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Assessment of quality improvement of soil of Spice crops under Bamboo based agoforestry system

Dhanyashri P.V.* M.S.Malik* Anil kumar* Jaikumar* Dr.M.Jadegowda* Saraswati Sahu Isha Thakur** Aishwarya Routray** Shashikumar M.C. ****
Department of Silviculture and Agroforestry &
Department of Forest products and Utilization
Faculty of forestry, Birsa Agricultural University, Kanke, Ranchi, Jharkhand-834006, India
**E-mail*: pvdhanyashri@gmail.com

ABSTRACT
This study was conducted to assess the quality of soil in terms of soil nutrients and other physico-chemical properties of spice crops under bamboo based agroforestry system . Systematic sampling was used to collect soil samples diagonally at five spots in each treatment and their adjacent non-tree fields as controls. The samples were analyzed for pH, % of Organic carbon (O-C), Nitrogen (N), available Phosphorus (P) and Pottassium (K). The study revealed that the mean levels of available N, P, K, O-C and pH under the treatments were higher than its control plot and sole bamboo. There was significant difference in the levels of N, P, K, O-C and pH under the treatments. However, the treatments were significantly different. In general, Trigonella foenum-graecum added more N to the soil compared to other treatments. Also, the Foeniculum vulgare added more P to the soil when compared to the other treatments. However, the difference were significant and pottassium was found more under Foeniculum vulgare compared to the control and sole bamboo. It is therefore, recommended that intercrops should be used for agro forestry practices particularly, where the soil needs some level of improvement in nitrogen and phosphorus respectively.
Key words: *Soil nutrients, Bambusa nutans, Foeniculum vulgare, Trigonella foenum-graecum, Corandrum sativum, Agro forestry.*

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INTRODUCTION
The world at present is facing innumerable problems such as burgeoning population, ecosystem degradation, particularly in the tropics, declining agricultural productivity, and changing environment. In order to sustain in the future, it is essential to find solutions to these problems, particularly with regard to ensuring food security and coping with the changing environment. Existing approaches to enhance productivity and mitigate environmental degradation are inadequate. Tree plantations improve soil physical, chemical and biological properties through accretion and decomposition of organic matter through litterfall and roots. Deep and extensive root systems of trees enable them to absorb substantial quantities poplar litterfall followed the order: Ca > N >K > S > P and Fe > Mn > Zn > Cu, respectively [11]. On account of recycling of organic matter, higher organic carbon (OC) and available N, P and K content were observed in the soil under an intercropped poplar plantation than at a site without trees [11] and the content varied depending upon the intercrops [7].

Soil pH

Soil pH refers to the soil's acidity or alkalinity. The pH of a soil will often determine whether certain plants can be grown successfully [5]. Soil pH largely controls plant nutrient availability and microbial reaction in the soil. It affects trees, shrubs and grass that dominate the landscape under natural condition and determine which cultivated crop will grow well or not in a given field [2].

Organic carbon

Forest soils can store large amounts of carbon that could be released to the atmosphere through deforestation [6]. Soil organic matter (carbon) content is often related to soil fertility. Trees are distinct in that they develop an organic layer above the mineral soil. When cultivated lands or soils that previously were low in organic matter are afforested or reforested, there can be substantial increase in the amount of soil organic matter [9]. Managing agricultural soils to store more carbon is likely to have ancillary benefits by reducing soil erosion through the use of cover crops, crop rotations, nutrient management and organic amendments is likely to increase soil fertility and enhance food security for affected population [10].

Nitrogen

Nitrogen is an essential nutrient element for living organisms. it is usually added in larger quantities to agricultural lands to obtain higher crop yields [2]. The atmosphere contains about 78% nitrogen gas (N_2), yet nitrogen is one of the most required elements for plant's growth. The reason is that, plants cannot utilize nitrogen as a gas. Plants absorb nitrogen either as ammonium or nitrate ion. The only storehouse of any kind of nitrogen is soil organic matter which must decompose before the nitrogen can be absorbed by plants [3].

