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Response of soil fertility with cropping system under different plantation of trees

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Abstract

The study was carried out at 30 years old plantation of tree species which followed with cropping system viz. Casuarina + Guava + Turmeric, Casuarina + Paddy + Wheat, Shisham, Shisham + Pergrass, Shisham + Mustard, Shisham + Paddy + Wheat and Eucalyptus). The influence of cropping system and plantation of tree species was evaluated the fertility level of soil at 0-15 cm depth. The samples were analyzed which resulted that the accumulation of available nutrients and microbial counts were higher under plantation of trees than control. The available macronutrient (Nitrogen, Phosphorus and Potassium), micronutrient (Zinc, Iron, Copper and manganese) and Microbial count (Bacteria, Fungi and Actinomycetes) were higher under Casuarina + Guava + Turmeric in surface layer) than other tree species. Therefore, the tree plantations and cropping system improved the nutrient availability and microbial counts in the soil.

Keywords: Macro-micronutrients content, microbial counts, cropping system, tree species

Introduction

Soil is a vital natural resource on which supporting life system and socio economic development depends. In India the land resources available for agriculture are shrinking our aim of optimizing the utilization of land resources with intensification of agriculture resulted either in the fast depletion of nutrients or occasionally in their accumulation. Agro forestry systems are generally perceived to be sustainable and to enhance soil properties. Growing trees in conjunction with annual crops is believed to provide a more thorough plant cover to protect the soil from erosion and a deeper or more prolific root system to enhance nutrient cycling. The available land area under cultivation for Agriculture productions are decreasing continuously due to the increasing population and acquisition of fertile land. The tree plantations influence the soil physical, chemical and biological properties through litter fall addition and root turnover. It is therefore important to monitor the fertility status of soil from time to time with a view to monitor the litter fall and decaying of roots which affect the soil health for long time can improve the physico-chemical properties of soil. A considerable amount of organic matter which returned the nutrients to soil through litter fall and root decay. Incorporation of nutrients to soil varies with plantation of tree species and cropping system. Trees can capture nutrients below the rooting zone of crops because of their deep root system and transfer them to surface soil. The effects of organic matter accumulation are higher on surface than subsurface horizons. Therefore, the study was conducted to evaluate the response of plantations of trees and cropping system maintaining the nutrients status and microbial diversity.

Materials and Methods

The investigation was carried out to evaluate the response of plantations of tree species and cropping system of agro forestry farms of Acharya Narendra Deva University Agriculture and Technology, Kumarganj, Ayodhya (U.P.), during the year 2019-2020. The site is located at a distance of 42 kms from Ayodhya city on Ayodhya - Raibareli road. Experimental site falls under subtropical climate in Indo-Gangetic plains having alluvial calcareous soil and lies between 26°33'N latitude and 81°50'E longitude with an elevation of about 113.0 meters from the mean sea level. Soil sample collected from eight plot of plantations of tree species viz. Casuarina + Guava + Turmeric, Casuarina + Paddy + Wheat, Shisham, Shisham + Pergrass, Shisham + Mustard, Shisham + Paddy + Wheat and Eucalyptus). The control plot was considered as the properties of soil before plantations of trees.

The trees were plantations planted last 30 years. For collection of soil samples the spots were selected by using the Geographical Positioning System (GPS) location of treatments. The samples were withdrawn from each replication of the treatments with GPS location with the help of post whole Auger. The available nitrogen was determined by alkaline permanganate method (Subbiah and Asija, 1956)^[17]. The available phosphorus as per procedure of Olsen's *et al.* (1954)^[11]. The available potassium was determined by flame photometer using neutral normal ammonium acetate as described by Jackson (1967). Available Zn, Fe Cu Mn were analyzed as described by Lindsay and Norvell, (1978)^[9]. The Biological Properties *viz.* Bacteria, Fungi and Actinomycetes population was estimated by using serial dilution technique used KNIGHT medium as describe by Aneja K.R. 2003^[11].

