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LONG TERM EFFECT OF SILVI-HORTI SYSTEMS ON SOIL CHEMICAL PROPERTIES AND AVAILABLE NUTRIENTS STATUS

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ABSTRACT

A field experiment was conducted to assess the long term effect of silvi-horti system on soil chemical properties and available nutrients status under an established silvi-horti system at UAS, Dharwad during 2023-24. The experiment was laid out in randomized block design with seven treatments replicated four times. Treatments comprised of, Sapota + *Pterocarpus marsupium*, Sapota + *Tectona grandis*, Sapota + *Terminalia alata*, Sapota + *Lagerstroemia lanceolata*, Sapota + *Terminalia paniculata*, Sapota (*Manilkara zapota*) and control (Soybean- Safflower). The study revealed that, the forest tree species in silvi-horti system have positive effect on soil chemical properties and available macro and micronutrients status. Sapota + *Tectona grandis* system recorded significantly higher electrical conductivity (0.46 and 0.42 dS m⁻¹), soil organic carbon (8.10 and 5.10 g kg⁻¹), available nitrogen (299.88 and 275.18 kg ha⁻¹), available phosphorus (56.20 and 46.42 kg ha⁻¹), available potassium (328.00 and 277.55 kg ha⁻¹) and available sulphur (32.93 and 26.21 kg ha⁻¹) at both 0-30 and 30-60 cm depths, respectively. Similar to macronutrients, DTPA- extractable micronutrients (iron, manganese, copper and zinc) were also significantly higher in Sapota + *Tectona grandis* system compared to control. Soil pH increased in sub-surface depth but other soil properties viz., electrical conductivity, organic carbon, available macro and micronutrients content decreased at sub-surface depth.

Keywords : Silvi-horti system, organic carbon, nutrients, soil depth.

Introduction

Silvi-horti systems represent an innovative land management strategy that combine features of silviculture and horticulture on the same unit of land. The concept of silvi-horti system emerges from the broader principles of agroforestry, which advocates the strategic use of trees to create more diverse, productive, sustainable and resource-efficient agricultural systems. Agroforestry as a traditional land-use adaptation may potentially support livelihood improvement through simultaneous production of food, fodder and firewood as well as mitigation of the impact of climate change (Pandey, 2007). The perennial trees

typically provide multiple benefits of shade, shelter, nutrients and organic matter to the crops, besides contributing to the structural and biological diversity to the environment. The soil, dynamic and complex natural resource, serves as the foundation for plant growth and medium for water and nutrient cycling. The three important properties viz. physical, chemical and biological makes soil a functionally complete resource (Abera and Meskel, 2013).

Silvi-horti systems by their dynamic nature, alter the soil environment through the introduction of varied root systems, changes in litter fall patterns and modifications in the soil microbial community due to

diverse plant species. These changes have a profound long-term effect on soil physico-chemical properties, nutrients status and biological properties. Return of large amounts of nutrients through litterfall to soil helps in replenishment and enriching the soil mineral composition along with organic matter and microbial population (Yadav *et al.*, 2008). Understanding the long-term effects of silvi-horti systems on soil properties is crucial in assessing the sustainability of these systems in terms of soil health which is critical for the longevity of both forestry and horticultural practices.