Phosphorus

Phosphorus is an essential nutrient for all organisms and is added in large quantities to obtain enhanced crop yields. Secondary sewage effluent often has high phosphorus content, making it an important source of phosphorus for irrigated soils [2]. The total supply of phosphorus in moist soils is usually low, and its relative availability is low. The total phosphorus in an average arable soil is approximately 0.1% but only a small part of it at any one time is available to the plant. The nucleus of each plant cell contains phosphorus and for that reason, cell division and growth are not possible without adequate phosphorus [3].

Potassium

The decomposition of litter (leaves, bark seeds etc.) added from tree species in the forest ecosystem can release K present in the organic combinations, so it can release during early stage of decomposition. The decomposition products (such as H+) of litter or tree rootscan release K present in the structure of minerals, K present in exchangeable or non exchangeable forms in the soil.

MATERIAL AND METHODS

The investigation entitled "Studies on Growth and Yield of Spices Under Bamboo-based Agroforestry System" was conducted at Ranchi Veterinary College, Kanke, Ranchi District of Jharkhand, India during 'Rabi' season 2017-18.. The study site is located in plain region of Chotanagpur Plateau of Jharkhand, which is situated at a distance of about is 3.5 km east from Faculty of Forestry, Birsa Agricultural University, Ranchi. The district is situated between 23°30' and 23°40' north latitudes and 85°30' and 85°40' east longitudes with an elevation of around 651 m from mean sea level. The district covers an area of 5097 km^2. Ranchi has a humid subtropical climate. However, due to its position and the forests around the city, it is known for its pleasant climate. Ranchi used to be a preferable hill station in the past. Temperature ranges from maximum 42 to 20 °C during summer and from 25 to 0 °C during winter. December and January are the coolest months with temperature getting to freezing point in some places of the city. The annual rainfall is about 1430 mm (56.34 inches). From June to September the rainfall is about 1,100 mm. The monsoon breaks out in the middle of June and last till mid-October. 21 plots consists of 7 treatments, 3 replications contains area of 120 m^2 (each plot) with treatment details (T_1) Bamboo *(B. nutans)*+ Sounf *(Foeniculum vulgare),* (T_2) Bamboo *(B. nutans)*+ Dhania (*Corandrum sativum*) , (T_3) Bamboo (B. nutans)+ Methi (*Trigonella foenum-graecum*), (T_4) Bamboo (*B. nutans* [Sole]), (T_5) Dhania *(Corandrum sativum* [Sole]), (T_6) Sounf (*Foeniculum* *vulgare* [Sole]) and (T_7) Methi (*Trigonella foenum-graecum* [Sole]) laid in RBD design. Spice crops were planted in the distance of 30cm X 30cm and Bamboo were planted in a distance of 5m X 5m.

The soil sample was collected from the experimental site with a soil depth of 0-30 cm (surface soil) for the estimation of nutrient status of the soil. The samples were collected initially before the intercrops and also after harvesting of agriculture crops. Collected soil samples were air-dried, powdered and sieved prior to chemical analysis. The composited samples were used for the analysis and determination of chemical properties like soil pH, organic carbon percent, available nitrogen (kg/ha), available phosphorus (kg/ha) and available potassium (kg/ha). The pH of the soil was determined by Potentiometry (pH meter). For this purpose, soil: water suspension was prepared (1:5) and tested with Potentiometry to know the value of pH. The soil samples collected from 15 cm depth, dried and powdered using wooden mallet and sieved through 2 mm sieve. The soil organic carbon content in the 2 gm sieved soil samples was calculated by Walkley and Black method [13]. Available soil nitrogen was estimated by Alkaline permanganate method of Subbiah and Asija [8]. The available nitrogen is expressed in terms of kg/ha. Available soil phosphorus was calculated by ascorbic acid method by using spectrometer [12]. The available phosphorus is expressed in terms of kg/ha. Available soil potassium was determined by flame photometer in soil solution prepared in extraction solution of normal ammonium acetate [1]. The available potassium is expressed in terms of kg/ha. Available Potassium.

