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Effect of pruning intensity and herbicidal application on soil properties under rice: *Dalbergia sissoo* based agroforestry system

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Abstract
A field experiment was carried out at Agroforestry research farm, Department of Forestry, JNKVV, Jabalpur, Madhya Pradesh, to assess the effect of pruning and weedicide application on soil properties in Rice-*Dalbergia Sissoo* based agroforestry system. The result revealed that EC, pH and organic carbon was at par during the experiment and the available N, P and K increases with decreasing intensities from 75 to no pruning. Hence highest value was recorded under no pruning which was significantly superior over other pruning treatments except P 25. The 75% pruning and open condition recorded the lowest content NPK. From pooled data it was noted that with the increasing of pruning intensity significantly decreased the NPK status of soil hence higher content of 308.14, 14.78 and 387.18 kg/ha of nitrogen, phosphorus and potassium respectively. Where, the lowest NPK status was observed under open condition and possess the values of 247.68, 11.26 and 282.12 kg/ ha respectively. Thus, the study suggests that Agroforestry land use system proved most compatible for increment in soil nutrient status as compare to sole cropping.

Keywords: Soil properties, pruning intensity, agroforestry, fertility, NPK

1. Introduction
Agroforestry is a land use system that integrates trees, crops and animals in a way that is scientifically proven, ecologically desirable, practically feasible and socially acceptable to the farmers. (Nair, 1979) [14]. Besides, tree based land use systems offer several ecosystem services which benefit the agricultural practices by improving soil fertility, maintains soil moisture, reduce soil erosion, reduce water runoff from surface soil and water conservation, enhancement of water quality, carbon sequestration and biodiversity conservation (Jose, 2009; Chittapur and Patil, 2017) [10, 3]. *Dalbergia sissoo* Roxb., is a deciduous, quickly growing, hardy, medium to large-sized, multipurpose tree, and yields excellent quality timber, high-calorie fuel wood, and crude protein-rich feed (Singh and Sharma, 2007; Jackson, 1987) [19, 8]. Because of these advantages, it is commonly recognised as a good agroforestry plant in Central India (Bhargava and Rai, 2019; Patel *et al*., 2017) [2, 17]. Rice (*Oryza sativa* L.) is the most important staple food for 65% of the population in India and most popular food of the developing world. Pruning of tree component is a powerful approach to regulate light, nutrient, and other resource competition (Frank and Eduao, 2003, Dhillon *et al*., 2010) [6, 5]. Many scientists reported that pruning improves wood quality and tree stem shape. Pruning decreased the tree taper and increase the volume. Pruning become an essential practice for reducing both above and below ground competition with associated crop (Bari and Rahim, 2010) [22]. The Agri silviculture (tree + crop) system proved more productive and sustainable than agriculture. Chundawat and Gautam, 1993 reported that some time tree shade gives positive impact on growth and grain yield of intercrops and also increase nutrients level of soil. Thus this study aimed to determine the effect of pruning and weedicide application on soil properties.

2. Method and Materials
2.1 Experimental location, topography and climate
Field experiment was set up in the Agroforestry Research Farm, Department of Forestry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP), located at 23° 12' 50" North latitude and 79° 57' 56" east longitude. The climate of the area is subtropical and sub humid with hot and dry summer and cool dry winter. As per the NAR Project of ICAR, New Delhi, it is designed as the "Kymore Plateau and Satpura hill" agroclimatic zone.

It has been classified as Agroecological Region 10, Central high lands (Malwa and Bundelkhand and sub region no. 10.1) Hot sub humid eco region. Jabalpur receives 1000 to 1500 mm of rainfall annually. The majority of rainfall occurs from mid- June to end of September with sporadic rain occurring during the rest of year.

2.2 Experimental location, topography and climate

The experiment was carried out in a Dalbergia sissoo Agroforestry system that had been place in. Which was planted in 1998 with a 5m x 5m planting geometry. After a well-established crown had grown, trees were subjected to four distinct pruning regimes based on their overall height. This model has been intercropped with paddy in Kharif every year. Study was carried out to determine the impact of various pruning regimes and weed control treatments on rice productivity and yield contributing traits. Rice variety MTU 1010 was sown at 20 cm row intervals. Treatments were arranged in a strip plot design, with five main plot treatments: (0% pruning, 25% pruning, 50% pruning, 75% pruning, and open condition and four weed management practices (W1: Pendimethalin at 1.0 kg a.i. ha^{-1} at 3 days after sowing. W2: Pendimethalin at 1 kg ha^{-1} at 3 days after sowing followed by Bispyribac sodium. W3: hand weeding at 30 and 60 DAS, W4 weedy check) put under sub plots. Each treatment combination replicated five times. Data pertaining to growth and yields of crop gathered and was subjected to statistical analysis of variance, as Gomez and Gomez (1984) [7] suggested. The soil samples were collected from each replication at 0-15 cm depth of soil surface during initial stage of crop *i.e.* before sowing and at the time of harvesting of crop to assess the nutrient status of soil by following standard methods of soil chemical analysis (Table 1).

