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# CONSERVATION EFFICIENCIES OF GRASSES IN BOULDERY RIVERBED LANDS

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**ABSTRACT :** An investigation was carried out at Research Farm of Central Soil and Water Conservation Research and Training Intstitute, Dehradun during 1993-94 to assess the conservation efficiencies of five grass species in bouldery riverbed lands of Doon valley. Among various grasses, *Saccharum munja* showed best performance with respect to clump diameter, lateral root spread, vertical root length, total number of roots, oven dry root and aerial biomass while other species showed their differential response for different root and shoot parameters. In general, the percentage root biomass decreased with increasing soil depth in all the species. Though the total root biomass was one of the lowest in *Eulaliopsis binata,* it was maximum in upper soil horizon (0-30cm), however, the trend was reverse in case of *S.munja.* The soil binding value was also the highest in *S.munja* (307.2) followed by *Panicum maximum* (254.3), *E.binata* (222.6) *Chrysopogon fulvus* (156.9) and minimum in *Arundo donax* (59.1) indicating their relative soil conservation efficiencies under degraded bouldery riverbed lands and can be exploited well as vegetative measures for the rehabilitation and efficient utilization of such lands.

Over thousands of years, various biotic and abiotic activities have continuously disturbed not only life on land but also the land itself owing to serious destruction and degradation of natural resources. As per estimate, in India about 16.35 tonnes $ha^{-1}$ $yr^{-1}$ soil is being eroded which is more than the permissible limit of 4.5 tonnes $ha^{-1}yr^{-1}$ (Dhruvanarayana and Ram Babu, 1983). There are various categories of degraded lands which are subjected with one or the other kinds of limitations. Bouldery riverbed is one occupying about 35 percent of the total geographical area of Doon valley(Singh *et al.*, 1985). The main farming constraints are high boulder contents of varying sizes and very poor water holding capacity leading to poor vegetal cover. Such sites can sustain life only if properly tended and top soil is reconstructed with conservation vegetation particularly the grasses (Hall, 1988 and Munshower, 1991).

In developed countries, considerable work on the evaluation of different grass species for their conservation ability has been done but in India, very limited information was generated by Dabadghao and Patil (1956), Singh (1985), Kulkarni (1989) and Sachan and Uttam (1992) who exphasized the role of grasses in soil conservation. Therefore, there is a need to develop a detailed data base under existing agroclimatic situations for rehabilitation of degraded lands through various grass covers. Present study was thus initiated in bouldery riverbed lands with the objective to infer the protection potential of different grass species of the region by comparing their root distribution pattern and conservation values.

## MATERIALS AND METHODS

The study was conducted at Soil Conservation Research Farm, Selakui, Dehradun (680 m asl, latitude 30° 20' 4" N and longitude 72° 52'12'E) during 1993-94 on a bouldery riverbed containing 68 per cent boulders (0.2 to 12 cm in dia) and the soil fractions were only 32 per cent. The average annual rainfall of the area is about 1630 mm, of which 81 per cent is received from

June to September. The various meteorological observations of the experimental site for the last 35 years have been depicted in Fig. 1. The soil samples from 0-15, 15-30, 30-45 and 45-90 cm depths were collected under different treatments and composited depth wise to represent the site. Only small fractions (<2mm of soil were used for mechanical (sand, silt and clay ) and chemical (pH, organic carbon, N, P and K) analysis.

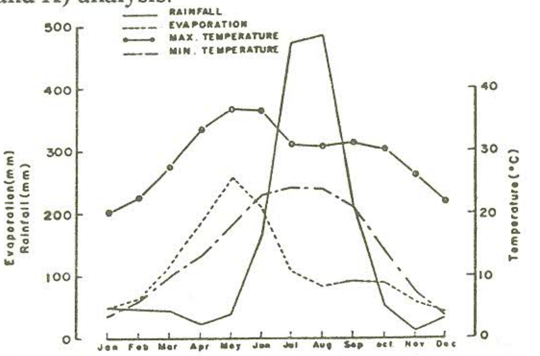


Fig. 1 Meterological data of the experimental site (Av. 35yrs, 1959-93)

Four year old plantations of five prominent grass species namely *Eulaliopsis binata*, *Chrysopogon fulvus*, *Panicum maximum*, *Arundo donax* and *Saccharum munja* were used for the purpose. The biomass studies were conducted in the month of October when all the grasses had attained maximum growth. The four sites were selected randomly where all the grass species were existing. These sites were treated as replications and the grass species as treatments. The data were analysed in RBD considering ten clumps as an unit under each treatment.

