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Effect of Integrated Nutrient Management Practices on Soil Biological Properties in Acid Lime (*Citrus aurentifolia* Swingle) Orchard

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A B S T R A C T

The present investigation deals with the effect of integrated nutrient management practices on soil biological properties in an established orchard of acid lime (*Citrus aurentifolia* Swingle). The experiment was undertaken with eleven treatments (T) including a control in randomized block design at PDKV, Akola, Maharastra during two growing seasons of 2010-11 and 2011-12. The observations were recorded for different soil biological properties such as, soil microbial count, soil microbial biomass carbon, dehydrogenase activity, CO_2 evolution, Organic carbon. Among the treatments, 'T_8' (75% RDF (450:225:225g NPK) + 50Kg FYM+ 500 g AM/Plant + 100g PSB /Plant+200g $ZnSO_4$/plant) followed by treatment 'T_{10}' (75% RDF (450:225:225g NPK) + 50Kg FYM+100g *Azospirillum* + 100g PSB /Plant+200g $ZnSO_4$/plant) showed significant variation as compared to other treatments studied. So, treatments T_8 and T_{10} are recommended to be followed in acid lime cultivation for better growth and development.

Introduction

Acid lime (*Citrus aurentifolia* Swingle) is originated in India and belongs to family *Rutaceae*. It contributed to more than 11 percent of world fruit production and ranks second in world with an annual production of 63.83 million tons from an area of 8.46 million ha (Anonymous, 2011). Citrus is considered as a highly nutrient-responsive perennial fruit crop (Srivastava, 2008). A wide gap still exists between domestic demand and supply for fruits and this gap can be bridged by increasing productivity at least equal to the extent possible through area expansion. India's fruit requirement for 2025 is estimated to be 120 MT (Tiwari, 2015). These production and productivity targets will be achieved through modern intensive horticulture practices and use of most recent technologies, including nutrient management. Conventional methods of fertilization although helped in improving the fruit quality but continuous fertilization, has failed to sustain the same yield on a long-term basis due to depletion of soil carbon stock and consequently emerged multiple nutrient deficiencies, would be further triggered through changes in microbial communities and activities within the rhizosphere (Patel *et al.,* 2009). Such changes will adversely affect the orchard's productive life in the long run. Integrated nutrient management is a holistic approach which maintains the soil fertility and nutrient supply to an optimum level for sustaining the desired crop productivity (Chundawat, 2001).

Integrated use of nutrient supplements *viz.*, organic, inorganic, biofertilizers and micronutrient holds a good potential to overcome most of soil physical, chemical and biological constraints (Patel et. al. 2009). Organic manure applied to soil, improve the soil physical properties and add important nutrients to the soil increase the availability and its ultimate absorption by plant. Biofertilizer like *Azospirillum, VAM* and *PSB* fix major nutrients in soil. The application organic manure and biofertilizers help in better utilization of added inorganic fertilizers and reduce its application level as well as the deleterious effect of harsh chemical fertilizers use **(**Dheware and Waghmare, 2009). Keeping in view the present investigation was carried out to testify the effect of integrated nutrient management practices on soil biological properties in an established acid lime orchard.

Materials and Methods

The experiment conducted in a 10 years old established orchard of acid lime cv. PDKV lime situated at Shivar Block, Central Research Station, Akola, Maharastra. The experiment consisted of eleven treatments including a control with three replications (Table 1). One plant from each treatment was selected, marked and kept under continuous observation for two years during 2010-11 and 2011-12. The data was recorded on a number of soil biological properties such as soil microbial count, soil microbial biomass carbon, Dehydrogenase activity, CO_2 evolution and organic carbon. Soil microbial biomass carbon was determined by chloroform fumigation method as described by Jenkison and Powlson (1976), dehydroginase activity by Klein *et al.*, (1971) and CO_2 evaluation of soil determined by alkali trap method of Anderson (1982). Organic carbon calculated by using method suggested by Walkely and Black (Nelson and Sommer, 1982). Serial dilution plate technique was used for counting and isolation of soil microbial populations. Statistical analysis was done as per Panse and Sukhatme (1967).

Results and Discussion

Microbial population in soil *rhizosphere* improved after application of different treatments (Table 1). During first season (2010-11), the highest soil fungi microbes was recorded in treatment T_8 which at par with T_5 while, in second season (2011-12) soil fungi microbes was recorded highest in T_7 which at par with T_8, and $T_{4.}$ In case of soil bacterial microbes the maximum population was recorded in T_{10} which at par with $T_{9.}$ The highest soil actinomycetes were recorded in same treatment i.e., T_8 in both the seasons which at par with T_9, T_{10} and T_7. These results are in accordance with the findings of Srivastava *et al.,* (2008) in citrus, Dutta *et al.*, (2010) in litchi, Marathe *et al.,* (2012) in sweet orange, Majhi and Rout (2016) in rice. Dehydrogenase activity was recorded highest in T_{10} in first season (2010-11) which at par with T_9, T_7, T_6 and T_5 respectively, but during second season (2011-12), maximum dehydrogenase activity was noted in T_8 at par with T_7, T_{10}, and T_9 (Table 2). Similarly, the maximum soil microbial biomass carbon was recorded in treatment T_8 and average with T_{10}, T_9, and T7 respectively, in first and second season of experiment. Whereas, CO_2 evolution influenced by integrated nutrient management showed significant variation among different treatments studied.

