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Effect of fertilization with fortified cow dung slurry on soil biological properties in mandarin (*Citrus reticulata* Blanco.) orchard

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Abstract

The present experiment was carried out during 2015-16 and 2016-17 at All India Coordinated Research Project (Fruits), Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the effect of fertilization with different fortified cow dung slurry on soil biological properties. The experiment was undertaken with ten treatments (T) including a control replicated trice in randomized block design. 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_7 (Fermented cow dung slurry @ 60 L plant^{-1} + 100% RDF *i.e.* 1200:400:400 g NPK plant^{-1}) followed by treatment T_8 (Fermented cow dung slurry @ 60 L plant^{-1} + 75% RDF *i.e.* 900:300:300 g NPK plant^{-1}) showed significant variation as compared to other treatments.

Keywords: Nagpur mandarin, slurry, soil biological properties

Introduction

Citrus is one of the leading tree fruit crop in the world. China ranks first in citrus production followed by Brazil and India (Anon., 2017) [2]. In India, the important citrus fruits grown are mandarin, sweet orange and acid lime sharing 37 per cent, 27 per cent and 22 per cent, respectively of total citrus fruit production in the country. Mandarin (*Citrus reticulata* Blanco.) is highly polyembryonic species of Chinese origin, having medium size upright trees, lanceolate shaped leaves with narrowly-winged petiole. Fruits medium sized, globose, sweet in taste, segments easily separable, usually 10-14 segments in each fruit, seeds pointed with light green cotyledon (Bose and Mitra, 1990) [3]. Cultivation of Nagpur mandarin is mostly concentrated in Amravati, Nagpur, Wardha, Yeotmal, Akola and Buldhana districts of Vidarbha region over an area of about 80,000 hectares with five lakh tons production (Kasabe Nanda, 2015) [6].

The production as well as quality of mandarin is deteriorating day-by-day because most of the soil is not fertile, it has low carbon and nitrogen contents which are essential for growth and development of plant. The black soils of Vidarbha region which support most of the citrus cultivation are poor in organic matter and physical conditions specially drainage (Marathe *et al.*, 1999) [11] with sub-optimum levels of N and Zn (Malewar, 1986; Kohli *et al.*, 1996) [10, 8].

To ensure maximum productivity and quality of fruits, it is essential to enrich the soil fertility by using integrated approach of inorganic fertilizers with different bio-organics such as cow dung slurries, organic manures and biofertilizers *viz*., *Azotobacter*, PSB, *Azospirilum*, VAM etc. New strategy of fertilization depends on using recycled animal waste to produce different form of slurries for enhancing biological cycles, improving soil fertility, and avoiding all forms of pollution that may result from conventional agricultural techniques.

Cow dung slurry contains organic nitrogen (mainly amino acids), abundant mineral elements and low-molecular-mass bioactive substances such as hormones, humic acids, vitamins, etc. (Liu *et al*., 2008) [9]. Biogas slurry is a by-product obtained from the biogas plant after the digestion of dung or other biomass for generation of biogas. It contains appreciable amounts of organic matter (20 to 30%). It has been reported by many researcher that the use of biogas slurry as manure improves soil fertility and increases crop yield. The fermented slurry which contains relatively high percentage of readily available nutrients and huge quantity of microbial load can be directly applied in liquid form to the plants both for basal and topdressing.

The application of 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) [4]. Thus, the present experiment was undertaken for sustainable quality production of mandarin by combined use of cow dung slurry, chemical fertilizers and biofertilizers in mandarin orchard.

Materials and Methods

The experiment was conducted at All India Coordinated Research Project (Fruits), Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2015-16 and 2016-17. The experiment was conducted in RBD with three replications. There were ten treatments (Table no.1) were applied in six split doses except control in which half dose of nitrogen and full dose of phosphorus, potassium and full doses of biofertilizers were applied in June and remaining half doses of nitrogen was applied at fruit set stage. 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 Jenkinson and Powlson (1976) [5], dehydrogenase activity by Klein *et al.*, (1971) [7] and CO_2 evaluation of soil determined by alkali trap method of Anderson (1982) [1]. Organic carbon calculated by using method suggested by Walkely and Black (Nelson and Sommer, 1982) [12]. 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). The highest population of fungi in soil was recorded in treatment T_7 during both seasons. Treatment T_7 was at par with treatment T_8, T_{10}, T_9, T_3, T_6 and T_5 during first season while during second season T_7 was at par with T_{10}, T_9, T_8, T_3, T_6 and T_5. In case of soil bacterial microbes the maximum bacterial population was recorded in treatment T_7 which was at par with treatment T_8, T_9 and T_{10} during first and second season of experiment. The highest soil actinomycetes were recorded in same treatment i.e., T_7 in both the seasons which was found at par with T_8, T_6 and T_9 during first and second season. These results are in accordance with the findings of Parham *et al.* (2003), Kumar *et al.* (2010), Nakhro and Dkhar (2010), Upadhyay *et al.* (2011), Mali *et al.* (2015), Srivastava *et al.* (2015), Hulemale (2016) and Deshmukh *et al.* (2018).

