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Response of wheat to varied pruning and weed management practices under *Dalbergia sissoo* Roxb. Based Agrisilviculture system

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Abstract

In the year 2020-21, an experiment was conducted at JNKVV, Jabalpur, Madhya Pradesh, to evaluate the influence of pruning and weed control measures on wheat production and yield contributing characteristics when cultivated under a 22-year-old *Dalbergia sissoo*-based Agrisilviculture model. The performance of wheat in an agroforestry system with various pruning regimes such as light, moderate, heavy, and no pruning was compared to that of wheat grown in open settings. Maximum plant height (92.57 cm), number of effective tillers per metre row length (89.48), length of ear head (8.21 cm), grain production (2812.07 kg ha^{-1}), and straw yield (4449.55 kg ha^{-1}) were observed under heavy, significantly at par with moderate pruning, while lowest under light and no pruning in the agroforestry system. Heavy, moderate, light, and no pruning treatments reduced wheat grain production by 19 percent, 25 percent, 36 percent, and 39 percent, respectively, as compared to the open condition or solitary wheat cropping. Weed management measures considerably increased wheat production and yield contributing factors compared to control plots where no weed management practises were used.

Keywords: *Dalbergia sissoo,* wheat, Agrisilviculture, pruning intensities, weed management

1. Introduction

Agroforestry is a land-use system that integrates trees with crops and animals. It is urgently needed in many regions of the nation to address issues such as land degradation, soil erosion, and deforestation. During the tree's gestation phase, intercropping is both economically and ecologically beneficial. Growing fast-growing trees alongside arable crops would not only enhance the long-term viability of agricultural systems, but it will also diversify farmer income, fulfil the raw material needs of wood-based businesses, create jobs, and provide food security. *Dalbergia sissoo* Roxb. Is a deciduous, fast-growing, hardy, and medium to a large-sized multifunctional tree that possesses the nitrogen-fixing potential and produces excellent quality lumber, high-calorie fuel wood, and crude protein-rich feed (Singh and Sharma, 2007; Jackson, 1987) [32, 14]. It is widely regarded as a good agroforestry plant in Central India because of these benefits (Bhargava and Rai, 2019; Patel *et al*., 2017) [3, 25]. Wheat is a staple crop around the world, including in India. Crop yields in agroforestry are often lower than in agriculture. However, crop yields may be boosted by using correct weed control techniques in crop and tree canopy management techniques like pruning. Farmers commonly believe that trees compete heavily with agricultural crops for light, moisture, and nutrients (Dhyani *et al*., 1990) [8]. With the expansion of the tree component and the formation of a permanent canopy above head, this rivalry becomes even fiercer. However, most Indian farmers are unaware that by properly managing the tree component, interactions between tree and crop may be avoided to a large amount. There are a variety of canopy management techniques that guarantee sufficient solar light reaches the crop and decrease yield loss due to shadow (Kar *et al*., 2019a; Kar *et al*. 2019b; Kar *et al*. 2019c) [15, 16, 17]. Pruning is one such excellent canopy management method, as it is an effective tool for reducing competition for precious resources (Dhillon *et al*., 2010; Upadhyaya and Nema, 2003; Frank and Eduaro, 2003) [7, 35, 10]. It not only lets more light into the system and minimizes competition, but it also gives an intermediate yield of tiny timbers and fuel wood, improves tree form, and increases the quality of the wood (Sahu and Kumar, 2015; Rani *et al*., 2011; Manhas *et al*., 2011; Newaj *et al*., 2010; Bari and Rahim, 2010; Takiya *et al*. 2010; Rai *et al*., 2008; Newaj and Dar, 2007) [31, 29, 20, 22, 2, 34, 28, 21]. This experiment aimed to determine the optimal pruning intensity of *D. sissoo* trees and the best weed control practices for maximizing wheat output in a *D. sissoo*-based Agrisilviculture System.

2. Materials and Methods
2.1 Experimental location, topography and climate-
The experiment was set up in the departmental research area of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP), located at 23o 12' 50" North latitude and 79o 57' 56" east longitude. This location is part of the Kymore Plateau and Satpura hill agro climatic zone, with a subtropical climate with hot, dry summers and cold, dry winters. In May and June, the temperature reaches 46 °C, while in December and January, it drops to 2 °C. The average annual rainfall in the area is 1350 mm, with most of it falling between June and September. The soil is reasonably deep black, and the region is simple to softly sloppy (0-1 percent).

