

Original Research Article

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Study on the Performance of Vegetative Barriers and Improved Forage Species on Productivity of Degraded Grasslands

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ABSTRACT

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A field experiment was conducted during *Kharif* 2013 and *Kharif* 2014 on sandy loam soil to study the effect of vegetative barriers and improved forage species on growth and productivity of degraded grasslands under mid hill sub temperate conditions of Himachal Pradesh. Napier bajra hybrid (*Pennisetum purpureum* L. x *P. Americanum* L.) as vegetative barrier produced significantly taller plants as compared to setaria grass planted as vegetative barrier. Shoot population was significantly higher in vegetative barrier of setaria grass, whereas leaf stem ratio was significantly higher in vegetative barrier of napier bajra hybrid. Each forage species in sole stand and also in the grass + legume mixture produced taller plants, more number of shoots and higher leaf stem ratio under the influence of different vegetative barriers as compared to no vegetative barrier. Vegetative barrier of setaria grass (*Setaria anceps* L.) gave significantly higher green forage (301.96 q ha⁻¹) and dry forage yield (66.22 q ha⁻¹) during two years of study. Planting of grass legume mixture i.e. setaria + stylosanthes produced 25.42, 87.51 and 92.29 per cent higher green fodder yield over setaria, stylosanthes and existing forage species, respectively. The respective increase in dry fodder yield was 11.75, 70.55 and 118.86 per cent.

Introduction

Natural grasslands and pastures occupy 27.01 per cent of geographical area in Himachal Pradesh covering an area of about 15038 km² (Anonymous, 2014). In the country and particularly in North Western Himalaya, natural grasslands and pastures are the primary source of fodder for livestock. The productivity of these grasslands is very low primarily because of the prevalence of unproductive species, infestation with weeds, indiscriminate grazing, improper cutting

management, lack of nutrition and absence of improved forage species etc. The availability of green and dry fodder in Himachal Pradesh is 3145 and 5298 thousand tonnes per annum as against the total requirement of 6205 and 11516 thousand tonnes per annum, respectively (Dev *et al.*, 2006) indicating a gap of 49 and 54 per cent, respectively. This deficit needs to be narrowed down to harness the productivity potential of improved and indigenous livestock population of the state. Under this situation forage deficit need immediate attention for addressal. Keeping in

view the above facts and needs for addressal of issues, the present experiment was an attempt to improve the productivity of the degraded grasslands.

Materials and Methods

The experiment was conducted for two years during *Kharif* 2013 and *Kharif* 2014 to evaluate the performance of vegetative barriers and improved forage species of perennial grass species under degraded grassland conditions at the experimental farm of Fodder Unit, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, (Himachal Pradesh) under sub temperate climatic conditions. The weather conditions during the cropping seasons at the experimental site were quite normal. Total rainfall of 2656 mm and 1384 mm was received during *Kharif* 2013 and *Kharif* 2014, respectively. The experiment was conducted in split plot design and replicated thrice. The experiment consisted of twelve treatment combinations of two vegetative barriers viz., napier bajra hybrid (*Pennisetum purpureum* L. x *P. Americanum* L.) and setaria (*Setaria anceps* L.) and no vegetative barrier in main plots and four forage species viz., setaria (*Setaria anceps* L.), stylosanthes (*Stylosanthes scabra* L.), setaria + stylosanthes and existing forage species in sub plots. Napier bajra hybrid a perennial, palatable and nutritious fodder plant is suitable for planting under varied soil and climatic conditions (Singh *et al.*, 2002). Setaria grass is another palatable and drought resistant grass species, better suited to the shallow soils and low rainfall situations. As a pioneering colonizer, stylosanthes establishes well on poor soils under dry land conditions, even when the topsoil is severely eroded. The dominant grass species at the experimental site was wild cane (*Saccharum spontaneum*). Three rows of vegetative barrier were planted at 3 m apart with plant to plant spacing of 10 cm and

forage species were planted at 30 cm x 30 cm spacing in between the rows of vegetative barriers. Three cuts were taken on 08.08.2013, 10.09.2013 and 23.10.2013 during *Kharif* 2013 and on 19.08.2014, 20.09.2014 and 21.10.2014 during *Kharif* 2014. Other packages of practices were followed as per recommendation for grass and legume species.

