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EFFECT OF LOPPING INTENSITIES ON TREE GROWTH AND GRASS YIELD UNDER SHISHAM (*DALBERGIA SISSOO*) BASED SILVIPASTORAL SYSTEM ON SODIC LAND

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SUMMARY

The study was carried out during 2011-12 in *Dalbergia sissoo* based silvipastoral system raised on sodic land at Main Experiment Station (Forestry) of Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad. The silvipastoral system had *D. sissoo* in combination with three stress tolerant perennial grasses viz., *Pennisetum purpureum, Brachiaria mutica* and *Panicum maximum*. The investigated area was divided into five equal quadrats (20 x 25 m size) within 0.25 ha area. Of these, four quadrats were chosen for trials of different intensities of lopping (25, 50, 75 and 100% lopping intensities) and one quadrat was treated as control (0% lopping intensity). Initial tree height across different lopping intensities ranged from 12.8-15.2 m (averaged 13.9 m) and dbh from 10.8-13.9 cm (averaged 12.4 cm). Across lopping intensities tree growth increments were maximum in rainy season (Tree height increment = 0.20-0.60 m/season; dbh increment = 0.20-0.80 cm/season) followed by summer season. Interestingly, there was a clear cut decrease in growth along increasing lopping intensity. Across lopping intensities, the annual green fodder yield for *P. purpureum* grass was found maximum (33.6-45.5 t/ha; average, 40.54 t/ha), followed by *B. mutica* (19.4-28.9 t/ha). There was a clear cut increase in herbage yield of all three grasses along increasing lopping intensities under this study.

Key words : *Dalbergia sissoo*, herbage yield, lopping intensity, silvipastoral system

Sustainable management of an agroforestry system depends on tree component that adapts well against existing physical and biotic stress of the site. Extremely nutrient poor salt affected soil (saline soil with alkaline character) in several parts of eastern Uttar Pradesh creates an inhospitable environment for agricultural production. However, due to high ecological amplitude, certain tree species are salt tolerant and capable of enduring high soil pH. *Dalbergia sissoo*, being an early successional tree species with nitrogen fixing characteristics, is capable of growing under such soils. Apart from this, it also indicates potential recovery after lopping as well. It provides high quality timber and also preferred for fuel and fodder in India.

There are reports on effect of artificial defoliation on stand yield (Harper, 1977) and impact of herbivores feeding on plant growth rate (Crawley, 1983) and pruning on foliage production (Kotwal, 1981; Nik Muhammad and Paudyal, 1992). Effects of lopping on growth of trees and stand productivity have also been reported by certain workers (Gorric, 1937; Bhimaya *et al*., 1964; Poulsen, 1983). Better spatio-temporal use in silvipastoral system with forage as inter-crops has been documented by several workers of northern India (Dev Roy *et al.*, 1980). However, the information on impact of lopping on tree growth under extremely nutrient poor sodic soil is meagre. To understand the effect of lopping intensity on tree growth, the sustainable leaf harvest level of twigs of trees is important. The major criteria for selecting *D. sissoo* were based on its winter deciduous character. The other criteria were nitrogen fixing character of the species helpful for improving fertility status of sodic soil under silvipastoral system. The first objective of this study was to assess the growth of *D. sissoo* trees under different levels of lopping intensities under silvipastoral system on sodic soil and the second objective was to compare forage yield of three selected grasses (*Pennisetum purpureum*, *Brachiaria mutica* and *Panicum maximum*) under same system.

MATERIALS AND METHODS

The site lies (26°47′ N lat. and 82°12′ E long.) in the Indo-Gangetic plains and is located about 42 km in south-west direction of Faizabad town at 113 m elevation. The climate of the area is governed by south-west monsoon. The sodic soil of open adjacent area had greater bulk density (0.99 g/cm^3; up to 30 cm soil depth) than soil of *D. sissoo* based silvipastoral system (0.96 g/cm^3) under present study. Greater soil pH (10.30), EC (3.52 dS/m) and ESP (38.96) were evident for open area than silvipastoral system (pH 8.6, EC 1.5-2.0 dS/m, ESP 25.8). Lower organic carbon (0.167%) was indicated in the soil of open area than value (0.31%) for silvipastoral system. Trees of *D. sissoo* were spaced at 8 x 4 m distance. Between rows of trees, three grass species were planted in randomized block design. Under this system, trees were given different lopping intensities to investigate tree growth and its effect on grass yield. The investigated area was divided into five equal quadrats (20 x 25 m size) within 0.25 ha area. Of these, four quadrates were chosen for trials of different intensities of lopping (25, 50, 75 and 100% lopping intensities) and one quadrate was treated as control (0% lopping intensity). All trees were identified and marked with metal tags in each of the quadrates. A black strip was painted at breast height on all the trees. All marked trees were lopped by a fixed intensity in each quadrate. Lopping of the trees was done during February 2011. Tree height and dbh for *D. sissoo* trees were measured in the beginning of the experiment and after the end of each season in the annual cycle. Tree height was measured by Ravi-multimeter. The dbh for forest species was determined with the help of caliper (Misra, 1968).