2.2 Experimental details
The research was carried out in a Dalbergia sissoo Agrisilviculture model that had been in place for 22 years. D. sissoo 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 and wheat in Rabi every year. During the Rabi season, this study was carried out to determine the impact of various pruning regimes and weed control strategies on wheat production and yield contributing elements. Wheat of the JW3288 type was selected and planted at a 20 cm line interval. The entire experiment was carried out in a strip plot design, with five main plot treatments: 0% pruning, 25% pruning, 50% pruning, 75% pruning, and open condition (sole wheat crop); and three weed management practises (W1: pendimethalin @ 1.0 kg a.i. ha-1 at 3 days after sowing followed by one hand weeding at 30 days after sowing, W2: pendimethalin @1 kg ha-1 at 3 days after sowing followed by metribuzin at 30 Each therapy combination was tested five times. The information gathered was submitted to statistical analysis of variance, as Gomez & Gomez (1984) [11] recommended.

2.3 Parameters estimation
2.3.1 Plant height (cm): At the harvesting stage, the plant height was measured in centimeters from the ground level up to the base of the last fully open leaf. Ten random plants were selected from each treatment plot for height measurement and obtained mean height.

2.3.2 Numbers of effective tillers per meter row length: The tillers producing ear heads are termed effective tillers. Total numbers of effective tillers per meter row length at harvesting stage were recorded by counting from five marked rows (one meter row length) in each plot and then the mean values were obtained by dividing the summation of five by five.

2.3.3 Length of ear head (cm): Ten ear heads from each plot was selected randomly at the time of harvesting and length was measured from the base to tip of the ear head. Thereafter, average of 10 readings was made.

2.3.4 Grain yield (kg ha^{-1}): Net plot grain yield was obtained by weighing the grains after proper winnowing and cleaning. It was then converted to grain yield per hectare basis by dividing the grain yield per plot by net plot area and multiplying with 10,000.

2.3.5 Straw yield (kg ha^{-1}): The straw yield of each plot was determined by subtracting the grain yield from the bundle weight of the crop of respective plots. The obtained values were converted into straw yield per ha by diving with net plot straw yield by net plot area and then multiplying with 10,000.

3. Results
Among the main plot treatments, all the yield contributing characters, grain yield and straw yield, increased with an increase in pruning intensity and light intensity in the system (table 1). Maximum plant height (96.12 cm), number of effective tillers per meter row length (95.89), length of ear head (8.25), grain yield (3477.61 kg ha^{-1}), and straw yield (5113.67 kg ha^{-1}) were recorded under open condition (sole wheat) and significantly higher than that under *D. sissoo* based agroforestry system. However in the agroforestry system, among the different pruning intensity treatments, maximum plant height (92.57 cm), number of effective tillers per meter row length (89.48), length of ear head (8.21 cm), grain yield (2812.07 kg ha^{-1}) and straw yield (4449.55 kg ha^{-1}) were recorded under heavy pruning (75%), which were at par with the plant height (90.48 cm), number of effective tillers per meter row length (88.35), length of ear head (7.89 cm), grain yield (2588.17 kg ha^{-1}) and straw yield (4252.05 kg ha^{-1}) under moderate pruning treatment (50%). While, minimum plant height (81.95 cm), number of effective tillers per meter row length (80.36), length of ear head (6.89 cm), grain yield (2087.97 kg ha^{-1}) and straw yield (3699.46 kg ha^{-1}) were recorded under zero pruning treatment (0%), which were at par with the plant height (86.47 cm), number of effective tillers per meter row length (85.46), length of ear head (7.51 cm), grain yield (2226.03 kg ha^{-1}) and straw yield (3765.02 kg ha^{-1}) under light pruning treatment (25%).
Among weed management practices (table 1), maximum plant height at harvest (96.25 cm), number of effective tillers per meter row length (96.78), wheat grain yield (2860.33 kg ha^{-1}) were reported in plots treated with pendimethalin + hand weeding (W_1), which were at par with plant height at harvest (94.46 cm), number of effective tillers per meter row length (94.58), wheat grain yield (2759.77 kg ha^{-1}) under pendimethalin + metribuzin (W_2) treatment. However maximum length of ear head (8.47 cm) and wheat straw yield (4676.56 kg ha^{-1}) were reported under pendimethalin + hand weeding (W_1) treatment. While, minimum plant height at harvest (90.35 cm), number of effective tillers per meter row length (84.83), length of ear head (6.90 cm), wheat grain yield (2295.00 kg ha^{-1}), and wheat straw yield (3581.12 kg ha^{-1}) were reported under weedy check (W_3) treatment.