Results and Discussion

Growth parameters

Vegetative barrier

Napier bajra hybrid as vegetative barrier produced significantly taller plants, whereas, plants with minimum plant height were produced by vegetative barrier of setaria grass at second and third cut. No significant difference was observed in the plant height of vegetative barriers at first cut. Singh *et al.*, (2002) and Gohain and Kithan (2014) also reported more plant height of napier bajra hybrid over setaria grass which may be due to genetic character of the grass species. Forage species did not significantly influenced the plant height of vegetative barriers except at second cut vegetative barriers produced significantly taller plants with sole stand of stylosanthes (Table 1). Setaria grass planted as vegetative barrier recorded significantly more number of shoots as compared to vegetative barrier of napier bajra hybrid at each cut. Vegetative barriers produced significantly higher shoot population with setaria + stylosanthes at first cut while remaining at par with sole stand of stylosanthes, however, at second and third cut vegetative barriers produced significantly higher shoot population with sole stand of stylosanthes (Table 1). Planting of napier bajra hybrid as vegetative barrier recorded significantly higher leaf stem ratio as compared to vegetative barrier of setaria grass at each cut. Leaf stem ratio of vegetative barriers was increased at second cut

and a decrease in leaf stem ratio of vegetative barriers was observed at third cut. Vegetative barriers recorded significantly higher leaf stem ratio with sole stand of setaria grass while remaining at par with sole stand of stylosanthes and setaria + stylosanthes at first cut (Table 1).

Forage species

Each forage species in sole stand and also in the grass + legume mixture produced taller plants under the influence of different vegetative barriers as compared to no vegetative barrier. Improved forage species of grasses and legume and existing forage species resulted in varying plant height at each cut, which might be due to their genetic character. No significant difference was observed in plant height of different forage species at first and second cut, whereas at third cut sole stand of setaria grass produced significantly taller plants with vegetative barrier of napier bajra hybrid. Sole stand of stylosanthes produced significantly taller plants with vegetative barrier of setaria grass while remaining at par with vegetative barrier of napier bajra hybrid (Table 2).

A keen observation of data (Table 3) indicated that at first cut sole stand of setaria grass produced significantly higher shoot population with the vegetative barrier of setaria grass and remained at par with vegetative barrier of napier bajra hybrid. At second and third cut setaria grass produced significantly higher shoot population with the vegetative barrier of napier bajra hybrid. Setaria grass in association with stylosanthes, it produced significantly higher shoot population with the vegetative barrier of napier bajra hybrid, at each cut, however it remained at par with vegetative barrier of setaria grass at third cut. Sole stand of stylosanthes produced significantly higher number of plants with vegetative barrier of napier bajra hybrid at each cut, while remaining at par with

vegetative barrier of setaria grass at first and third cut. However, when stylosanthes was grown in combination with setaria, it produced significantly higher number of plants with vegetative barrier of setaria grass at each cut and, however it remained at par with vegetative barrier of napier bajra hybrid at first and third cut. Existing forage species produced significantly higher shoot population with vegetative barrier of setaria grass at first and third cut, however, at second cut existing forage species produced significantly higher shoot population with vegetative barrier of napier bajra hybrid while remaining at par with each other at second and third cut (Table 4).

Leaf stem ratio of setaria grass in sole stand at each cut was not significantly influenced by different vegetative barriers (Table 5). When setaria grass was grown in combination with stylosanthes it produced significantly higher leaf stem ratio with vegetative barrier of setaria grass at first and second cut, while remaining at par with vegetative barrier of napier bajra hybrid at second cut. Sole stand of stylosanthes recorded significantly higher leaf stem ratio with vegetative barrier of napier bajra hybrid at first and second cut and it remained at par with vegetative barrier of setaria grass at second cut. When stylosanthes was grown in combination with setaria grass, it produced significantly higher leaf stem ratio with vegetative barrier of setaria grass at each cut and remained at par with vegetative barrier of napier bajra hybrid at third cut.

Fodder yield

Different factors were apparently responsible for the variable productivity of different vegetative barriers and forage species. The growth components like plant height, shoot number and leaf stem ratio observed in the present study reflected their effect on green fodder yield of the grass and legume species.

