Effect of Conventional Lopping of *Prosopis cineraria* on soil moisture, soil erosion and herbage production

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Abstract

This study was conducted to determine the effect of different lopping intensities of *Prosopis cineraria* (Jand) on soil moisture, soil loss, herbage production and ground vegetation cover. Twelve sample trees of almost uniform size were selected in Rakh Dagar Kotli, Thal. The lopping treatments were assigned randomly to the sample trees. The study showed that jand trees play an important role in protecting the soil and ground vegetation from harmful effects of prevailing harsh climatic condition in the Thal desert. Accordingly, more soil moisture and less soil erosion losses were found under unlopped trees. Similarly herbage production with better ground vegetal cover was also found beneath the unlopped trees.

Introduction

Prosopis cineraria commonly known as Jand or Kandi is indigenous to the semi-arid and arid zones of Pakistan. It is fairly distributed in the Punjab plains and Sindh. The annual rainfall in these localities varies from 75 mm to 635 mm. The minimum temperature in the area drops as low as 0^0C and maximum temperature rises as high as 50^0C. Ground water level varies from a few meter to 30 m below surface. The soil of the tract is lose and is subject to wind erosion resulting in sand dune formation.

Jand is a medium-sized thorny tree. It is a drought resistant and frost hardy tree species. It grows well in alluvial sandy loam soils and is salinity tolerant. It may attain a maximum height of 15 meter and diameter at breast height of 60 cm. It is a deep rooted tree species and its tap root may penetrate 25 m to 36 m in the soil. It is a multipurpose tree species. Its wood is used for building material, furniture, agricultural tools, fuelwood and charcoal making. The brush wood is also used for hedges. Its leaves, pods and succulent twigs are used as fodder. Camels and goats relishly browze it (Parkash *et. al.* 1980, Sheikh, 1986 amd Troups, 1921).

The conventional complete lopping of Jand trees for fuelwood and leaf fodder is commonly practiced in its habitat where it grows on farm boundaries and uncultivated lands. Bhimaya *et. al.*, (1964) have reported that the tree is completely lopped for its nutritional leaf fodder in India. Further, complete lopping yielded more fodder but the recurring lopping decreased its production. On the other hand, Srivastava (1978) found that complete lopping on annual basis produced higher fodder with no detrimental loss on tree growth or fodder yield. Similar studies have not been carried out in Pakistan to investigate the effect of lopping on leaf fodder yield or its effect on associated parameters. Accordingly, this study was undertaken in Dagar Kotli, Thal to determine lopping effects on soil moisture, soil loss through wind erosion, herbage production and cover percent.

Materials and Methods

This study was carried out during February, 1988 in compartment number 13A of the reserved forest at Rakh Dagar Kotli. Twelve Jand trees of almost uniforms height, diameter and crown-width were selected for lopping treatments and their effect on soil moisture content, wind erosion and herbage production. Three lopping treatments namely; control (no lopping), moderate lopping (lopping upto mid-height of the tree) and heavy lopping (complete lopping upto top of the tree) were randomly assigned. The treatments were replicated 4 times (Table 1).

The trees assigned to moderate and heavy lopping treatments were lopped in January, 1988. The chopped off material was weighed (both green and air dried) for the biomass production. In order to investigate the effect of lopping treatments on soil moisture, wind erosion and herbage production, the following investigations were also conducted.

Table 1
Measurement of Jand Trees Assigned to Different Lopping Treatments.

Treatment	No. of trees in each treatment	Measurement: Average D. B. H.(cm)	Measurement: Average height (m)	Measurement: Average crown width (m)
1. Control (No lopping)	4	23.8	8.8	6.5
2. Moderate Lopping (Lopping upto mid-height of the tree)	4	24.4	8.3	6.1
3. Heavy Lopping (complete lopping upto top of the tree)	4	24.2	9.1	6.3

1. Determination of soil Moisture

Starting from stem, four lines indicating four directions namely; north, west and south were marked on the ground for all selected trees. Soil samples at a distance of 3 meter from stem and at 0.3 m depth were collected in all four directions with soil sample. Soil samples were taken during February and September, 1988 for seasonal variations. The fresh samples were weighed in the field and then brought to Pakistan Forest Institute, Peshawar. Each individual sample was dried in oven at 105^0C for 24 hours and was reweighed. The gravimetric method was applied to determine the soil moisture content using formula (Ww-Wd/Wd), where Ww is wet weight and Wd is dry weight.