Table 1: Effect of pruning intensities *D. sissoo* and weed management practices on yield and yield contributing parameters of wheat under Agrisilviculture system

Main plot treatments	Plant height at harvest (cm)	No. of effective tillers/ MRL	Length of ear head (cm)	Grain Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})
P_0- Zero pruning (0%)	81.95	80.36	6.89	2087.97	3699.46
P_{25}- Light pruning (25%)	86.47	85.46	7.51	2226.03	3765.02
P_{50}- Moderate pruning (50%)	90.48	88.35	7.89	2588.17	4252.05
P_{75}- Heavy pruning (75%)	92.57	89.48	8.21	2812.07	4449.55
Sole wheat (Agriculture)	96.12	95.89	8.25	3477.61	5113.67
C.D. (0.05)	4.57	6.36	0.62	242.02	391.80
S.Em±	1.16	2.18	0.21	80.73	130.70
Sub plot treatments (Weed management practices)					
W_1- Pendimethalin + Hand weeding	96.25	96.78	8.47	2860.33	4676.56
W_2- Pendimethalin + Metribuzin	94.46	94.58	7.93	2759.77	4510.18
W_3- Weedy check	90.35	84.83	6.90	2295.00	3581.12
C.D. (0.05)	3.35	5.17	0.16	116.94	193.32
S.Em±	1.12	1.67	0.05	35.86	59.29

4. Discussion

This study aimed to see how pruning intensity and weed control strategies affected wheat production and yield contributing characteristics in a Dalbergia sissoo-based Agrisilviculture system. Compared to an agroforestry system, yield and yield contributing factors were higher in open circumstances, i.e., without trees. The most likely reason for this is that in an open environment, more light is accessible to the crop, resulting in a better rate of photosynthesis, cell multiplication, and, eventually, a larger yield. Puri *et al*. (2001) [27] observed that when a wheat crop was grown beneath Ceiba pentandra, the growth and yield contributing features were altered by trees as compared to solitary cropping. Goyal *et al*. (2001) [13]; Pandey *et al*. (2001) [24]; Islam *et al*. (2006); Karwar *et al*. (2006) [18]; Dhillon *et al*. (2007) [6]; Palai *et al*. (2021) [23]; Sahoo *et al*. (2007) have all found similar findings (2020). However, yield and yield were contributing factors when the pruning intensity and light intensity in the agroforestry system grew. Heavy and moderate pruning treatments produced yields comparable to and considerably superior to light and no pruning treatments. Droppelmann *et al*. (2000) [9] observed that pruning boosted intercrop production in Acacia saligna trees as compared to unpruned trees in a comparable experiment. In Albizia procera, Dar (2007) [5] found that 70 percent pruning substantially increased the growth and yield contributing features of black gram, green gram, mustard, and wheat compared to 50 percent pruning and no pruning treatment. Thakur and Singh (2008); Singh *et al*. (2020) [33]; Patel *et al*. (2017) [25]; Kosta and Sahu (2017) all came to similar conclusions (2016). However, wheat's highest production and yield contributing characteristics were reported under pendimethalin + hand weeding, followed by and on par with pendimethalin + metribuzin, and considerably superior to weedy check plots where no weed control measures were used. This was attributable to the removal of weed competition and improved aeration owing to surface soil manipulation, resulting in increased yield in hand-weeding plots. These findings are comparable to those of Abbas *et al*. (2016) [1], Kumar *et al*. (2015) [31], Chandrakar (2015) [4], and Goud *et al*. (2015), (2013) [12].

5. Conclusion

Crown management strategies play an essential role in enhancing crop output in an agroforestry system. Pruning enhances the quality of the wood and the straightness of the bole, as well as allowing light to penetrate up to the agricultural produce zone. Heavy, moderate, light, and no pruning treatments reduced wheat grain production by 19 percent, 25 percent, 36 percent, and 39 percent, respectively, compared to the open condition or solitary wheat cropping. In this experiment, the highest yield and yield contributed characteristics were found under moderate and severe pruning, whereas the lowest yield and yield contributed characters were found under no pruning and light pruning. Crop yield reductions in agroforestry can be offset by lumber and fuel wood yields from the tree component.

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