Material and Methods

A field experiment was conducted to study the long term effect of silvi-horti system on soil chemical properties and available nutrients status at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during 2023-24. It is located at 15° 26' North latitude, 75° 07' East longitude and 678 m above mean sea level (MSL). The soil type of the experimental site was *Vertisol*. The silvi-horti system was established in the year 2006. The experiment was laid out in randomized block design with seven treatments replicated four times. Treatments comprised of, T₁- Sapota + *Pterocarpus marsupium*, T₂- Sapota + *Tectona grandis*, T₃- Sapota + *Terminalia alata*, T₄- Sapota + *Lagerstroemia lanceolata*, T₅- Sapota + *Terminalia paniculata*, T₆- Sapota (*Manilkara zapota*) and T₇- control (Soybean-Safflower). Soil samples were collected from the experimental field at the two different sampling depths (0-30 and 30-60 cm) and analyzed in the laboratory for soil pH, electrical conductivity (EC), soil organic carbon (SOC), available nitrogen (N), phosphorus (P₂O₅), potassium (K₂O), sulphur (S) and micronutrients (iron, manganese, copper and zinc) following standard procedures. Soil pH was measured by potentiometric method, electrical conductivity (EC) was measured by conductometric method, soil organic carbon (SOC) was measured by Walkley and Black's wet oxidation method (Sparks, 1996), available N was measured by modified alkaline permanganate oxidation method (Sharawat and Burford, 1982), available P₂O₅ was determined following the Olsen's method, available K₂O was determined using NH₄OAC extraction method and available S was determined by turbidimetric method (Sparks, 1996). The contents of iron, zinc, copper and manganese were measured by atomic absorption spectrophotometer as described by Lindsay and Norvell (1978). The initial (2016) soil properties of the experimental site under different silvi-horti systems are mentioned in Table 1. The data obtained from the experiment on various characters

was subjected to statistical analysis as per the analysis of variance (ANOVA) technique for Randomized Block Design (Gomez and Gomez, 1984).

Results and Discussion

Chemical properties of soil

Soil reaction (pH)

The soil pH was significantly higher under conventional agricultural system as compared to silvi-horti systems. The results related to soil pH are presented in Table 2. This reduction in soil pH under silvi-horti systems is might be due to the decomposition of litterfall at the surface which adds organic matter and releases organic acids. Soil pH increased with increase in soil depth. The surface layer had the lowest pH due to the enrichment of organic matter from litterfall and fine root mass. As organic matter decomposed, organic acids were released, lowering the pH (Geetha *et al.*, 2021). But there was no significant difference in soil pH among the silvi-horti systems. Significantly highest soil pH was recorded in control (8.31) at 0-30 cm depth. There were no significant differences in soil pH among different treatments at 30-60 cm depth.

Electrical conductivity (EC)

EC varied significantly among different silvi-horti systems and soil depth (Table 2). The soil EC was significantly higher in silvi-horti systems than conventional agricultural system and showed a decrease with successive soil depth. This could be due to the enrichment of soil mineral basic salts through the addition and decomposition of litter which is more pronounced at surface (Singh *et al.*, 2022). Among the treatments, significantly highest soil EC was observed in Sapota + *Tectona grandis* (0.46 dS m⁻¹) followed by Sapota + *Lagerstroemia lanceolata* (0.43 dS m⁻¹) and it was significantly lower in control (0.34 dS m⁻¹) at 0-30 cm depth. Significantly highest soil EC was recorded in Sapota + *Tectona grandis* (0.42 dS m⁻¹) followed by Sapota + *Lagerstroemia lanceolata* (0.40 dS m⁻¹) at 30-60 cm depth.

Soil organic carbon

The organic carbon of soil was significantly higher under silvi-horti systems than conventional agricultural system (Table 2). No significant difference in soil organic carbon content was observed among different silvi-horti systems in 0-30 cm depth but it was significantly lowest in control (6.10 g kg⁻¹). At 30-60 cm depth, significantly highest soil organic carbon content was recorded in Sapota + *Tectona grandis* (5.10 g kg⁻¹) followed by Sapota + *Terminalia alata* (4.85 g kg⁻¹) and Sapota + *Lagerstroemia lanceolata*

(4.90 g kg⁻¹). The soil enrichment in organic carbon under tree based systems could be due to several factors such as addition of litter, annual fine root biomass recycled and root exudates and its reduced oxidation of organic matter under tree shades (Devi *et al.*, 2021). The SOC content in the soil decreased with

increasing depth, with the highest levels observed at a depth of 0-30 cm across all treatments. This is likely because majority of organic matter inputs, such as leaf litter, plant residues and root exudates, are concentrated near the soil surface, where microbial activity is highest.