RESULT AND DISCUSSION

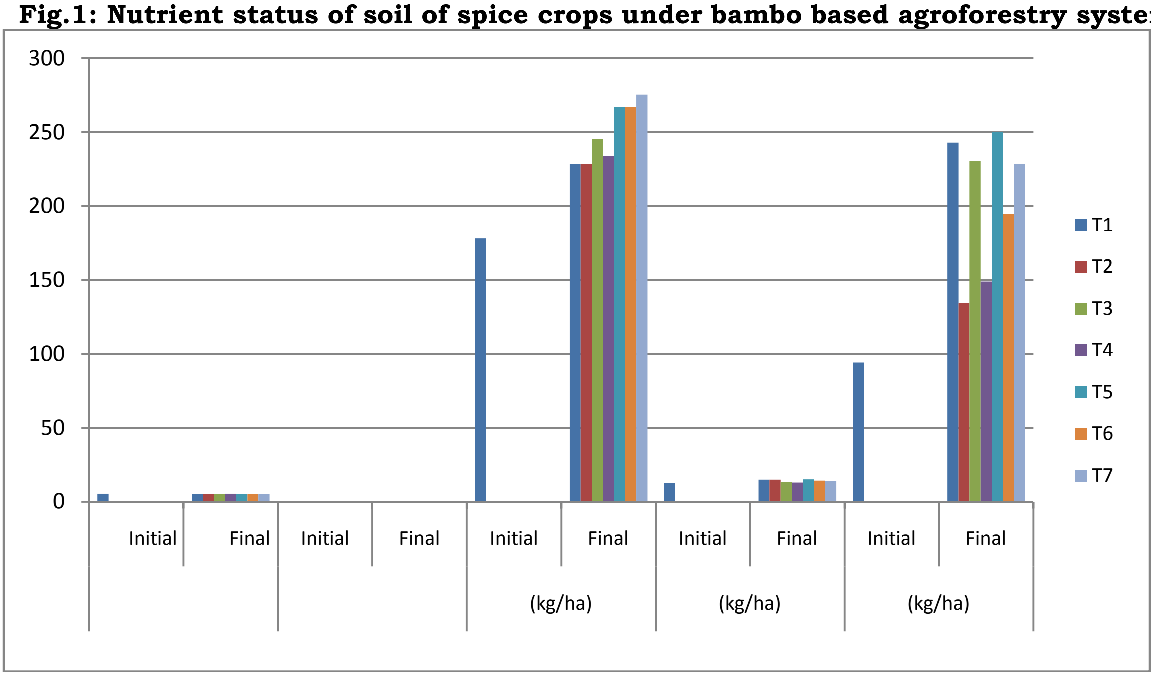
The data on soil status after harvesting of intercrops are presented in Table 1 and in Figure 1 The scrutiny of the data revealed that the pH of the treatment plots was significantly varying from 5.19 to 5.5. The maximum pH was found in T_4 followed by T_3, T_7 and T_5, T_2, T_1 are at par with each other and lowest was found in T_6. The organic carbon content of the treatment plots are presented in Table 1. Perusal of the data has indicated that the organic carbon content of the treatments plots were varying from 0.40 to 0.50. The maximum organic carbon content was found in T_5 followed by T_1, T_7, T_3, T_2, T_4 and minimum was found in T_6. Results on available nitrogen, available phosphorus and available potassium under different treatments are presented in Table 1. Perusal of data indicated that the N, P, K were varied under different treatments. The maximum (275.43 kg/ha) available nitrogen was found in treatment T_7 followed by T_6 and T_5 (267.2 kg/ha), T_3 (245.15 kg/ha), T_4 (233.8 kg/ha) and least (228.3 kg/ha) in T_1 and T_2. The available phosphorus was more (15.1 kg/ha) in case of T_5 followed by T_2 (14.93 kg/ha), T_1 (14.95 kg/ha), T_6 (14.33 kg/ha), T_7 (13.75 kg/ha) and least T_3 (13.19 kg/ha) in T_3 whereas the available potassium was maximum (249.93 kg/ha) in T_5 followed by T_1 (242.93 kg/ha), T_3 (230.41kg/ha), T_7 (228.54 kg/ha), T_6 (194.493 kg/ha) T_4 (148.84 kg/ha) and minimum (134.4 kg/ha) in T_2.

