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Effect of Pruning Intensities and Pasture Combinations on Productivity of Ber-Based Hortipastoral System

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Abstract: Ber-based hortipastoral system was studied for four consecutive years (2001-02 to 2004-05) involving ber tree with different pruning intensities to utilize understorey through different pasture combinations for increasing productivity and profitability. Over the four years medium pruned trees (40 cm of secondary branches) produced maximum fruit (26.28 kg fruit tree^{-1}) followed by light (23.41 kg tree^{-1}) and severely pruned trees (18.31 kg tree^{-1}). Severely pruned trees produced significantly higher pasture (4.05 t DM ha^{-1}) followed by medium (4.02 t DM ha^{-1}) and light pruned trees (3.77 t D M ha^{-1}). Among pasture combinations, Guinea grass + *Stylosanthes hamata* produced significantly higher forage (6.33 t DM ha^{-1}) as compared to Dinanath + Guinea grass + *S. hamata* (5.06 t DM ha^{-1}), Dinanath + *S. hamata* (3.28 t DM ha^{-1}) and natural pasture (1.32 t DM ha^{-1}). Related economics of ber (10-year-old plantation)-based hortipastoral system indicated that maximum benefit:cost ratio (1:3.99) over four years of experiment was obtained when 10-year-old ber trees were medium pruned along with understorey pasture of Guinea grass + *S. hamata*.

Key words: Ber cv. Gola, Dinanath grass, Guinea grass, *Stylosanthes hamata* pruning intensities.

Vast area of our country (about 157 m ha) is under various extent of degradation, where cultivation of arable crops is economically not viable. Fruit tree-based land use has been acceptable as a viable alternate land use system (Pareek and Chandra, 1993; Pathak and Pathak, 2000). Hortipastoral system is socially accepted, ecologically feasible and economically viable for class IV and V types of lands, where fruit trees are grown in association with grass and legume (Singh, 1996; Sharma, 2004). Among fruit trees, ber (*Ziziphus mauritiana* L.) was preferred because of its hardiness and profitable production under harsh edaphic and climatic conditions and limited external inputs (Chovatia *et al.*, 1991; Sharma and Saran, 1999). Pruning intensities promote fruit bearing. Chovatia *et al.* (1991) and Kundu *et al.* (1994) observed that pruned ber trees maintained normal flowering, increased fruit set and reduced fruit drop, whereas unpruned trees produced more abnormal flowers, reduced fruit set and fruit retention. Keeping this in view, an experiment was conducted to assess the effect of various pruning intensities in fruit setting, fruit retention and pasture production in understorey interspaces through different pasture combinations in 10-year-old ber plantation.

Materials and Methods

An experiment was conducted on 10-year-old established ber plantation (6 x 6 m) of cultivar 'Gola' at Central Research Farm of Indian Grassland and Fodder Research Institute, Jhansi, for four consecutive years from 2001-02 to 2004-05. The soil was sandy loam, poor in available N (182.2 kg ha^{-1}), P (6.8 kg ha^{-1}), organic carbon (0.41%); and medium in available K (111.6 kg ha^{-1}). The experiment was laid out under factorial RBD with three replications. The selected trees were pruned in April 2001, 2002, 2003 and 2004 with three levels of intensities, severe (20 cm of secondary branches), medium (40 cm of secondary branches) and light (60 cm of secondary branches). The understorey of each plot (6x12 m) was intercropped with four pasture combinations viz., Guinea grass + *S. hamata* (G_1 + L), Guinea grass + Dinanath grass + *S. hamata* (G_1 +G_2 +L), Dinanath grass + *S. hamata* (G_2+ L) and natural vegetation (control). The grasses were transplanted 100 x 50 cm apart and in between two rows of grass; one row of *S. hamata* was sown in July 2001. Recommended doses of FYM and fertilizers were applied to the tree and pasture each year. The observations on tree height, canopy spread, fruit yield, fuel wood, ber leaf fodder (Pala) yield after harvesting of fruit and pasture production were recorded. The economics of the system was worked out on the basis of prevailing market price for all inputs during respective year (2001-02 to 2004-05) viz., man day^{-1} @ Rs. 80, 84, 90 and 94 in 2001, 2002, 2003 and 2004, respectively; tractor @ Rs. 120 h^{-1} needed for field preparation in first year only, farmyard

manure 50 kg plant^{-1} year^{-1} @ Rs. 200 t^{-1}, fertilizers viz., urea Rs. 4.25 kg^{-1}, single super phosphate Rs. 3.70 kg^{-1} and murate of potash Rs. 3.60 kg^{-1}, *S. hamata* seed @ Rs. 100 kg^{-1}, guinea grass @ Rs. 300 kg^{-1}, Dinanath grass @ Rs. 120 kg^{-1}, fungicide Rs. 300 kg^{-1}, insecticide Rs. 300 L^{-1} for ber and hired saw @ Rs. 100 season^{-1} for pruning of ber tree and miscellaneous expenditure Rs. 1000 year^{-1}. Produce sold as pasture @ Rs 1800 t^{-1} dry matter of sown pasture, Rs. 1200 t^{-1} dry matter of natural biomass and ber fruit @ Rs. 8.00 kg^{-1}, fuel wood as pruning by-product Rs. 0.40 kg^{-1} and ber leaves (pala) Rs. 0.60 kg^{-1}.