Table 1: Initial (2016) soil properties of experimental site under different silvi-horti systems

Treatment	pH (1:2.5)	EC (dS m ⁻¹)	SOC (g kg ⁻¹)	Av. N	Av. P ₂ O ₅	Av. K ₂ O
				(kg ha ⁻¹)		
T ₁	7.45	0.31	4.60	210.34	41.60	222.80
T ₂	7.35	0.36	5.10	239.00	43.00	230.90
T ₃	7.39	0.33	4.80	218.60	42.50	227.60
T ₄	7.37	0.35	4.90	231.40	42.70	229.30
T ₅	7.43	0.32	4.70	213.46	42.00	225.10
T ₆	7.49	0.28	4.45	211.60	39.80	200.70
T ₇	7.15	0.46	4.30	196.00	30.30	176.80

Table 2 : Effect of Silvi-Horti systems on soil reaction, electrical conductivity (dS m⁻¹) and soil organic carbon (g kg⁻¹)

Treatment	pH (1:2.5)		Electrical Conductivity (dS m ⁻¹)		Soil organic carbon (g kg ⁻¹)	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
T ₁	7.37	8.07	0.40	0.36	7.70	4.70
T ₂	7.11	7.61	0.46	0.42	8.10	5.10
T ₃	7.28	7.78	0.42	0.37	7.90	4.85
T ₄	7.21	7.71	0.43	0.40	8.00	4.90
T ₅	7.33	7.83	0.41	0.38	7.79	4.80
T ₆	7.52	8.22	0.39	0.35	7.60	4.60
T ₇	8.31	8.45	0.34	0.29	6.10	4.30
SEM±	0.19	0.21	0.01	0.01	0.20	0.12
CD @ 5%	0.58	NS	0.03	0.03	0.61	0.38

Available nutrients status of soil

Soil available nitrogen, phosphorus, potassium and sulphur were higher in silvi-horti systems as compared to conventional agricultural system and decreased with increasing depth (Table 3). Maximum available nitrogen, phosphorus, potassium and sulphur were recorded in Sapota + *Tectona grandis* system (299.88, 56.20, 328.00 and 32.93 kg ha⁻¹ at 0-30 cm depth and 275.18, 46.42, 277.55 and 26.21 kg ha⁻¹ at 30-60 cm depth, respectively) followed by Sapota + *Lagerstroemia lanceolata* system (282.24, 55.80, 325.70 and 31.14 kg ha⁻¹ at 0-30 cm depth and 257.54, 45.93, 264.34 and 24.47 kg ha⁻¹ at 30-60 cm depth, respectively) and were least in control (204.62, 39.00, 256.80 and 21.97 kg ha⁻¹ at 0-30 cm depth and 179.93, 28.86, 194.78 and 16.25 kg ha⁻¹ at 30-60 cm depth, respectively). The increase in available nutrients content under various tree species was due to the addition of organic matter in the soil from litter fall and fine root biomass. The mineralization of this organic matter improved the nutrient status of the soil (Miah *et*

al., 2022). The highest amount of available nitrogen in the surface soil was due to the greater turnover of organic residues in the surface layer and their mineralization, which decreased with soil depth. The similar research findings were obtained by Chaturvedi *et al.*, 2008 who reported that the increase in soil organic carbon and available nitrogen compared to their initial value was believed to be due to the effect of litter addition. In tree-based systems, available phosphorus was high due to the increased activity of acidic phosphatase enzymes and the exudation of organic anions which mobilized P in the rhizosphere. Similar results were observed by Salve and Bharadwaj (2020) who reported that extractable phosphorus decreased with an increase in soil depth. The higher potassium content in the surface soil compared to the sub-surface layer could be due to the increased mobility of potassium in the surface layer (Singh *et al.*, 2018). Available sulphur was higher in the surface soil due to greater organic matter accumulation and mineralization and decreased with increasing soil

depth. Similar trends of higher sulphur availability in tree-based systems compared to agricultural soils were reported by Nitant *et al.* (1992).