Table.1 Effect of different treatments on plant height, shoot population and leaf stem ratio of vegetative barriers (Mean of 2 years)

Treatment	Plant height			Shoot Population (m ⁻²)			Leaf stem ratio		
	I cut	II cut	III cut	I cut	II cut	III cut	I cut	II cut	III cut
Vegetative barrier									
Napier bajra hybrid	110.4	120.3	77.6	74	73	59	1.45	1.31	0.64
Setaria	107.2	70.5	55.0	157	125	78	0.70	1.15	0.52
SE m+	2.69	2.05	2.38	1.78	1.39	1.48	0.04	0.04	0.02
CD (P=0.05)	NS	6.29	7.31	5.45	4.26	4.55	0.11	0.11	0.06
Forage species									
Setaria	110.5	83.5	65.5	111	95	66	1.18	1.27	0.54
Stylosanthes	109.3	107.0	69.0	122	116	77	1.11	1.24	0.60
Setaria + Stylosanthes	106.1	94.0	67.2	123	98	70	1.06	1.26	0.57
Existing forage species	109.4	97.2	63.6	105	88	60	0.95	1.12	0.60
SE m+	3.81	2.90	3.37	2.51	1.96	2.10	0.05	0.05	0.03
CD (P=0.05)	NS	8.90	NS	7.71	6.02	6.44	0.15	NS	NS

Table.2 Effect of different treatments on plant height (cm) of forage species (Mean of 2 years)

Treatment	Setaria	Stylo	Setaria + Stylo		Existing forage species
			Setaria	Stylo	
			I cut		
Napier bajra hybrid	104.6	23.6	108.2	24.7	95.0
Setaria	105.6	21.7	104.2	22.8	96.6
No vegetative barrier	95.5	20.8	95.6	21.7	90.5
SE m+	2.28	1.09	3.00	1.47	3.89
CD (P=0.05)	NS	NS	NS	NS	NS
			II cut		
Napier bajra hybrid	74.4	24.9	84.4	35.4	59.2
Setaria	68.3	23.3	77.1	37.3	55.0
No vegetative barrier	59.8	19.2	64.8	30.0	52.7
SE m+	5.85	1.35	5.08	2.44	2.55
CD (P=0.05)	NS	NS	NS	NS	NS
			III cut		
Napier bajra hybrid	53.5	17.1	55.6	22.4	38.0
Setaria	43.5	21.1	55.2	21.6	34.1
No vegetative barrier	42.6	14.7	47.4	21.7	31.0
SE m+	0.95	1.21	1.64	0.55	1.57
CD (P=0.05)	3.82	4.89	6.62	NS	NS

Table.3 Effect of different treatments on shoot population/ number of plants (m⁻²) of forage species (Mean of 2 years)

Treatment	Setaria	Stylo	Setaria + Stylo		Existing forage species
			Setaria	Stylo	
			I cut		
Napier bajra hybrid	262	119	247	86	206
Setaria	270	110	208	87	225
No vegetative barrier	234	86	201	56	182
SE m_±	5.82	2.46	2.24	1.26	4.17
CD (P=0.05)	23.48	9.99	9.06	5.16	16.81
			II cut		
Napier bajra hybrid	259	83	231	73	188
Setaria	212	69	195	79	172
No vegetative barrier	201	63	179	67	142
SE m_±	5.47	2.29	2.57	1.74	4.43
CD (P=0.05)	22.07	9.29	10.39	5.79	17.89
			III cut		
Napier bajra hybrid	238	80	193	70	157
Setaria	206	77	188	76	160
No vegetative barrier	177	56	137	57	122
SE m_±	3.93	4.96	4.75	3.39	5.67
CD (P=0.05)	15.86	20.01	19.16	13.78	22.85

Table.4 Effect of different treatments on leaf stem ratio of forage species (Mean of 2 years)

Treatment	Setaria	Stylo	Setaria + Stylo		Existing forage species
			Setaria	Stylo	
			I cut		
Napier bajra hybrid	0.99	0.88	0.72	0.73	1.43
Setaria	0.85	0.71	1.11	0.89	1.77
No vegetative barrier	0.51	0.63	0.62	0.58	1.14
SE m±	0.06	0.03	0.02	0.04	0.03
CD (P=0.05)	NS	0.11	0.06	0.15	0.12
			II cut		
Napier bajra hybrid	1.25	1.04	1.19	0.95	1.49
Setaria	1.73	0.98	1.41	1.33	1.77
No vegetative barrier	0.71	0.84	1.02	0.79	1.25
SE m±	0.05	0.04	0.06	0.06	0.05
CD (P=0.05)	NS	0.18	0.26	0.27	0.23
			III cut		
Napier bajra hybrid	0.57	0.71	0.53	0.74	0.56
Setaria	0.61	0.68	0.56	0.81	0.68
No vegetative barrier	0.48	0.52	0.48	0.65	0.46
SE m±	0.03	0.03	0.07	0.03	0.01
CD (P=0.05)	NS	NS	NS	0.10	0.03