Results and Discussion

Fruit yield

The medium pruned trees produced significantly higher ber fruit yield as compared to severely pruned trees (Table 1). Severely pruned trees sprouted late, which resulted in decreased flowering and fruit setting. Lower production (16.5 kg tree^{-1}) during third year (2003) might be due to steep fluctuations in rainfall distribution ranging between 411.6 mm during May to August and 637.3 mm during September. Trees with natural vegetation (control) produced significantly higher fruit yield as compared to sown pasture combinations. The average fruit production of ber tree had favorable response to early rainfall (May-August). Kumar *et al.* (2005) had reported that 50 mm rainfall during September had detrimental effect on fruit productivity.

Pasture production

The pasture production significantly increased with pruning intensities and pasture combination (Table 1). The average pasture production under severely pruned trees was significantly higher (4.05 t DM ha^{-1}) as compared to light pruned tree 3.77 t DM ha^{-1}. Among pasture combinations under grown up ber orchard, Guinea grass +*S. hamata* produced significantly higher yield (6.29 t DM ha^{-1}) followed by Guinea grass + Dinanath grass + *S. hamata* (4.68 t DM ha^{-1}), Dinanath grass + *S. hamata* (2.82 t DM ha^{-1}) and natural vegetation (1.26 t DM ha^{-1}). Sansamma and Pillai (2000) also reported similar trend of forage production in Guinea grass under coconut orchards. Dinanath grass is an annual, but being a profuse seeder, it comes every year by self-seeding, however, its production was mainly limited to first and second year (Trivedi, 2002). Rai and Singh (1991) reported that the grass production rises up to three to four years then starts declining. Kumar *et al.* (2006) also reported that owing to rainfall distribution pattern as well as shallow-rooted nature of grasses, the pasture combinations are quite suitable for rainfed situation and their growth period is confined from July to October. From November onwards when the temperature starts declining, it becomes dormant.

Table 1. Yield of ber fruit (kg tree^{-1}) and Pasture (t DM ha^{-1}) as influenced by pruning intensities and understorey pastures

Treatment	Fruit yield (kg tree^{-1})					Pasture yield (t DM ha^{-1})				
	1st year	2nd year	3rd year	4th year	Mean	1st year	2nd year	3rd year	4th year	Mean
Pruning intensities										
Severe	21.82	17.59	13.26	20.58	18.31	4.10	4.49	4.54	3.91	4.05
Medium	33.09	25.08	18.31	28.64	26.28	3.84	4.25	4.35	3.63	4.02
Light	28.32	23.12	17.97	24.26	23.41	3.73	4.01	3.98	3.36	3.77
Mean	27.74	21.93	16.51	24.49	22.68	3.88	4.26	4.23	3.63	4.00
CD (5%)	1.28	1.92	1.78	1.66		0.28	0.43	0.45	0.32	
Pasture combinations										
G_1+L	27.89	20.92	15.83	23.88	22.12	5.40	6.35	7.02	6.55	6.33
G_1+G_2+L	26.82	19.42	16.32	23.21	21.49	4.66	5.53	5.37	4.67	5.06
G_2+L	26.56	21.47	15.83	24.46	22.08	4.16	3.84	3.11	2.00	3.28
Control	29.69	25.93	18.07	25.96	24.91	1.30	1.27	1.43	1.28	1.32
Mean	27.74	21.93	16.51	24.94	22.60	3.88	4.26	4.23	3.63	4.00
CD (5%)	1.35	2.21	1.78	NS		0.35	0.57	0.53	0.38	
Pruning x pasture	NS	NS	NS	NS		NS	NS	NS	NS	

Table 2. Production of ber leaf (Pala) and fuel wood (kg tree^{-1}) as influenced by pruning intensities and understorey pastures