Table.1 Effect of integrated nutrient management on soil microbial population in acid lime

Treatment	Microbial population (cfu g^{-1})					
	Fungi		Bacteria		Actinomycetes	
	(2010-11)	(2011-12)	(2010-11)	(2011-12)	(2010-11)	(2011-12)
T_1 RDF (600gN+300g P +300g K+50 kg FYM/Plant)	5.24	5.33	20.16	20.45	12.46	**12.24**
T_2 (T_1+200g.ZnSo4/Plant)	6.73	7.30	20.25	20.52	13.33	**13.28**
T_3 (75%RDF +50kg FYM+ 500g AM/ Plant)	7.19	8.23	21.17	21.48	14.11	**14.44**
T_4 (T_3+200g $ZnSo_4$/Plant)	8.63	8.33	20.88	21.43	11.87	**14.59**
T_5 (T_3)+50kg FYM+100gm Azospirillum	8.70	7.90	22.43	22.63	13.55	**14.15**
T_6 (T_5 +200g $ZnSo_4$/Plant)	6.45	7.96	22.63	22.89	14.19	**13.43**
T_7 (T_3+ 100g PSB/Plant)	8.45	9.10	23.05	24.16	15.40	**15.62**
T_8 (T7+ 200g $ZnSo_4$/Plant)	8.92	9.07	24.25	24.41	16.21	**16.33**
T_9 (T5+100g PSB/Plant)	8.05	8.49	25.32	25.50	15.47	**15.07**
T_{10} (T9+200g $ZnSo_4$/Plant)	8.03	8.68	26.10	26.37	15.46	**15.52**
T_{11} (Control)	3.18	3.57	12.15	12.24	10.36	**10.92**
SEm $\pm$	0.22	0.31	0.72	0.68	0.49	**0.57**
CD at 5 %	**0.66**	**0.93**	**2.13**	**2.01**	**1.46**	**1.67**

Table.2 Effect of integrated nutrient management on dehydrogenize activities, soil microbial biomass carbon, CO_2 evolution and organic carbon in acid lime

Treatment	Dehydrogenize Activity (µgTPFg^{-1}24^{-1}hr)		Soil microbial biomass carbon(µg 100 g^{-1} soil)		CO_2 Evolution (mg 100 g^{-1} soil)		Organic carbon (%)	
	(2010-11)	(2011-12)	(2010-11)	(2011-12)	(2010-11)	(2011-12)	(2010-11)	(2011-12)
T_1 RDF (600gN+300gP +300g K+50 kg FYM/Plant)	62.97	61.96	149.67	154.00	72.03	66.77	0.42	**0.45**
T_2 (T_1+200g ZnSo4/Plant)	64.62	63.85	162.33	166.00	72.88	69.36	0.44	**0.47**
T_3 (75% RDF +50kg FYM+ 500g AM/ Plant)	65.17	62.77	176.67	180.00	73.67	72.38	0.46	**0.47**
T_4 (T_3+200g $ZnSo_4$/Plant)	68.11	64.25	172.00	180.00	73.59	71.44	0.44	**0.46**
T_5 (T_3)+50kg FYM+100gm Azospirillum	65.99	66.25	181.33	179.00	73.65	71.13	0.45	**0.47**
T_6 (T_5 +200g $ZnSo_4$/Plant)	66.87	67.66	178.67	178.33	71.33	71.11	0.46	**0.47**
T_7 (T_3+ 100g PSB/Plant)	69.81	72.58	185.67	183.33	76.29	74.11	0.50	**0.53**
T_8 (T7+ 200g $ZnSo_4$/Plant)	74.63	75.03	196.67	193.67	77.14	81.08	0.56	**0.58**
T_9 (T5+100g PSB/Plant)	75.33	71.22	190.67	191.67	76.55	81.40	0.51	**0.54**
T_{10} (T9+200g $ZnSo_4$/Plant)	78.21	72.25	192.67	193.00	76.77	76.01	0.54	**0.57**
T_{11} (Control)	33.54	30.96	115.00	118.00	51.88	49.17	0.32	**0.32**
SEm $\pm$	4.34	2.04	4.78	3.66	2.41	2.28	0.012	**0.009**
CD at 5%	**12.82**	**5.99**	**14.12**	**10.73**	**7.30**	**6.70**	**0.038**	**0.026**

T_8 recorded maximum CO_2 evolution during first season equality with all treatments, while, in second season in T_9 at par with T_8 and T_{10}. In both the seasons, minimum data was recorded on all the studied parameters in T_{11} (control). Similar effect was also observed by Aseri *et al.,* (2008) in pomegranate, Patel *et al.,* (2009) in sweet orange, Suresh and Ghosal (2013) in soyabean. The maximum organic carbon was noted in T_8 during first and second season of experiment which, at par with T_{10} during both season of experiment. Increasing organic carbon due to application of organic manures and inorganic fertilizers along with biofertilizers recorded higher organic carbon content in Sweet orange (Patel *et al.,* 2009). Regarding this experiment of all parameters results showed significant variations under different treatments in both the seasons. So, treatments T_8 and T_{10} are recommended to be followed in acid lime cultivation for better growth and development. However, the finding of this investigation needs to be further confirmed by long term studies for sustainable fruit production in *Citrus* species.

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