2. Determination of soil Erosion Loss

Three parallel lines along the prevailing wind direction on leeward side of each sample tree were marked. The length of each line was 3 times height of the trees. Of these, central line was marked in alignment with the tree trunk. Other two lines were marked on two sides of the central line at mid-point beneath the left half and right half of crown width. Small wooden pegs 3 meter apart were fixed flush to ground on all the 3 lines. Data on soil removal(–) or soil deposit(+) on each point (peg) were recorded with mm ruler during April and July, 1988.

3. Determination of Herbage Production, Cover Percent and Species Composition

The directional lines of No. 1 above, around sample trees, were utilized for determination of forage production, cover percent and species composition. A quadrat of 1 × 1 m size was laid out on each direction at 3 meter distance from stem under the tree crown and data of ground vegetation were collected. Data of percent cover and species composition were recorded in February (control trees only), July and September, 1988. Forage production was determined in September, 1988 only. The distribution of surface material were recorded during July and September, 1988. For estimation of herbage production the ground vegetation was clipped in each quadrat and its fresh and air dry weight was found out.

Results and Discussions

The results are presented in contingency and multi-dimentional contingency tables. The marginal means and numerical frequencies, where necessary , are provided in the tables. The results are prepared by simple calculations without any statistical tests. The results are discussed as follows:

1. Soil Moisture Contents Under Jand Trees

The results indicated a higher value (14%) of soil moisture contents under unlopped trees in February and (61%) under heavy lopping in September, 1988. Moreover, the highest values of soil moisture contents were found in northern direction in all treatments both in February and September while these values were lowest in the southern direction. On an average, the soil moisture was 15% in February and 63% in September in northern direction as compared to 9% and 56% in the

southern direction (Table 2).

Table 2

Soil Moisture Contents Under Jand Trees at 0.3 m Depth Below Ground Surface

Treatment	N		E		W		S		Average	
	Feb.	Sep.	Feb	Sept.	Feb.	Sept.	Feb.	Sept.	Feb.	Sept.
1. Control	18	61	11	50	14	51	14	55	14	54
2. Moderate Lopping	13	62	7	61	6	61	4	57	8	60
3. Heavy Lopping	12	66	8	64	6	59	7	55	8	61
Average	15	63	9	58	9	57	9	56		

The study has indicated appreciable temporal variations in the soil moisture content. This was probably due to the seasonal variations in rainfall in the study area. The area received a heavy rainfall a few days before soil samples collection in September thus there was high soil moisture and low inter-directional and inter-treatments variation. The higher value of soil moisture contents under northern direction seems to be due to the fact that it is shady and hence has low soil temperature and vaporation loss. A higher value of soil moisture under unlopped trees suggests a positive role of trees in moisture conservation in the study area.

2. Soil Erosion Loss Under Jand Trees

It is difficult to estimate the soil loss through wind erosion during one season particularly on a small area. The results indicated a decrease in soil loss with increase in distance on leeward side of the control (unlopped) trees. However, no clear trend was noticed under moderate and heavy lopping treatments. The average soil loss under unlopped trees was 0.14 mm (36 percent) compared to 0.22 mm under heavy lopping in April 1988. Similarly, the average soil loss (0.4 mm) was less under unlopped trees as compared to 0.6 mm under heavily lopped trees at 3 meter away from tree base, Soil loss was almost negligible at 24m from tree base — a distance equal to 3 times height of the sample trees (Table 3).

Table 3

Effect of Lopping on Wind Erosion on Leeward Direction of Jand Trees upto 3 Times their Height in April 1988.