Before starting the excavation, the above ground bimass of every species was harvested separately and root crown was secured firmly to maintain them in original position. Thereafter, the root distribution studies were conducted by the excavation method as this method is very effective in very stoney soils to study the root system (Weaver, 1926). Separate below ground biomass per clump was determined in 0-30, 30-60, 60-90 and more than 90 cm soil depths under each species. After excavation, the soil mass containing roots was gently washed under tap water over a mesh sieve. Various root parameters like vertical root length, lateral spread, number of roots, root diameter and dry weight of roots were recorded for each species. The percentage root biomass at different depths were computed on the basis of roots present in 30 x30 x 30 cm monolith. The soil binding factor W/ $r^2$ (Bhimaya *et al.*, 1956) was used in the present study to assess the soil binding capacity of different grass species. In the above factor 'W' is the weight of roots (g) present in a given volume of soil and 'r' is average radius of the roots (mm) present in the same volume of soil.

## RESULTS AND DISCUSSION

Data presented in table 1 reveal that with the increasing soil depth, the machanical fractions of the fine sand, silt and clay were decreased while coarse sand particles increased markedly, confirming the findings of Lal *et al.* (1980). Similarly, organic C and available nutrients (N,P and K) were also decreased with increasing soil depth. The soil pH also showed similar trend, however, the magnitude of variation was low (7.4 to 7.7). The extent of variation in physico-chemial properties in consecutive soil layers was maximum in upper layers (in between 0-15 and 15-30 cm) than those of deeper layers ( 15-30 and 30-45, 30-45 and 45-90 cm). Overall, the site condition was very poor attributed mainly due to the presence of the boulders in larger proportions and poor nutrient status which is absolutely not suitable for production of grain crops.

Table 1. *Physico-chemical properties of soil*

| Parameter | Soil depth (cm) | | | | |
|---|---|---|---|---|---|
| | 0-15 | 15-30 | 30-45 | 45-90 | Average |
| Mechanical analysis(%) | | | | | |
| Coarse sand | 21.8 | 36.2 | 40.9 | 45.5 | 36.1 |
| Fine sand | 54.4 | 45.7 | 43.4 | 42.5 | 46.5 |
| Silt | 12.3 | 8.5 | 8.2 | 7.6 | 9.2 |
| Clay | 11.5 | 9.6 | 7.5 | 4.4 | 8.3 |
| Chemical analysis | | | | | |
| pH | 7.7 | 7.7 | 7.6 | 7.4 | 7.6 |
| Organic Carbon (%) | 0.52 | 0.24 | 0.16 | 0.13 | 0.26 |
| Available N {Kg $ha^{-1}$} | 124.7 | 80.5 | 73.8 | 69.3 | 87.1 |
| Available P {Kg $ha^{-1}$} | 6.1 | 4.8 | 4.1 | 3.9 | 4.7 |
| Available K {Kg $ha^{-1}$} | 88.1 | 51.9 | 47.2 | 46.4 | 58.4 |

It is obvious from the data (Table2) that among various grass species the *S.munja* was the most vigorous species followed by *P. maximum* and *A.donax*. However, the observations indicate that this species can be exploited commercially under bouldery land situations of submountaineous region. Whereas, the vigour of *E.binata* and *C.fulvus* was less and in the close proximity though they are widely spread species of the region. The average clump diameter was maximum in *S.munja* (22.6 cm) followed by *P. maximum* (17.4 cm), *E binata* (16.5 cm), *C.fulvus* (14.3 cm) and minimum in *A. donax* (12.2 cm). Both root and aerial biomass were significantly more in *S. munja* followed by *P. maximum* and *A.donax*. Performance of these grasses showed their biological potential that can be used to improve the conditions of bouldery riverbeds for production and to check environmental degradation.

Table 2. *Biomass production of different grass species*

| Species | Clump diameter (cm) | Oven dry biomass (g) | |
|---|---|---|---|
| | | Root biomass | Aerial biomass |
| *E.binata* | 16.5 | 57.9 | 618.9 |
| *C.fulvus* | 14.3 | 64.3 | 548.8 |
| *A.donax* | 12.2 | 106.2 | 1550.6 |
| *P.maximum* | 17.4 | 124.6 | 1628.9 |
| *S.munja* | 22.6 | 435.1 | 1833.3 |
| CD at 5% | 0.56 | 13.19 | 42.80 |

The pattern of root distribution of any plant type is an important feature for anchorage, absorption and conservation of soil and water. Data presented in table 3 showed that the vertical root length was maximun in *S. munja* (163.6 cm), followed by *P. maximun* (97.9cm), *C.fulvus* (82.8 cm), *E. binata* (75.3 cm ), and minimum in *A.donax*(68.0 cm). The lateral spread was also maximun in *S. munja*(144.2 cm), followed by *A.donax* (80.1 cm), *E.binata* (71.4 cm), *C.fulvus* (64.5 cm) and *P.maximun* (60.4 cm). Similarly, the total root number per clump was maximum in *S.munja* (1299.0) followed by *E.binata* (932.5), *C.fulvus* (783.7), *P.maximum* (755.5) and minimum in *A. donax* (232.2). The roots of *E.binata* (0.51 mm), *C.fulvus* (0.64 mm) and *P.maximum* (0.70 mm) were thinner as compared to *S.munja* (1.19 mm) and *A.donax* (1.34 mm). The variation in different grass species for various root parameters was highly significant showing their inherent characteristics of root system. Infact, grass cover is the first line defence against erosion (Tejwani and Mathur, 1972, Kemper *et al.*, 1992, and Anonymous, 1993) and it is the root system which mainly decides the conservation efficiency.