The difference in available soil nitrogen due to different crops was significant over the control. It was further noted that treatment with pea indicated more soil nitrogen as compared to other plots which may be due to leguminous crops. More nitrogen in general for all the plots of intercrop treatments over the control plots may be due to addition of organic matter in form of F.Y.M. or crop residues and may be due to low uptake of nitrogen by crops as it was expected for good yields. The other reason of more nitrogen due to pea may be due to symbiotic fixation by the micro-organisms also. The lowest available soil nitrogen was recorded in sole treatment may be due to uptake of nitrogen from the soil for their life cycle completion and may be due to the activity of bacteria which are encouraged by organic matter secreted by grass roots. Available potassium content in soil showed significant difference due to different treatments. The lowest (134.4 kg/ha) available soil potassium was recorded in plots of sole treatment due to uptake of potassium by natural vegetation for its life cycle completion. The highest (249.93 kg/ha) potash was recorded in potato which is similar to other intercrops may be due to addition of organic matter in form of F.Y.M. or crop residues. The available soil potassium of all the plots was slightly decreased as compared to potash contents before intercrops may be due to luxurious consumption of intercrops or available soil potassium was converted into unavailable soil potassium for maintenance of equilibrium of soil potassium. Hossain *et al.* (2014) reported that, after experimentation, nutrient elements in soil were found increased slightly than initial soils.

Table 1: Nutrient status of soil of spice crops under bambo based agroforestry system.

Treatment	pH		OC (%)		N (kg/ha)		P_2O_5 (kg/ha)		K_2O (kg/ha)	
	Initial	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
T_1	5.5	5.2	0.41	0.47	178.2	228.3	12.55	14.95	94.2	242.93
T_2		5.2		0.43		228.3		14.93		134.40
T_3		5.3		0.44		245.15		13.19		230.41
T_4		5.5		0.42		233.8		12.93		148.84
T_5		5.2		0.51		267.2		15.10		249.93
T_6		5.19		0.40		267.2		14.33		194.49
T_7		5.26		0.45		275.43		13.75		228.54
Mean		5.27		0.45		249.34		14.17		204.30
SE(m)		0.21		0.02		3.06		0.51		2.47
C.D (5%)		0.64		0.06		9.42		1.56		7.62
C.V. (%)		6.80		8.08		2.16		6.20		2.1

Fig.1: Nutrient status of soil of spice crops under bambo based agroforestry system.



CONCLUSION

Agroforestry is an ecologically based, natural resources management system that sustains production and benefits all those who use the land by integrating trees on farms and in the agricultural land scape. In addition to provide timber, fodder, fuelwood, medicines, etc., it conserves soil and enhances soil fertility. Improvement in soil fertility takes place by the process of checking soil erosion and runoff, maintaining soil organic matter, enhancement of soil physical, chemical, and biological properties, increment of nitrogen input by N-fixing trees and shrubs, and mining of minerals from lower horizons by roots and its recycling through litter fall on ground. Thus, the tree based agriculture play an important role, not only in improving the productivity and overall returns from the system, but also protects the soil from further degradation and improve the quality of the soil across the profile layers. Fourth, there is a need for the development of farm-scale dynamic nutrient budget models to better interpret the implications of negative nutrient balances for the sustainability of farming systems. Measurements of N mineralization in different soil layers, and N losses by leaching and denitrification are urgently.

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