DTPA-extractable micronutrients (Mn, Zn, Fe and Cu) status

DTPA-extractable iron, copper, zinc and manganese contents were significantly higher under silvi-horti systems compared to the conventional agricultural system and showed a consistent decreasing trend with increasing soil depth (Figures 1 and 2). The maximum micronutrient contents were recorded in the Sapota + *Tectona grandis* system (Fe: 14.46 and 13.70 mg kg⁻¹; Cu: 2.50 and 1.48 mg kg⁻¹; Zn: 0.75 and 0.69 mg kg⁻¹; Mn: 24.13 and 23.22 mg kg⁻¹ at 0–30 and 30–60 cm depths, respectively), followed by Sapota +

Lagerstroemia lanceolata, whereas the lowest values were observed in the control system. The higher availability of micronutrients in tree-based systems can be attributed to increased organic matter inputs through litter fall and fine root turnover, which on decomposition release micronutrients in chelated and more plant-available forms. In addition, improved soil structure and enhanced microbial activity under silvi-horti systems promote nutrient retention and recycling in the surface soil. The reduction in micronutrient content with soil depth may be due to lower organic matter content, reduced root density and microbial activity in the sub-surface layers. Similar enhancement of DTPA-extractable micronutrients under agroforestry systems has been reported by Singh *et al.* (2022).

Table 3 : Effect of Silvi-Horti systems on available nitrogen (kg ha⁻¹), available phosphorus (kg ha⁻¹), available potassium (kg ha⁻¹) and available sulphur (kg ha⁻¹)

Treatment	Av. N		Av. P ₂ O ₅		Av. K ₂ O		Av. S	
	(kg ha ⁻¹)							
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
T ₁	239.90	215.21	53.50	41.85	319.60	233.62	27.55	20.83
T ₂	299.88	275.18	56.20	46.42	328.00	277.55	32.93	26.21
T ₃	264.60	239.90	55.30	42.91	324.50	248.78	29.57	22.85
T ₄	282.24	257.54	55.80	45.93	325.70	264.34	31.14	24.47
T ₅	246.96	222.26	53.90	42.41	321.40	247.53	28.37	21.82
T ₆	229.32	204.62	49.20	38.32	282.20	226.03	25.31	18.59
T ₇	204.62	179.93	39.00	28.86	256.80	194.78	21.97	16.25
SEm±	6.64	6.00	1.40	1.11	8.29	6.36	0.75	0.58
CD @ 5%	20.02	18.09	4.21	3.34	24.99	19.18	2.26	1.73

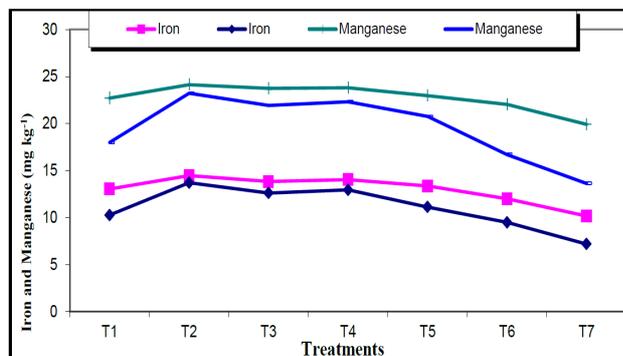


Fig. 1. Effect of Silvi-Horti system on DTPA-extractable iron and manganese

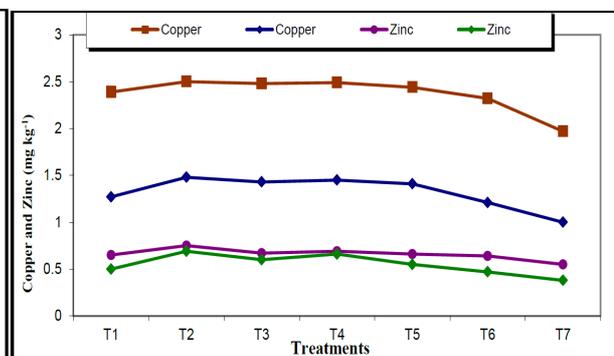


Fig. 2. Effect of Silvi-Horti system on DTPA-extractable copper and zinc

T₁ - Sapota + *Pterocarpus marsupium* (Honne) T₂ - Sapota + *Tectona grandis* (Teak) T₃ - Sapota + *Terminalia alata* (Laurel)
 T₄ - Sapota + *Lagerstroemia lanceolata* (Benteak) T₅ - Sapota + *Terminalia paniculata* (Kindal) T₆ - Sapota (*Manilkara zapota*)
 T₇ - Control (Soyabean- Safflower cropping system)