(Soil loss in mm)

Treatment	Distance from tree base (m)								Average
	3	6	9	12	15	18	21	24	
1. Control	.4	.2	.2	.1	.1	.1	.03	0	0.14
2. Moderate Lopping	.6	.5	.6	0	.3	+.3	.3	0	0.21
3. Heavy Lopping	.6	.2	+.1	.5	.03	.2	.2	.1	0.22

Note: Plus(+) sign indicates soil deposition.

Wind erosion showed a different effect in July (Table 3A). There were soil deposition(+) rather than soil loss (–) under different treatments. The soil deposition was highest under unlopped trees. This was probably due to the presence of good ground cover during the month of July, 1988. The results suggest that both the trees and ground vegetation cover protect the soil from wind erosion in Thal tract.

Table 3 A

Effect of Lopping on Wind Erosion on Leeward Direction of Jand Trees Upto 3 Times their height in July, 1988

(Soil loss in mm)

Treatment	Distance from tree base (m)								Average
	3	6	9	12	15	18	21	24	
1. Control	0.2	+.1	+.1	+.3	.2	+.1	+.2	+.1	+.06
2. Moderate Lopping	+.1	.3	+.4	+.3	.3	+.1	+.05	0	+.04
3. Heavy Lopping	.03	+.2	+.3	.2	.3	+.2	+.1	.1	+.02

3. Herbage Production, cover Percent and Species Composistion Under Jand Trees

a. Herbage Production

The study indicated variation in herbage quantity under different treatments. Dry matter (DM) herbage production was 106 gms/m^2 under unlopped (control) trees followed by 88 gm/m^2 under heavily lopped trees. The herbage production was lowest (76 gm/m^2) under moderately lopped trees. Over all herbage production was highest (93 gm/m^2) in western direction followed by (90 gm/m^2) in eastern direction. The lowest production of 88 gm/m^2 was found in the southern direction (Table 4.)

Table 4

Herbage Production Under Jand Trees in September, 1988

(DM gm/m^2)

Treatment		Directions				Average
		N	E	W	S	
1. Control	GV	86	110	120	106	106
	B	15	61	18	112	51
2. Moderate Lopping	GV	86	64	85	69	76
	B	20	32	0	40	23
3. Heavy Lopping	GV	95	95	74	90	88
	B	4	10	0	10	6
Average	GV	89	90	93	88	
	B	13	34	6	54	

Note: GV = Ground Vegetation
B = Browze from Jand tree above quadrats.

Though over all soil moisture content was higher in northern direction (Table 2) yet no appreciable increase in herbage production was found under the trees in this direction. This was probably due to micro environmental factors (lower heat, more shade, etc.) in the northern direction of the trees. This was also shown by the fact that though, the herbage production in northern direction was lowest under unlopped trees (control), it was highest under moderate and heavy lopping treatments. However, the tree shade compen-

sated the loss in herbage production in northern direction by increased production on western, eastern, and even southern sides. Thus study has shown that tree shade was beneficial for increased herbage production in the Thal area while moderate or heavy lopping had negative effects on herbage production.

b. Vegetation Cover

In January, 1988 the cover percent was 64% as compared to 40 percent in July and 45 percent in September, 1988 under the unlopped (control) trees. Considerable decrease in cover percent in July was indicative of preceding dry and hot period (April through June) in the Thal desert. A slight increase in cover percent during September over July is probably due to better growing conditions in late summer months. A similar trend was observed under moderate and heavy lopping treatments during July and September, 1988. The variation in cover percent in different directions of trees under different treatments was negligible during September, 1988. The average cover percent was 46 in the eastern direction followed by 43 percent in the western direction. It was lowest (30 percent) in southern direction. Over all cover percent under unlopped (control) trees was highest of all the other treatments in February, July and September 1988 (Table 5.)

Table 5
Vegetation Cover Per cent Under Jand Trees in February, July and September, 1988

Treatment		Direction				Average
		N	E	W	S	
1. Control	Feb.	54	74	73	58	64
	July	—	—	—	—	40
	Sept.	40	54	46	39	45
2. Moderate Lopping	July	—	—	—	—	40
	Sept	42	39	50	45	44
3. Heavy Lopping	July	—	—	—	—	32
	Sept	37	46	32	34	37
Average Sept		40	46	43	39	

Table 6
Percent Distribution of surface material under Jand trees in July, 1988.