Result and Discussion

Available macro nutrients (N, P and K): The status of available macronutrient *viz.* N, P, and K are presented in the Table No.1. The data from the table evident that the maximum available nitrogen (265.00 kg ha⁻¹) was recorded from treatment No.2 (Casuarina + Guava + Turmeric) and minimum (230.00 kg ha⁻¹) was in treatment No.1 (Control). The maximum available phosphorus (26.00 kg ha⁻¹) was recorded with the treatment No.2 (Casuarina + Guava +

Turmeric) whereas minimum available phosphorus (20.00 kg ha⁻¹) was found at treatment No.1 (Control). As far as the Potassium level is concerned the maximum available potassium (157.03 kg ha⁻¹) was recorded in treatment No.2 (Casuarina + Guava + Turmeric) and minimum available potassium (130.00 kg ha⁻¹) was found in the treatment No.1 (Control). The available nitrogen was ranged from 230.00-265.00 kg ha⁻¹ with an average value of 252.63 kg ha⁻¹, available phosphorus ranged from 20.00-26.00 kg ha⁻¹ with an average value 23.50 kg ha⁻¹, and available potassium ranged from 130.00-157.03 kg ha⁻¹ with an average value 148.65 kg ha⁻¹. The Standard deviation of available nitrogen, phosphorus, and potassium were 11.15, 1.87, and 8.44 respectively. The increase nitrogen, phosphorus and potassium availability might be due to the addition of a big amount organic matter on upper layer of soil. The various plantations of tree species provides the litter fall and turn over root and root exudates which decomposed and accumulate as organic matter, solubilisation of insoluble nutrients and also supplementing the depleted nutrients as external sources which released more quantity of nutrients in soil and enhanced the availability of nutrients. These results were also corroborated with the findings of Sharma (1993)^[14], Kumar *et al.*, (1998)^[8], Toky *et al.*, (1986)^[18], Dutta *et al.*, (2002)^[5], and Pal *et al.*, (2015)^[12].

Table 1: Effect of different plantation of tree species with cropping system on available macro and micro nutrients in soil.

S. No.	Treatment Name	G.P.S. Location	Available Macronutrients (kg ha ⁻¹)			Available Micronutrients (mg kg ⁻¹)			
			N	P	K	Zn	Fe	Cu	Mn
1.	Control	Latitude -26°55'98" N Longitude -81°84'89"E	230.00	20.00	130.00	0.62	4.01	0.30	1.26
2.	Casuarina + Guava + Turmeric	Latitude -26°55'84" N Longitude -81°84'84"E	265.00	26.00	157.03	0.96	4.67	0.55	2.18
3.	Casuarina + Paddy + Wheat	Latitude -26°56'01" N Longitude -81°84'90"E	262.00	25.00	155.03	0.90	4.58	0.52	2.10
4.	Shisham	Latitude -26°55'77" N Longitude -81°84'91"E	250.00	22.97	148.00	0.78	4.30	0.44	1.80
5.	Shisham + Peragrass	Latitude -26°55'75" N Longitude -81°84'82"E	255.00	24.03	151.03	0.84	4.48	0.48	1.92
6.	Shisham + Mustard	Latitude -26°56'01" N Longitude -81°85'03"E	255.00	23.50	150.00	0.81	4.20	0.46	1.85
7.	Shisham + Paddy + Wheat	Latitude -26°56'04" N Longitude -81°85'05"E	259.00	24.50	153.07	0.88	4.50	0.50	2.01
8.	Eucalyptus	Latitude -26°55'95" N Longitude -81°84'85"E	245.00	22.00	145.07	0.74	4.20	0.40	1.70
Range			230.00-265.00	20.00-26.00	130.00-157.03	0.62-0.96	4.01-4.67	0.30-0.55	1.26-2.18
T. Average			252.63	23.50	148.65	0.82	4.37	0.46	1.85
S. Deviation			11.15	1.87	8.44	0.11	0.23	0.08	0.29

Available micronutrients (Zinc, Iron, Copper and Manganese)

The status of soil sampling site for available Zinc, Iron, Copper and Manganese are presented in the Table No.1. The maximum available Zinc (0.96 mg kg⁻¹) was recorded in treatment No.2 (Casuarina + Guava + Turmeric) where as minimum available Zinc (0.62 mg kg⁻¹) was found in treatment No.1 (Control). The maximum available Iron (4.67 mg kg⁻¹) was recorded in treatment No.2 (Casuarina + Guava + Turmeric) and minimum available Iron (4.01 mg kg⁻¹) was found at treatment No.1 (Control). The maximum available Copper (0.55 mg kg⁻¹) was recorded in treatment No.2 (Casuarina + Guava + Turmeric) and minimum available Copper (0.30 mg kg⁻¹) was found at treatment No.1 (Control). The maximum available Manganese (2.18 mg kg⁻¹) was recorded in treatment No.2 (Casuarina + Guava + Turmeric)