RESULTS AND DISCUSSION

Seasonal pattern of tree growth of *D. sissoo* in different lopping intensities under silvipastoral system on sodic land is presented in Table 1. *D. sissoo* trees were lopped from 0 to 100 per cent intensity which affected the tree height and diameter at breast height (dbh). The results showed that as the time period increased the height and dbh also increased. Maximum height and dbh increment were recorded in control (0% lopping intensity), whereas the height (Fig. 1) and dbh (Fig. 2) of *D. sissoo* tree decreased with increase in lopping intensity from 25 to 100 per cent. Vishwanatham *et al.* (1999) observed that lopping intensity did not affect tree survival and also canopy growth in most years, but collar diameter and dbh decreased significantly at higher intensity of lopping. Height and dbh of *D. sissoo* trees increased from June to October, 2011 and then decreased in February 2012 which might be due to low temperature. Similarly, observations were also reported by Tewari (1998) that the effect of season was mainly responsible for the large variations in height and diameter growth of the *Acacia tortilis* and also observed that for height growth winter is the better season of lopping followed by monsoon and summer season. In dry summer, high temperature increases loss of photosynthetic produce through greater respiration in the plants, whereas during

TABLE 1
Seasonal pattern of tree growth in *D. sissoo* trees under silvipastoral system on sodic land during 2011-12

Lopping intensity of *D. sissoo* trees (%)	February (2011) (Initial growth)		June (2011) (Summer)		October (2011) (Rainy)		February (2012) (Winter)	
	Tree height (m)	dbh (cm)	Tree height (m)	dbh (cm)	Tree height (m)	dbh (cm)	Tree height (m)	dbh (cm)
0	13.1	13.9	13.6	14.4	14.2	15.2	14.55	15.5
25	15.1	13.1	15.5	13.5	16.0	14.2	16.3	14.5
50	13.4	11.6	13.7	12.0	14.2	12.6	14.5	12.9
75	12.8	10.8	13.0	11.1	13.4	11.5	13.7	11.7
100	15.2	12.7	15.3	12.9	15.5	13.1	15.6	13.3
Average	13.9	12.4	14.2	12.8	14.7	13.3	14.9	13.6
C. D. (P=0.05)	0.54	0.43	0.35	0.42	0.25	0.42	0.56	0.45