Treatment		Surface material		
		Plant base	Litter Cover	Bare soil
1. Control	Feb*	9	44	47
	July	6	28	66
2. Moderate Lopping		6	24	70
3. Heavy Lopping		6	17	77

* The data were collected for control trees only.

The percent distribution of surface material (plant base, litter and bare soil) showed similar trends under different treatments as vegetation cover percent. The litter was highest under the control during February amongst all the treatment and consequently the bare soil percent was lowest. Percent plant base in all treatments was more or less same (Table 6 and 7).

Table 7

Percent distribution of Surface Material Under Jand Trees in October, 1988.

Treatment/Surface material	directions				Average
	N	E	W	S	
1. Control	7	7	7	7	7
i. Plant base	10	16	19	11	14
ii. Litter	83	77	74	82	79
iii. Bare soil					
2. Moderate Lopping	6	6	6	5	6
i. Plant base	8	13	11	11	11
ii. Litter	86	81	83	84	83
iii. Bare soil					
3. Heavy Lopping	7	7	7	7	7
i. Plant base	10	14	8	9	10
ii. Litter	83	80	85	83	83
iii. Bare soil					
Average	7	7	7	7	
i. Plant base	9	14	13	10	
ii. Litter	84	79	80	83	
iii. Bare soil					

c. *Species Composition*

Eleusine-Cenchrus community was found under Jand trees in Rakh Dagar Kotli. Seven Grasses, forbs and shrubs species were growing under the trees, The order of percent area covered by different species was more or less same under all the treatments (Table 8).

Table 8

Species Composition by Cover Percent in the Study Area July, 1988.

Species	Treatments			Average
	Control	Moderate Lopping	Complete Lopping	
1. Eleusine compressa	17.6	25.5	9.2	17.4
2. Cenchrus ciliaris	6.8	5.6	10.9	7.8
2. Cymbopogon jawarancusa	8.4	0.9	6.9	5.4
4. Aerua gavanicu	3.6	3.8	2.3	3.2
5. Crotolaria burhia	2.6	2.5	0.3	1.8
6. Lasiurus hirsutus	0.9	1.7	0.9	1.2
7. Hetropogon contortus	0.0	0.1	1.8	0.6
Total	40	40	32	37

4. Biomass Production by Lopping Jand Trees

The medium sized tree produced about 60 Kg (37 Kg DM) of fuel wood and 38.5 Kg (18 Kg DM) leaf fodder under heavy lopping. Moderate lopping produced about 40 percent less biomass-fuelwood and fodder (Table 9). The time taken by the trees to recover to original crown shape, size and biomass production after heavy lopping has to be investigated. However, as observed in the field, the growth habits of Jand trees are slow growth with fast recovery and it may therefore take about 3-5 years for this purpose. It is consistent with the results of the lopping study by Bhimaya (1964) who had found substantial decrease in tree growth and forage yield due to recurring lopping.

Table 9
Biomass Production from Lopping Jand Trees (Kg).

Treatment	Wood		Fodder		Total	
	Green weight	Dry weight	Green weight	Dry weight	Green weight	Dry weight
1. Control	—	—	—	—	—	—
2. Moderate Lopping	38.3	23.7	25.0	10.1	63.3	33.8
3. Heavy Lopping	60.3	37.4	37.4	18.2	97.8	55.6

Conclusion

This sutdy has shown that Jand shade had a positive effect on soil moisture content, soil conservation and the ground vegetation in extremely hot and arid climatic conditions of Thal desert. The tree shade helped conserved soil moisture which in turn improved the growth and cover percent of the natural ground vegetation (grasses and forbs) . Similarly the presence of trees and ground vegetation had reduced soil loss by wind erosion.

Though heavy lopping had negatively effected ground vegetation cover, herbage production, soil moisture contents and soil conservation yet it provided much needed leaf fodder and fuelwood to the local farmers. The availability of leave fodder during winter months and demand of fuelwood by farm families preclude any restriction on lopping. However, considering the positive effect of tree cover on different parameters, complete lopping may be replaced by moderate lopping of jand trees.

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