and minimum available Manganese (1.26 mg kg⁻¹) was found in treatment No.1 (Control). The available Zinc was ranged from (0.62-0.96 mg kg⁻¹) and with an average value of (0.82 mg kg⁻¹), available Iron ranged from (4.01- 4.67 mg kg⁻¹) and with an average value (4.37 mg kg⁻¹), available Copper ranged from (0.30 - 0.55 mg kg⁻¹) and with an average value (0.46 mg kg⁻¹), similarly available Manganese ranged from (1.26-2.18 mg kg⁻¹) and with an average value (1.85 mg kg⁻¹). The Standard deviation of Zinc, Iron, Copper and Manganese were 0.11, 0.23, 0.08 and 0.29 respectively. The majority of soil sample collected were from the soil which has followed the different plantation tree species and cropping system. This might be due the addition of organic matter from leaves and root turnover of trees and solubilisation of the nutrients in surface soil. This is in agreement with the finding reported by Bhola and Mishra (1998)^[3], Lindsay and Norvell (1978)^[9],

Toky *et al.*, (1986)^[18], Drechsel *et al.*, (1991)^[4] and Singh *et al.*, (2002)^[16].

Available microbial population (Bacteria, Fungi and Actinomycetes): The status of microbial counts *viz.* Bacteria, Fungi and Actinomycetes are presented in the Table No.2 and Fig. 1. It is evident from the data that the maximum Bacteria count (6.18 cfu*10⁶g⁻¹) was recorded in treatment No. 2 (Casuarina + Guava + Turmeric) whereas minimum Bacteria count (4.96 cfu*10⁶g⁻¹) was found in treatment No. 1 (Control). The maximum Fungi count (5.86 cfu*10³g⁻¹) was recorded in treatment No. 2 (Casuarina + Guava + Turmeric) and minimum Fungi count (5.24 cfu*10³g⁻¹) was found at treatment No.1 (Control). The maximum Actinomycetes count (5.72 cfu*10⁴g⁻¹) was recorded in treatment No. 2 (Casuarina + Guava + Turmeric) and minimum Actinomycetes count (4.94 cfu*10⁴g⁻¹) was found at treatment No.1 (Control). The Bacteria was ranged from (4.96-6.18

cfu*10⁶g⁻¹) and with an average value of (5.96 cfu*10⁶g⁻¹), Fungi ranged from (5.24-5.86 cfu*10³g⁻¹) and with an average value (5.75 cfu*10³g⁻¹), similarly Actinomycetes ranged from (4.94- 5.72 cfu*10⁴g⁻¹) and with an average value (5.61 cfu*10⁴g⁻¹). The Standard deviation of Bacteria, Fungi and Actinomycetes were 0.41, 0.21 and 0.27 respectively. The higher population of bacteria, fungi and, actinomycetes in plantation of tree species and cropping system maybe because there is more organic material in Plantation land with good vegetation cover which increased microbial population and activity. Higher bacteria, fungi and actinomycetes population in Forest land may also be due to the higher pore-space and organic material added to the soil through leaf litter which serves as a source of energy for the microbial population. Similar results were also observed by Badiyala *et al.*, (1990)^[2], Hyano *et al.*, (1995)^[6], Nardi and Pizzeghello (2004)^[10], Qin *et al.*, (2006)^[13], Sharma *et al.*, (2010)^[15].

Table 2: Effect of different plantation of tree species and cropping system on microorganism in soil.

S. No.	Treatment Name	G.P.S. Location	Micro Organisms (cfu*g ⁻¹)		
			Bacteria (10 ⁶)	Fungi (10 ³)	Actinomycetes (10 ⁴)
1.	Control	Latitude -26°55'98" N Longitude -81°84'89"E	4.96	5.24	4.94
2.	Casuarina + Guava + Turmeric	Latitude -26°55'84" N Longitude -81°84'84"E	6.18	5.86	5.72
3.	Casuarina + Paddy + Wheat	Latitude -26°56'01"N Longitude -81°84'90"E	6.16	5.84	5.72
4.	Shisham	Latitude -26°55'77"N Longitude -81°84'91"E	6.09	5.80	5.70
5.	Shisham + Pergrass	Latitude -26°55'75"N Longitude -81°84'82"E	6.07	5.83	5.71
6.	Shisham + Mustard	Latitude -26°56'01" N Longitude -81°85'03"E	6.09	5.80	5.71
7.	Shisham + Paddy + Wheat	Latitude -26°56'04"N Longitude -81°85'05"E	6.12	5.81	5.71
8.	Eucalyptus	Latitude -26°55'95"N Longitude -81°84'85"E	6.00	5.79	5.70
Range			4.96-6.18	5.24-5.86	4.94-5.72
T. Average			5.96	5.75	5.61
S. Deviation			0.41	0.21	0.27

