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Runoff and erosion control with fodder grass - legume mixture in a watershed

G. RANGARAJU, S. RAMASAMY AND A. MOHMMED ALI
Agricultural Research Station, Tamil Nadu Agricultural University, Ramanathapuram - 623 501, Tamil Nadu

Abstract : Performance of different grass - legume combinations in controlling runoff and soil loss that occurred in a 3.7 per cent sloppy arable land of the watershed, besides contributing to the fodder requirement of this area was tested in Palar watershed during 1995 - 1998. *Cenchrus ciliaris* grass as main crop with legumes recorded significantly superior establishment, growth characters and consequently produced the highest green fodder yield of 30.5 t $ha^{-1}yr^{-1}$. Growth and yield performance of *Stylosanthes scabra* were better and comparable with other legumes. The mixture of the above two species in 3.1 row arrangement, besides yielding better green fodder, reducing runoff and soil erosion to 229.4 mm. yr^{-1} and 1868 kg kg ha^{-1} yr^{-1} respectively, which were 21.5 and 58.2 per cent lesser than those occurred in control. (***Key words :*** *Watershed, Sloppy arable dry lands, Runoff and soil erosion, Fodder production, Ecosystem).*

Livestock rearing is the prime enterprise of the farming community of Palar Watershed, situated in the North Eastern Zone of Tamil Nadu. But only limited pastures existed which were ill maintained and over exploited. Due to inadequate fodder production, the goats and other cattle were allowed in the forest area nearby for grazing and thereby the ecology of the forest was being deteriorated. This type of indiscriminate grazing accelerated the runoff and soil loss in sloppy lands (Singh and Rao, 1988). Also, for uplying shallow depth catchment areas like this, fodder grasses with their well developed root zone, short growth period and their capacity for regeneration were identified as suitable (Datya, 1988). Hence, to identify a suitable crop canopy coverage with grass-legume species to contribute to the fodder requirement of the area besides reducing the runoff and soil erosion, the present investigation was carried out in the arable shallow dry lands of the watershed.

Materials and Methods

The experiment was conducted from 1995 to 1998 in a 3.7 per cent sloppy arable land of Palar watershed in Vellore district. The treatments consisted of nine possible combinations of three grasses (*Cenchrus ciliaris, Chloris gyana* and *Pennisetum pedicillatum*) and three legumes (*Stylosanthes scabram, Desmanthus virgatus* and *Vigna unguiculata*) with a fallow as control, replicated thrice in randomized block design. The land was with shallow depth (35cm) sandy loam soil containing 0.27 per cent organic carbon, 1.37 gm cc^{-1} of bulk density and 116 mm m^{-1} of maximum available soil moisture. The available nutrients status of the soil was low in nitrogen, medium in phosphorus and medium in potash.

The grass seeds were treated with cow dung slurry before sowing and the legume seeds were soaked in water for six hours and shade dried. The soil was opened with minimum tillage and the treated seeds were sown in 45 cm distanced rows across the slope in 5m x 4m plots. Spacing adopted for grass and legumes within the rows were 20 cm and 30 cm respectively in 3:1 row arrangement. At the lower side of the slope in each of the treatment area the runoff pits were taken, lined with polythylene sheet (200 micron) and utilized to measure runoff and sedimentation of eroded soil (Verma, 1988). Suitable diversion channels were provided to prevent the run off from the upper reaches into the experimental area. Periodical observations on plant height, basal spread an important variable in soil and moisture conservation and green biomass production at each harvest were recorded. The available soil moisture prevailed in each of the treatments were estimated at regular interval. The data were subjected to statistical analysis for their significance.

Results and Discussion

Establishment percentage

Maximum establishment percentage of 96.5 was registered by *Pennisetum pedicillatum* among the grass species tried which was on par with *Cenchrus ciliaris* irrespective of legume combination. The least establishment of 86.6% was recorded by *Chloris gyana.* Among the legumes the percentage of establishment was highest (93.8) in *Demanthus virgatus* although the difference was insignificant.

Plant height and basal spread

The plant height at harvest recorded by

Table 1. Growth characters and green bio-mass yield of grasses and legumes (mean over three years)

Treatment	Establishment (%)		Plant height (cm)		Basal spread (mm)		Green bio-mass yield (t ha^{-1} yr^{-1})		
	Grass	Legume	Grass	Legume	Grass	Legume	Grass	Legume	Total
$G_1 + L_1$	94.6	88.2	57.2	33.7	67	26	30.2	5.0	35.2
$G_1 + L_2$	95.6	93.5	57.6	46.8	75	32	30.5	5.6	35.1
$G_1 + L_3$	94.6	88.7	57.3	46.8	70	17	30.3	4.4	34.7
$G_2 + L_1$	86.6	88.2	39.7	32.6	37	23	16.9	4.7	21.6
$G_2 + L_2$	87.8	93.2	39.8	45.8	40	28	16.8	5.6	22.4
$G_2 + L_3$	87.0	87.6	39.6	38.5	35	15	16.8	4.4	21.2
$G_3 + L_1$	95.8	84.8	57.2	32.9	64	25	24.3	4.6	28.9
$G_3 + L_2$	95.7	93.8	57.9	46.5	71	30	24.2	5.5	29.7
$G_3 + L_3$	96.5	88.1	57.1	38.7	64	14	24.1	4.4	28.5
SE_d	1.8	4.1	1.1	1.6	4.4	2.9	2.7	0.4	1.2
CD	3.7	NS	2.3	3.3	9.0	6.1	5.5	0.9	2.5