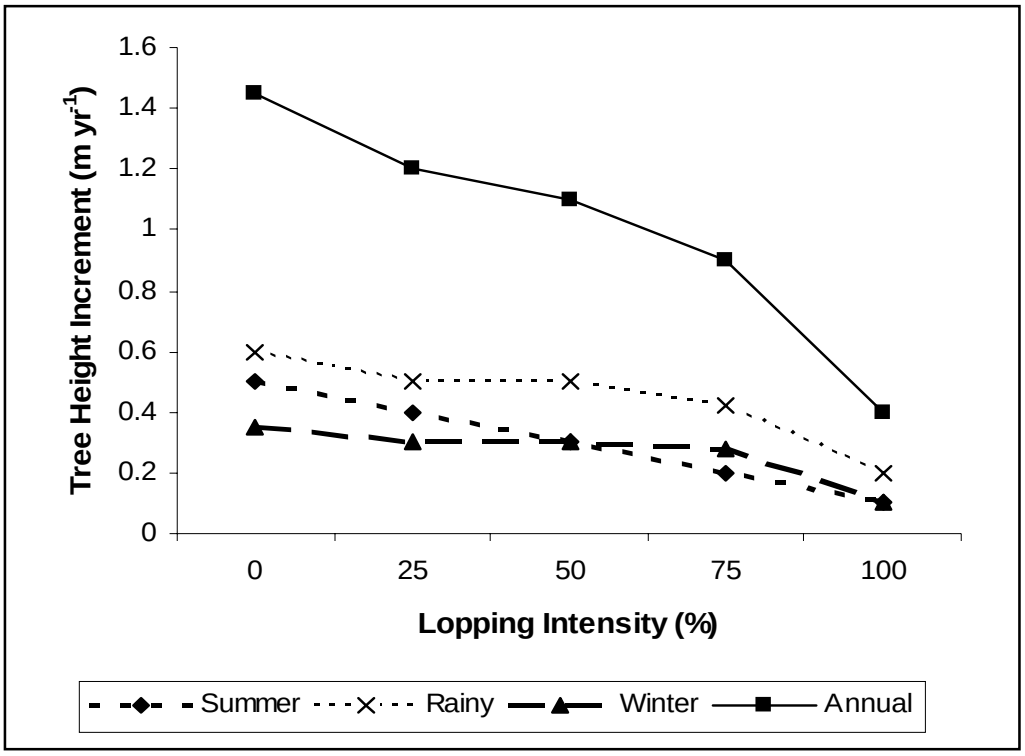

Fig. 1. Effect of lopping on tree height increment of *D. sissoo* trees on sodic land.

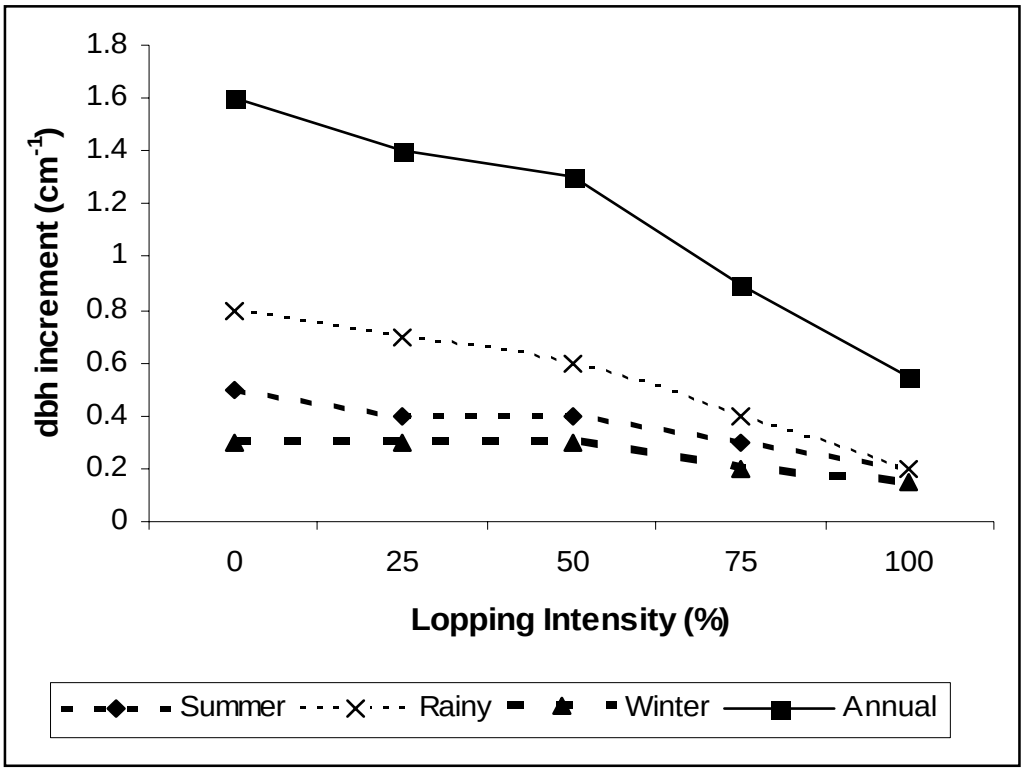

Fig. 2. Effect of lopping on tree dbh increment of *D. sissoo* trees on sodic land.

winter lower atmospheric temperature negatively affects the physiological processes leading to slower photosynthesis rate. In case of most of the deciduous species, during winter overall efficiency is reported leading to senescence observed by Rana (1985).