Conclusion

Sapota + *Tectona grandis* system resulted in significantly lower soil pH and higher electrical conductivity at 0-30 and 30-60 cm depths respectively than control. Significantly higher build-up of soil organic carbon, available nitrogen, phosphorus,

potassium, sulphur and DTPA-extractable micronutrients (iron, manganese, copper and zinc) were observed in Sapota + *Tectona grandis* system at both surface and sub-surface depths compared to control. Soil pH increased in sub-surface depth but other soil properties viz., EC, SOC and available macro

and micronutrients content decreased at sub-surface depth.

References

- Abera, G., & Meskel, E. W. (2013). Soil properties and soil organic carbon stocks of tropical Andosol under different land uses. *Open Journal of Soil Science*, **3**(3), 153–162.
- Chaturvedi, O. P., Das, D. K., & Chakraborty, A. K. (2008). Biomass production and root distribution of *Acacia lenticularis* (L.) under an agri-silvicultural system in north-west alluvial plain of Bihar. *Indian Journal of Agroforestry*, **10**(1), 24–29.
- Devi, S., Bhardwaj, K. K., Dhillon, R. S., Sharma, M. K., & Dahiya, G. (2021). Nutrient dynamics associated with leaf litter fall under agroforestry systems in semi-arid region of Haryana. *Indian Journal of Agroforestry*, **23**(1), 13–17.
- Geetha, K., Chaitanya, T., Padmaja, G., & Krishna, A. (2021). Effect of different land use systems on soil properties. *The Pharma Innovation Journal*, **10**(8), 1–6.
- Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research* (2nd ed.). John Wiley & Sons.
- Lindsay, W. L., & Norvell, W. A. (1978). Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Science Society of America Journal*, **42**, 421–428.
- Miah, M. M. U., Uddin, M. H., Miah, M. G., Rahman, M. M., Ahmed, M., & Matsumoto, M. (2022). Changes of soil physical and chemical properties in aonla (*Phyllanthus emblica* L.) based multistoried agroforestry system. *Journal of the Faculty of Agriculture, Kyushu University*, **67**(1), 39–51.
- Nitant, H. C., Bhushan, L. S., & Inderpal. (1992). Status of soil properties in Yamuna ravines under forest covers. *Journal of Tropical Forestry*, **8**(1), 31–37.
- Pandey, D. N. (2007). Multifunctional agroforestry systems in India. *Current Science*, **92**(4), 455–463.
- Salve, A., & Bhardwaj, D. R. (2020). Soil carbon stock and nutrient study in different agroforestry systems at Kinnaur district, Himachal Pradesh. *Plant Archives*, **20**(2), 4251–4260.
- Sharawat, K. L., & Burford, J. R. (1982). Modification of alkaline permanganate method for assessing the availability of soil nitrogen in upland soils. *Soil Science*, **133**, 53–57.
- Singh, I., Rawat, P., Kumar, A., & Bhatt, P. (2018). Soil physico-bio-chemical properties under different agroforestry systems in Terai region of the Garhwal Himalayas. *Journal of Pharmacognosy and Phytochemistry*, **7**(5), 2813–2821.
- Singh, J., Singh, B., & Dhaliwal, S. S. (2022). Long-term impact of poplar and eucalyptus based agroforestry systems on physico-chemical properties and nutrient status of soil in north-western India. *Range Management and Agroforestry*, **43**(1), 66–73.
- Sparks, D. L. (1996). *Methods of soil analysis: Part 3-Chemical methods*. Soil Science Society of America.
- Yadav, R. S., Yadav, B. L., & Chhipa, B. R. (2008). Litter dynamics and soil properties under different tree species in a semi-arid region of Rajasthan, India. *Agroforestry Systems*, **73**, 1–12.