Treatment	Ber leaf (Pala) production (kg tree^{-1})					Fuel wood yield (kg tree^{-1})				
	1st year	2nd year	3rd year	4th year	Mean	1st year	2nd year	3rd year	4th year	Mean
Pruning intensities										
Severe	3.14	2.78	3.35	3.23	3.13	23.80	26.20	29.6	26.70	26.58
Medium	3.79	3.46	4.45	3.95	3.91	29.50	31.60	37.4	32.25	32.69
Light	3.72	3.36	5.12	4.25	4.11	33.50	35.00	40.9	35.95	36.34
Mean	3.55	3.21	4.30	3.81	3.72	28.93	29.90	35.9	31.63	31.59
CD (5%)	0.07	0.05	0.50	0.31		4.21	5.01	2.95	3.09	
Pasture combinations										
G_1+L	3.46	3.14	3.96	3.89	3.61	27.00	28.2	35.8	31.52	30.63
G_1+G_2+L	3.49	3.26	4.30	3.76	3.70	28.60	29.3	36.1	30.65	31.16
G_2+L	3.57	3.21	4.36	3.20	3.59	29.10	29.7	35.3	31.40	31.38
Control	3.68	3.32	4.60	4.39	3.99	31.00	31.5	36.6	32.95	33.01
Mean	3.55	3.31	4.30	3.81	3.72	28.93	29.9	35.9	31.63	31.55
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Pruning x pasture	NS	NS	NS	NS		NS	NS	NS	NS	

G_1= Guinea grass, G_2 = Dinanath grass, L = *Stylosanthes hamata.*

Table 3. Economics of ber (10-year-old plantation) – based hortipastoral system with different pruning intensities and pastures combinations

Treatment	Parameter*	1st year	2nd year	3rd year	4th year	Total	Mean
Pruning intensities							
Severe	Input	14766	14198	14527	15178	58669	14667.25
	Output	45439	37472	29548	43405	155864	38966
	B:C ratio	3.08	2.63	2.03	2.85		2.65
Medium	Input	13886	13358	13886	14238	55368	13842
	Output	68060	52707	40387	59726	220880	55220
	B:C ratio	4.90	3.95	2.90	4.19		3.99
Light	Input	13566	13106	13616	13956	54244	13561
	Output	59243	49266	40227	51729	200465	50116.25
	B:C ratio	4.36	3.75	2.95	3.70		3.69
Pasture combinations							
G_1+L	Input	7810	4940	5660	5390	23800	5950
	Output	9720	11430	12630	11790	45570	1139.50
	B:C ratio	1.24	2.31	2.23	2.18		1.99
G_1+G_2+L	Input	7795	4940	5210	4920	22865	5716.25
	Output	8388	9954	9666	8406	36414	9103.50
	B:C ratio	1.07	2.01	1.85	1.70		1.66
G_2+L	Input	7620	4184	4310	4168	20282	5070.5
	Output	7488	6912	5598	3600	23598	5899.50
	B:C ratio	0.98	1.65	1.29	0.86		1.19
Control	Input	1800	1260	1350	1410	5820	1455
	Output	1560	1524	1716	1536	6336	1584
	B:C ratio	0.86	1.20	1.27	1.08		1.10

Input/output in Rs. ha^{-1}; G_1= Guinea grass, G_2= Dinanath grass, L= *Stylosanthes hamata.*

Pala production

After fruit harvesting, ber trees were pruned in April which produced 2.78 to 5.12 kg tree^{-1} leaves (pala) as fodder (Table 2). The light pruned trees produced significantly higher pala as compared to severely pruned trees as the former produced early and more sprouting. The pala production was positively related to total rainfall during the season. Thus production was maximum (4.30 kg tree^{-1}) during the 3rd year (2003-04) when maximum rainfall (1176.3 mm) was recorded.

Fuel wood production

Light pruned ber trees produced significantly higher fuel wood as compared to severely pruned trees in all years (Table 2). Chovatia *et al.* (1991) reported that light pruned trees produced significantly higher dry wood (9.3 kg tree^{-1}) as compared to severe pruned tree (7.8 kg tree^{-1}) in 3-year-old plantation of ber cv. Gola. It might be due to early sprouting in light pruned trees, which become thick (Kumar *et al.*, 2004). The fuel wood was also correlated with total rainfall during the monsoon. The fuel wood productivity was higher in third year (35.9 kg tree^{-1}). This is attributed to the higher rainfall (1176.3 mm with 37 rainy days) and continuous sprouting during November.

Economics of the system

The economics of the system showed that pruning intensities and understorey pasture combinations influenced the benefit:cost ratio of 10-year-old ber plantations (Table 3). The maximum B:C ratio over four years of experiment was recorded when trees were pruned medium (1:3.99) followed by light (1:3.69) and severely pruned trees (1:2.65). Among understorey pasture combinations, Guinea grass with stylo gave maximum B:C ratio (1:1.99) followed by Guinea grass + Dinanath grass + stylo (1:1.66), Dinanath + stylo (1:1.19) and natural vegetation (1:1.10). Guinea grass is perennial where as Dinanath grass is an annual comes every year by self-seeding. In first year low natural biomass was recorded due to land preparation and other operations followed for tree and pasture sowing. In the subsequent seasons, the production was influenced by rainfall. It can be concluded that maximum profit from 10-year-old ber cv. Gola plantation can be obtained by medium pruning with understorey pasture of Guinea grass + *S. hamata.*

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