G_1. *Cenchrus ciliaris* G_2. *Chloris gyana* G_3. *Pennisetum pedicellatum*
L_1. *Stylosanthus scabra* L_2. *Desmanthes virgatus* L_3. *Vigna unguiculata*

Table 2. Runoff and soil loss as influenced by different crop canopy coverage

Year	1995-96		1996-97		1997-98		Mean	
Annual rainfall (mm)	449		1006		777		744	
Events observed	18		21		24		21	
Events rainfall (mm)	285		352		365		334	
Treatment	Runoff (mm)	Soil loss (kg/ha/yr)	Runoff (mm)	Soil loss (kg/ha/yr)	Runoff (mm)	Soil loss (kg/ha/yr)	Runoff (mm)	Soil loss (kg/ha/yr)
$G_1 + L_1$	133	1598	310	2276	244	1730	229	1868
$G_1 + L_2$	149	1689	316	2788	249	2181	238	2220
$G_1 + L_3$	141	1808	322	2934	253	2251	239	2331
$G_2 + L_1$	146	1933	331	3094	258	2360	245	2463
$G_2 + L_2$	149	2065	336	3300	263	2546	250	2637
$G_2 + L_3$	152	2177	342	3620	267	2766	254	2855
$G_3 + L_1$	156	2344	346	3843	272	2927	258	3038
$G_3 + L_2$	158	2586	352	4109	276	2984	262	3227
$G_3 + L_3$	161	2456	359	4410	284	3172	268	3346
Control	178	3173	373	6401	305	5019	292	4470
SE_d	7.2	63.2	4.0	117.9	3.5	216.1	6.5	284.2
CD	3.5	31.0	2.0	57.0	1.7	106.1	3.2	139.6

Pennisetum pedicillatum was maximum at all the years of observation and was on par with *Cenchrus ciliaris*. *Chloris gyana* recorded the least plant height of 36.6 cm. Plant height of *Desmanthus virgatus* (46.7 cm) among the legumes was statistically superior. The basal spread of *Cenchrus culiaris* recorded at harvest was significantly higher than that recorded by other grasses. In the case of legumes, highest mean basal spread was registered by *Desmanthus virgatus* and was on a par with *Stylosanthes scabra*.

Runoff and soil loss

The three year mean runoff water recorded in the control plot with no crop cover was 292mm which was 39.1 per cent of the mean annual rain fall received. The lowest mean annual runoff of 229mm was recorded with *Cenchrus ciliaris* + *Stylosanthes scabra* which was 21.5 per cent lesser than that occurred in control. Higher quantity of soil loss (4470 kg ha^{-1} yr^{-1}) and was followed by *Cenchrus ciliaris* + *Desmanthus virgatus* with 2219.6 kg ha^{-1} yr^{-1}. The best treatment *Cenchrus ciliaris* + *Stylosanthyus scabra* reduced the soil loss to 55.8 per cent to that occurred in control plot with no crop coverage. This could be possible for this crop mixture due to their higher basal girth, well developed root system and foliage cover on the ground which might have facilitated to pond the running rainwater for much a longer period. This wouls have increased the opportunity time to the water to infiltrate, besides reducing the velocity which consequently resulted with lesser runoff water and lesser intensity of soil erosion. The results are in agreement with the findings of Yadav *et al.*, (1988) and Reddy *et al.* (1992).

Green biomass

The higher grass yield was recorded by *Cenchrus ciliaris* with a mean annual green biomass of 30.5 t ha^{-1} followed by *Pennisetun pedicellatum* with 24.2 t ha^{-1} and the least was in *Chloris gyana* with 16.8 t ha^{-1}. With respect to legumes, the higher yield was recorded by *Demanthus virgatus* with 5.6 t ha^{-1} yr^{-1} followed by *Stlosanthes scabra* with 5.0 t ha^{-1}. The total mean annual green biomass of grass and legume in 3:1 combination was maximum in *Cenchrus ciliaris* + *Desmanthus virgatus* and followed by *Cenchrus ciliaris* + *Stylosanthes scabra* mixture with 35.2 t ha^{-1} yr^{-1} and thus explaining the beneficial compatibility of *Cenchrus ciliaris* with *Stylosanthes scabra* and least yield was recorded in *pennisetum pedicellatum* + *Vigna unguiculata* with 28.5 t ha^{-1}. Considering the favourable effects of *Stylosanthes scabra* in soil and moisture conservation as a quick growing ground cover, this along with *Cenchrus ciliaris* in the shallow sloppy arable areas with three to four per cent slope, was found useful in soil & moisture conservation, besides providing fodder to the livestock population. Thus it indirectly also prevented the damage caused by te cattle to the natural vegetation and sustained the ecosystem of the watershed. The results are in accordance with the reports of Katyal and Das (1992).

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