Table 3. *Root distribution pattern of different grass species*

| Species | Root parameters | | | |
|---|---|---|---|---|
| | Vertical length (cm) | Lateral spread (cm) | Total number of roots | Average diameter (mm) |
| *E.binata* | 75.3 | 71.4 | 932.5 | 0.51 |
| *C.fulvus* | 82.8 | 64.5 | 783.7 | 0.64 |
| *A.donax* | 68.0 | 80.1 | 232.2 | 1.34 |
| *P.maximum* | 97.9 | 60.4 | 755.5 | 0.70 |
| *S.munja* | 163.6 | 144.2 | 1299.0 | 1.19 |
| CD at 5% | 3.30 | 6.46 | 31.47 | 0.08 |

The percentage root biomass, irrespective of the grass species in different soil layers presented in table 4 indicated that the major quantity of it in all the grass sepecies confined to upper layer of 0-30 cm which was decreased with increasing soil depths. The results are in confirmity with those of Singh (1985) who mentioned that on an average 50 and 76 per cent of the grass roots are found within the 7.6 and 30 cm upper soil profile, respectively. Decrease in root concentration with increase in soil depth has also been reported by Khybri and Mishra (1967) and Sachan and Uttam (1992) in different grass species. The per cent root biomass at 0-30cm depth was maximum in *E.binata* (73.75) followed by *A.donax* (71.28), *C.fulvus* (66.87), *P.maximum* (64.37) and minimum in *S.munja* (46.52), though the total root biomass was maximum in *S.munja* followed by *P.maximum, A.donax, C.fulvus* and minumun in *E binata*. This variation in total root biomass and their distribution in different soil layers varied with the type of grass species grown in a particular agroclimatic condition. It was also observed that in case of *C.fulvus, E.binata* and

*A.donax*, the root biomass distribution was confined upto 90cm soil depth while in *P.maximum* and *S.munja* it was found beyond 90 cm, though the concentration was meagre.

Table 4. *Root biomass and soil binding factor of different grass species*

| Species | Per cent root biomass in different soil layers (cm) | | | | Soil binding factor |
|---|---|---|---|---|---|
| | 0-30 | 30-60 | 60-90 | >90 | |
| *E.binata* | 73.75 | 24.70 | 1.55 | - | 222.6 |
| | (42.7) | (14.3) | (0.9) | (-) | |
| *C.fulvus* | 66.87 | 26.75 | 6.38 | _ | 156.9 |
| | (43.0) | (17.2) | (4.1) | (-) | |
| *A.donax* | 71.28 | 27.4 | 1.32 | - | 59.1 |
| | (75.7) | (29.1) | (1.4) | (-) | |
| *P.maximum* | 64.37 | 22.77 | 6.82 | 1.04 | 254.3 |
| | (80.2) | (34.6) | (8.5) | (1.3) | |
| *S.munja* | 46.52 | 29.42 | 18.52 | 5.54 | 307.2 |
| | (202.4) | (128.0) | (80.6) | (24.1) | |

Figures in parentheses indicate the absolute root weight (g)

The soil binding factor is an index to express the conservation efficiency of different plant species. In the present investigation, the soil binding factor (Table 4) was in order of *S. munja* (307.2) > *P. maximum* (254.3) > *E. binata* (222.6) > *C. fulvus* (156.9) and *A. donax* (59.1). These variations in soil binding values in different grass species were in agreement with the finding of Singh and Gupta (1983) and Dadhwal and Singh (1993). The highest soil binding value of *S. munja* was due to the higher root biomass as compared to all other grass species and the trend was similar with the *P. maximum*. However, the increased soil binding value of *E. binata* inspite of lowest total root biomass was mainly attributed by the thinner root system. Contrary to this, the lowest soil bindig value was observed in case of *A. donax* probably due to thicker root system. Therefore, the soil binding value under a particular plant species mainly depends upon the root biomass as well as the type of root system. In general, the root system of grasses are fibrous but the fine roots with their close and elaborate network have greater soil binding capacity than those of thicker roots (Bhimaya *et al.*, 1956).

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