The treatment T_7 had maximum soil microbial biomass carbon during first and second season, which was found at par with treatments T_8, T_9, T_6, T_3 and T_5 during first season while during second season the treatment T_7 was found at par with T_8, T_3, T_9, T_5, T_6, T_2 and T_{10}. Similarly, treatment T_7 had maximum CO_2 evolution during first and second season of experimentation, which was found at par with treatments T_8 and T_9 during first season and with Treatment T_8 during second season. The same treatment i.e. T_7 had highest dehydrogenase activity during first and second season. During first season treatment T_7 was found at par with treatments T_{10}, T_9 and T_8 and during second season treatment T_7 was found at par with T_{10}, T_8, T_9, T_5, T_6 and T_2. These results are similar with the findings of Goyal *et al.* (1999), Joa *et al.* (2010), Chakraborty *et al.* (2011), Adak *et al.* (2014), Srivastava *et al.* (2015), Hulemale (2016), Mohapatra Amrita *et al.* (2016) and Deshmukh *et al.* (2018).

The maximum organic carbon was noted in T_8 during first season of experiment which was at par with treatments T_7 and T_9 whereas during second season of experiment, the maximum organic carbon was recorded in treatment T_7 which was at par with treatment T_8. Similar findings were also reported by Badole and More (2000), Fu-chu *et al.* (2014), Adak *et al.* (2014) and Mohapatra Amrita *et al.* (2016). Regarding this experiment of all parameters results showed significant variations under different treatments in both the seasons. So, it is concluded that higher soil biological activity were found with the application of fermented cow dung slurry @ 60 L plant^{-1} + 100 per cent RDF (1200:400:400 g NPK plant^{-1}). However, the finding of this investigation needs to be further confirmed by long term studies for sustainable and remunerative quality fruit production of Nagpur mandarin.

Table 1: Effect of fertilization with fortified cow dung slurry on soil microbial population

Treatment	Fungi (10^4 cfu g^{-1})		Bacteria (10^6 cfu g^{-1})		Actinomycetes (10^4 cfu g^{-1})	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1- Fresh cow dung slurry (60 L plant^{-1}) + 100% RDF (1200:400:400 g NPK plant^{-1})	7.33	8.00	20.67	21.33	12.33	13.00
T_2- Fresh cow dung slurry (60 L plant^{-1}) + 75% RDF (900:300:300 g NPK plant^{-1})	8.33	9.67	21.33	22.67	12.67	13.67
T_3- Fresh cow dung slurry (120 L plant^{-1}) + Azotobacter (100 g) + Phosphate Solubilizing Bacteria (100 g)	12.67	13.67	26.33	27.00	14.00	15.33
T_4- Biogas slurry (60 L plant^{-1}) + 100% RDF	8.00	10.33	21.00	23.67	13.33	13.33
T_5- Biogas slurry (60 L plant^{-1}) + 75% RDF	11.00	12.33	19.67	22.00	13.00	14.33
T_6- Biogas slurry (120 L plant^{-1}) + Azotobacter (100 g) + Phosphate Solubilizing Bacteria (100 g)	11.33	12.67	22.67	25.33	15.67	17.00
T_7- Fermented cow dung slurry (60 L plant^{-1}) + 100% RDF	13.67	14.67	29.67	32.33	17.00	17.33
T_8- Fermented cow dung slurry (60 L plant^{-1}) + 75% RDF	13.33	14.00	28.00	31.33	16.33	16.67
T_9- Fermented cow dung slurry (120 L plant^{-1}) + Azotobacter (100 g) + Phosphate Solubilizing Bacteria (100 g)	13.00	14.00	27.67	29.33	15.33	16.33
T_{10}- 900:300:300 g NPK + Azospirillum (100 g) + Phosphate Solubilizing Bacteria (100 g) + VAM (500 g) + Trichoderma (100 g) (control)	13.33	14.33	27.33	29.33	13.33	14.67
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) $\pm$	1.09	1.01	0.80	1.72	0.68	0.48
CD at 5%	3.27	3.03	2.39	5.14	2.05	1.44

Table 2: Effect of fertilization with fortified cow dung slurry on soil microbial biomass carbon, CO_2 evolution, dehydrogenase activity and soil organic carbon

Treatment	Soil microbial biomass carbon ($\mu g\ g^{-1}$soil)		CO_2 evolution (mg $100g^{-1}$)		Dehydrogenase activity (μg TPF g^{-1} $24hr^{-1}$)		Soil organic carbon (%)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1	160.39	168.88	58.00	59.00	64.91	65.45	0.76	0.81
T_2	163.33	171.67	58.33	59.00	65.05	66.87	0.75	0.77
T_3	167.35	175.28	58.67	59.50	63.66	63.24	0.67	0.69
T_4	156.43	162.33	57.33	58.67	65.15	66.37	0.81	0.96
T_5	165.41	174.43	58.67	59.33	66.60	67.89	0.72	0.81
T_6	168.16	174.15	59.00	59.33	67.32	67.85	0.67	0.69
T_7	175.64	178.69	63.00	66.67	71.43	70.85	0.94	1.19
T_8	175.01	177.63	62.00	62.67	67.58	70.11	0.98	1.12
T_9	169.03	175.03	59.83	59.67	67.64	69.48	0.85	0.94
T_{10}	165.18	170.22	59.00	59.00	68.93	70.58	0.63	0.75
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) $\pm$	3.51	2.91	1.08	1.56	1.32	1.34	0.05	0.03
CD at 5%	10.51	8.73	3.25	4.66	3.95	4.01	0.15	0.08

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