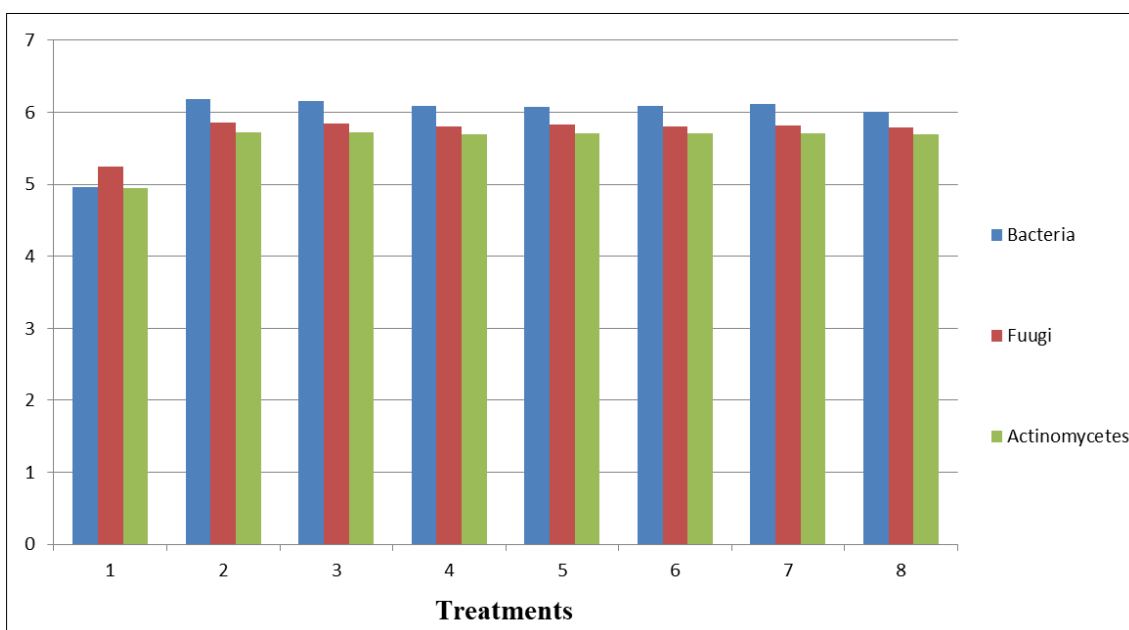


Fig 1: Effect of different plantation of tree species and cropping system on microorganism in soil

Conclusion

It is clear from the investigation that available macronutrient (N, P, and K), micronutrient (Zn, Fe, Cu and Mn) and microbial counts (Bacteria, Fungi and Actinomycetes) in soil profiles different cropping system and plantation of tree species is varied considerably. The available elevated N- 265 kg ha⁻¹, P- 26 kg ha⁻¹, K- 157.03 kg ha⁻¹, Zn- 0.96 mg kg⁻¹, Fe- 4.67 mg kg⁻¹, Cu- 0.55 mg kg⁻¹, Mn- 2.18 mg kg⁻¹, Bacteria- 6.18 cfu*10⁶g⁻¹, Fungi- 5.86 cfu*10³g⁻¹ and Actinomycetes- 5.72 cfu*10⁴g⁻¹ in soil profiles depth of 0-15 cm treatment No. 2 (Casuarina + Guava + Turmeric) at agroforestry farm of AND University of Agriculture and Technology Kumarganj Ayodhya. The available macro-micro and microbial counts in soil profiles decreased with increasing soil depth at all the plots. The results of the study indicate that Casuarina + Guava + Turmeric cropping system has higher potential of accumulating available macronutrient (N, P, and K), micronutrient (Zn, Fe, Cu and Mn) and microbial counts (Bacteria, Fungi and Actinomycetes) in the soil than other tree species.

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