Table 1: Soil Chemical Analysis Methods

Soil Chemical Test	Method adopted
Soil pH	Combined glass electrode pH (Jackson, 1973) [9]
Soil Electrical Conductivity (mS/cm,)	Conductivity meter (Piper, 1950) [18]
Soil Organic Carbon%	Walkey and Black's, 1934 [21]
Available Nitrogen (Kg Ha^{-1}.)	Subbiah and Asija, 1956 [20]
Available Phosphorus (Kg Ha^{-1}.)	Olsen *et al*. 1954 [15]
Available Potassium (Kg Ha^{-1}.)	Merwin and Peech (1951) [13]

3. Result and Discussion

After all the observations were examined and the following results were obtained:-

3.1 Electrical conductivity

The electricity conductivity of soil was determined in each year of experimentation at harvest of crop and data were pooled for further interpretation. It is clear from the data (Table -2) that the value of electrical conductivity slightly reduced during second year over previous, however, neither the pruning intensity nor the weed management practices pose any significant effect on electrical conductivity. However, the electrical conductivity values should Trend over the years and as compared with initial.

3.2 Soil Reaction (pH)

As depicted in Table-2 pH of soil was determined after the harvest of crop during both the years of experimentation and compared with the initial value. The hydrogen ion concentration (pH) of soil did not changed due to neither with the change of pruning nor with herbicidal treatments in any of the year. Moreover, the slight reduction in pH value were observed over the year and initial values.

Table 2: Physical properties of soil as influenced by various pruning and herbicidal treatment in agroforestry.

Treatment	Electrical conductivity (ds/m)			Soil reaction (pH)		
	I Year	II Year	Pooled	I Year	II Year	Pooled
Initial value	0.43			7.02		
Pruning intensity						
P0 - 0% Pruning	0.48	0.47	0.47	7.06	7.04	7.05
P1 – 25% Pruning	0.49	0.48	0.49	7.78	7.21	7.49
P2 – 50% Pruning	0.49	0.48	0.49	7.48	7.33	7.4
P3 – 75% Pruning	0.51	0.49	0.5	7.3	7.47	7.39
Open (without tree)	0.49	0.46	0.47	7.33	7.32	7.32
SE(m)±	.02	.02	.03	0.08	0.06	0.07
C.D. at 5%	NS	NS	NS	NS	NS	NS
Herbicidal treatment						
W1 – Pendimethalin@ 1.0 lit/ha as PE at 3 DAS	0.49	0.48	0.48	7.24	7.14	7.16
W2 – Pendimethalin @ 1.0 lit/ha as PE at 3 DAS +Bispyribac sodium@25 g/ha PoE at 25 DAS	0.48	0.47	0.48	7.4	7.14	7.32
W3 – Hand weeding at 30 and 60 DAS	0.49	0.48	0.49	7.36	7.27	7.32
W4 – Weedy check	0.5	0.47	0.49	7.4	7.36	7.38
SE(m)±	0.03	0.04	0.035	0.07	0.06	0.06
C.D. at 5%	NS	NS	NS	NS	NS	NS

3.3 Organic Carbon

It is evident from the data that each treatment as individual and in combination to each other conditions had positive effect on increasing the organic carbon content in soil. The percent of organic Carbon content in soil is highest (0.68%) which observed under no pruning closely followed by pruning level at 25%. The lowest content of OC (0.51%) recorded in open condition, However all these values were markedly higher over initial values. The treatment applied for control of weeds in rice cop did not find effective for bringing out any significant change in content of organic carbon among the treatments. Moreover, the values for OC% recorded under different weed control treatments and proved superior over initial values.

Table 3: Effect of various pruning intensity and herbicidal treatment on Organic Carbon%.