Table.5 Effect of vegetative barriers and improved forage species on green and dry fodder yields (q ha⁻¹) (Mean of 2 years)

Treatment	Green fodder yield				Dry fodder yield			
	I Cut	II Cut	III Cut	Total	I Cut	II Cut	III Cut	Total
Vegetative barrier								
Napier bajra hybrid	127.70	96.84	59.59	284.12	27.98	20.97	14.83	63.78
Setaria grass	144.25	98.88	58.85	301.96	29.34	21.14	15.75	66.22
No vegetative barrier	75.81	53.34	31.73	160.88	15.74	11.19	8.21	35.13
SE m+	2.98	1.36	0.63	3.25	0.53	0.36	0.25	0.80
CD (P=0.05)	12.04	5.51	2.56	13.11	2.14	1.46	1.01	3.25
Improved forage species								
Setaria	139.45	82.79	56.33	278.55	28.59	22.00	16.47	67.06
Stylosanthes	88.66	63.19	34.47	186.32	14.42	11.80	8.03	34.24
Setaria + Stylosanthes	154.76	118.49	76.14	349.38	30.78	24.60	19.57	74.94
Existing forage species	80.81	67.59	33.28	181.69	23.63	12.66	7.65	43.94
SE m+	1.64	1.05	0.93	2.79	0.61	0.37	0.39	0.85
CD (P=0.05)	4.93	3.15	2.80	8.35	1.84	1.13	1.19	2.55

In the mean performance of two years vegetative barrier of setaria grass showed its superiority and resulted in significantly higher green fodder yield at first and second cut while remaining at par with vegetative barrier of napier bajra hybrid, however at third cut vegetative barrier of napier bajra hybrid produced significantly higher green fodder yield, while remaining at par with vegetative barrier of setaria grass. Vegetative barrier of setaria grass resulted in the production of 301.96 q ha⁻¹ green fodder yield, which was 6.27 and 87.69 per cent more than napier bajra hybrid as vegetative barrier and no vegetative barrier, respectively. The higher green fodder yield with vegetative barriers might be due to beneficial effect of runoff water infiltrated more with vegetative barrier as compared to no vegetative barrier. Owing to better adaptability, quick establishment, better germination and higher herbage yield, Premi and Sood (2001) also reported the superiority of setaria grass over siratro in sub-temperate natural grasslands of Himachal Pradesh. At each cut and also in the total green forage yield vegetative cover of setaria + stylosanthes (349.38 q ha⁻¹) maintained its significant superiority over setaria (278.55 q ha⁻¹), stylosanthes (186.32 q ha⁻¹) and existing forage species (181.69 q ha⁻¹). Setaria + stylosanthes produced 25.42, 87.51 and 92.29 per cent higher green fodder yield over setaria, stylosanthes and existing forage species, respectively. Lakshmi *et al.*, (2002) also reported superiority of grass legume mixtures consisting of stylosanthes.

Vegetative barrier of setaria grass produced significantly higher dry fodder yield at each cut and also in total yield of three cuts while remaining at par with vegetative barrier of napier bajra hybrid. Setaria grass as vegetative barrier produced 86.40, 88.91, 91.83 and 88.49 per cent higher dry fodder yield over no vegetative barrier at first cut, second cut, third cut and total of three cuts,

respectively. Sood and Jaswal (1993) and Sharma and Sood (1994) also reported that setaria is one of the highly suitable and most adaptive species for introduction in natural grasslands in Kangra valley. Introduction of improved grass and legume species in the existing sward produced significantly higher dry fodder yield compared to existing forage species. At each cut and also in the total dry fodder yield, vegetative cover of setaria + stylosanthes (74.94 q ha⁻¹) maintained its significant superiority over setaria (67.06 q ha⁻¹), existing forage species (43.94 q ha⁻¹) and stylosanthes (34.24 q ha⁻¹). Setaria + stylosanthes produced 11.75, 70.55 and 118.86 per cent higher dry fodder yield over sole stand of setaria, existing forage species and sole stand of stylosanthes, respectively. Baba *et al.*, (2011) also reported higher total dry matter yield in grass legume mixture than their grass monoculture.

In conclusion, the overall performance indicated that vegetative barriers of setaria grass and napier bajra hybrid are profitable with respect to herbage yield. The interference that can be drawn from the above findings are planting of setaria grass in association with stylosanthes can increase the total fodder production under degraded grassland conditions.

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