Green herbage yield for three grasses planted in combination with *D. sissoo* trees under silvipastoral system on sodic land is presented in Table 2. Under different lopping intensities, herbage yield of all the three grasses was found maximum in rainy season followed by summer season and minimum in winter season under the tree canopy. The average green herbage yield of *P. purpureum* grass was found maximum (33.6-45.5 t/ha, average 40.54 t/ha), followed by *B. mutica* (19.4-28.9 t/ha) and was found minimum in *Panicum maximum* (20.3-27.3 t/ha). There was a clear cut increase in seasonal herbage yield of all three grasses along increasing lopping intensities of *D. sissoo* trees. Climate and biotic conditions have a remarkable effect on productivity of any ecosystem reported by Sims and Singh (1978). Since this study on silvipastoral system was carried out under rainfed condition, the active growth of grasses was triggered by the advent of monsoon rain and peak value of aboveground herbage across all lopping intensities was attained in rainy season. According to Saxena *et al.* (1996) during winter with lowering of temperature, there was marked accumulation of belowground biomass, perhaps due to translocation of food reserves to the belowground parts with the advent of unfavourable conditions for shoot growth. With increase in lopping intensity from 0 to 100 per cent, the forage yield of all the three grasses increased. Maximum forage yield of grasses was recorded under 100 per cent lopping intensity, while minimum in control (0% lopping intensity). Singh (2014) also reported that Jatropha plantation had significant effect on the growth and yield of *Brassica juncea, Eruca sativa, Cicer arietinum* and *Hordeum vulgare* during both the years of experimentation. However, the growth, yield and yield attributes of all the test crops were reduced more in second year as compared to first year of experimentation. Samra *et al*. (1999) reported that the effect of tree species on different growth parameters of grasses was not uniform with *G. optiva* and *B. prupurea* causing comparatively more synergistic effect on clump height and clump diameter, respectively. Although the performance of grasses was good under *A. lebbek* and *L. leucocephala* in the early years, these tree species resulted in the lowest grass dry weight in the later years. The beneficial effect of higher lopping intensity of 75 per cent was observed on the growth and biomass production of grasses over 50 per cent lopping, presumably due to increased light penetration into the under-story. The biomass production of grasses reached a maximum at four years of growth. After which, it decreased gradually to less than half. The total biomass production was highest in association with *B. purpurea* followed by *G. optiva*, which appeared to be the most suitable tree species along with *E. binata* for sustainable silvopasture development on the marginal lands. Singh and Bishnoi (2010) reported that the fodder yield was generally more from the trees that were lopped annually as compared to those lopped once in two years or once in three years. It was also observed that the yield of forage increased as the tree girth increasesd. The results obtained led to the conclusion that *P. cineraria* trees should be lopped annually to gain maximum fodder yield.

TABLE 2

Forage (green fodder) yield (t/ha) for three grasses under *Dalbergia sissoo* based silvipastoral system on sodic land

Lopping intensity (%)	Seasonal yield			Total (Annual) yield
	Summer	Rainy	Winter	
	Pennisetum purpureum			
0	9.40	18.40	5.80	33.60
25	10.20	20.40	6.90	37.50
50	11.80	22.80	7.40	42.00
75	12.40	23.90	7.80	44.10
100	12.80	24.30	8.40	45.50
Average	11.32	21.96	7.26	40.54
C. D. (P=0.05)	0.14	0.20	0.08	0.08
	Brachiaria mutica			
0	6.80	9.70	2.90	19.40
25	7.50	10.80	3.10	21.40
50	8.60	11.60	4.60	24.80
75	9.10	12.90	5.30	27.30
100	9.40	13.60	5.90	28.90
Average	8.25	11.72	4.36	24.36
C. D. (P=0.05)	0.10	0.58	0.16	0.85
	Panicum maximum			
0	8.40	9.80	2.10	20.30
25	9.20	10.50	2.50	22.20
50	9.60	11.60	2.90	24.10
75	10.10	12.10	3.50	25.70
100	10.80	12.70	3.80	27.30
Average	9.62	11.34	2.96	23.92
C. D. (P=0.05)	0.14	0.21	0.32	0.75

It can also be concluded that the trees with an optimum girth (girth > 60 cm) should be lopped for higher returns in the form of fodder production. The effect of different lopping intensities (moderate, heavy or not lopped) of *Prosopis cineraria* (jand) on herbage production and ground vegetation cover was studied and observed that more herbage production and better ground vegetation cover were found beneath the unlopped trees and was not much different between the two lopping treatments in these respects. Biomass production per tree under the two treatments was 97.8 and 63.3 kg green weight, respectively, for the heavy and moderate lopping (55.6 and 33.8 kg dry weight) reported by Sardar (1990).

Increase in lopping intensities of a *D. sissoo* tree under silvipastoral system on sodic wasteland significantly affected the height and dbh increment of the *D. sissoo*. Moreover, decrease in lopping intensities increased the possibility of above ground grass biomass production and also found that *P. purpureum* was most suitable grass species grown under *D. sissoo* based silvipastoral system.

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