Initial Value	**0.49**				
Treatments	**W1**	**W2**	**W3**	**W4**	**Mean**
P0 - 0% Pruning	0.68	0.65	0.69	0.59	0.65
P1 – 25% Pruning	0.63	0.64	0.65	0.52	0.61
P2 – 50% Pruning	0.6	0.61	0.62	0.53	0.59
P3 – 75% Pruning	0.6	0.62	0.6	0.51	0.58
Open (without tree)	0.55	0.59	0.50	0.60	0.56
Mean	0.62	0.62	0.61	0.55	

	Pruning intensity	**Weedicidal treatment**	**pruning intensity x herbicidal treatment**
SE(m)±	0.019	0.011	0.034
C.D. at 5%	0.06	NS	NS

3.4 Studies on changes in soil behaviour under *Dalbergia sissoo* based Agroforestry system (NPK).

To study the effect of various pruning intensities and herbicidal treatments on nutrient content in post harvest soils Data presented in Table indicated that pruning intensity pose a significant effect on status of nutrients in post harvest soil during both the years and pooled data.

The, available N, P and K increased with decreasing intensities from 75 pruning to no pruning. Hence, highest value were recorded under no pruning which was significantly superior over other pruning treatments except P 25%. The 75% pruning and open condition recorded the lowest content NPK. From pooled data it was noted that with the increasing of pruning intensity significantly decreased the NPK status of soil hence higher content of 308.14, 14.78 and 387.18 kg / ha of nitrogen, phosphorus and potassium respectively. Where, the lowest NPK status was observed under open condition and possess the values of 247.68, 11.26 and 282.12 kg/ ha respectively.

Further it was also noted that the differences between no pruning and 50% pruning was found significant but the two closer percent like no pruning and 25% similarly 50% and 75% were not significant for all the three major nutrients.

On the other hand, weed control treatments did not affect the status of major nutrient (NPK) in post harvest soils. However, the content of N, P and K markedly increased over initial status with respect to N, P and K content.

Table 4: Nitrogen Phosphorus Potassium status of soil as influenced by various pruning and herbicidal treatment in agroforestry.

Treatment	**Nitrogen (Kg/ ha)**			**Phosphorus (Kg/ ha)**			**Potassium (Kg / ha)**		
	2020	**2021**	**Pooled**	**2020**	**2021**	**Pooled**	**2020**	**2021**	**Pooled**
Pruning intensity									
Initial values	259.8			11.8			272		
P0 - 0% Pruning	309.52	308.26	308.89	14.65	14.91	14.78	305.45	368.90	337.18
P1 – 25% Pruning	296.16	294.90	295.53	13.85	13.84	13.85	300.61	302.88	301.75
P2 – 50% Pruning	281.60	273.75	277.68	12.76	12.74	12.75	295.28	297.95	296.62
P3 – 75% Pruning	276.03	266.30	271.17	12.07	12.02	12.05	287.78	286.93	287.36
Open (without tree)	240.87	254.43	247.65	11.13	11.39	11.26	284.18	280.05	282.12
SE(m)±	4.76	4.05	3.90	0.73	0.87	0.85	3.31	7.02	5.09
C.D. at 5%	14.30	16.8	15.5	2.10	2.50	2.31	9.90	21.0	15.30
Herbicidal treatment									
W1 – Pendimethalin @ 1.0 lit/ha as PE at 3 DAS	288.80	283.00	285.90	13.02	13.00	13.01	302.02	300.88	301.45
W2 – Pendimethalin @ 1.0 lit/ha as PE at 3 DAS +Bispyribac sodium @ 25 g/ha PoE at 25 DAS	282.10	281.20	281.65	12.86	12.80	12.83	299.00	295.14	297.07
W3 – Hand weeding @ 30 and 60 DAS	277.66	279.58	278.62	12.64	12.54	12.59	294.36	292.68	293.52
W4 – Weedy check	274.34	274.32	274.33	12.48	12.20	12.34	285.64	290.26	287.95
SE(m)±	3.91	2.04	3.80	0.94	0.85	0.90	1.89	2.06	1.90
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Similar results were obtained by Pareek and Sharma (1993) [16] that tamarind in pastoral system is able to fix nitrogen in soil. Similarly, improvement in soil was reported by Kumar *et al*., 2009 [12] in Aonla based horti-pastoral system. Kumar and Shukla (2010) [11] also reported nutritional buildup of soil in association with trees was better in all respect *viz*. organic carbon, available nitrogen, phosphorus and potash as compared to sole pasture crop in 10 years old grown plantation. Berry *et al*., 2021 also reported that soil nutrients increases in agroforestry system as compared to sole cropping.

4. Conclusion

Thus, the study suggests that Agroforestry landuse system proved most compatible with leguminous tree like *D. sissoo* in terms of maximizing soil nutrition status and canopy management proves to play important role in increasing soil nutrient status. Canopy with 0% pruning proves best for increasing soil nutrient followed by 75%, 50%, 25% pruning and minimum increase in soil nutrient was found in open cropping.

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