
T_{12}	7.99	6.09	1.42	0.98	1.08	35.41	81.61
S.Ed	0.05	0.03	0.01	0.02	0.04	0.43	1.32
CD(P=0.05)	0.08	0.06	0.03	0.05	0.09	0.89	2.67

Treatment Details: T_1 – Control, T_2-100% RDF (400:200:220 g/ 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).

respectively. Acid lime responds well to the application of manures and fertilizers, hence biofertilizers application improved plant growth, fruit yield and chemical composition through rapid mineralization and transformation of plant nutrients in soil and also through the exertion of plant growth promoting substances mainly IAA, gibberellic acid and cytokine in like substances, vitamins and amino acid by microorganism. These results are in accordance with the findings of Ram *et al*., (2007) in guava, Singh *et al*., (2008) in aonla and Rubee Lata *et al*., (2011) in guava.

The decrease in acidity of fruits may be attributed to their conversion into sugars and their derivatives by the reactions involving reversal of glycolytic pathway or might be used in respiration or both. An increase in TSS and total sugars contents with Azotobacter and vermicompost application may be attributed due to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits, conversion of complex polysaccharides into simple sugars. These findings are in agreement with the result of Athani *et al.,* (2009) in guava and Bohane *et al*., (2016) in ber.

Application of nitrogen fixing bacteria with lower dose of inorganic fertilizers might have exhibited regulatory role on the absorption and translocation of various metabolites, in which carbohydrates are most important which affects the quality of fruits. During ripening of fruits the carbohydrates reserves of the root and stem are drawn upon heavily and hydrolyzed into sugars hence results in better fruit quality. The results are in accordance with Ram *et al*., (2007) in guava, and Baviskar *et al.,* (2011) in sapota.

Sah *et al.,* (2009) in pear and Vadak *et al.,* (2014) in sweet orange 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 biochemical quality of fruits may be due to beneficial and stimulatory effect of nitrogen and other nutrient.

Application of nutrients along with VAM inoculation resulted in an overall increase in plant growth, fruit yield and fruit quality which reasonably can be explained from the fact that VAM contribute upto 20-30% N and 25-50% P_2O_5 respectively (Mohandas, 1996) in banana. Inoculation of VAM along with nutrients also proved effective in increasing the total soluble solid, total sugar and ascorbic acid content of fruits while acid content declined through the inoculation of bio-fertilizers. These results are in accordance with the findings of Shukla *et al*., (2009) in guava and Bohane and Tiwari (2014) in ber.

Summary

Thus, it could be seen that the application of organic manures at the rate of 15kg FYM + 7.5 kg Vermicompost

and Biofertilizers at the rate of 25g Azotobacter + 25g PSB + 150g VAM can reduce the inorganic fertilizations to at extent of 50 percent (200g nitrogen, 100g phosphorus and 110g potassium per tree) increasing the bio chemical parameters of acid lime. This may be due to proper absorption and production of various energy sources like starch, sucrose, protein, amino acids and amino sugars etc., and the improvement of soil structure, root penetration and root proliferation, moisture retention and water uptake efficiency stimulates various physiological and metabolic processes.

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