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Evaluation of various crop canopies for water erosion resistance

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Abstract

A field experiment in randomised block design was conducted on black soils (Aridic Haplusterts) during 1994-95 to 1996-97, growing hybrid cotton, hybrid sorghum, pigeonpea, and greengram followed by safflower with a view to evaluate the various crop canopies for its water erosion resistance. Surface runoff as well as soil and NPK losses were lowest in greengram - safflower cropping sequence followed by hybrid sorghum, pigeonpea and hybrid cotton in increasing order. In view of the economic return and reduction in soil and nutrient losses, the cropping sequence of greengram - safflower was found sustainable in dry farming system.

Additional keywords: Crop canopies, surface runoff, soil loss, nutrient loss.

Introduction

Crop canopy is one of the most important factor affecting the loss of soil and nutrients in a watershed area (Dhruva Narayana *et al.* 1983; Bharad *et al.* 1991). Arable crops differ greatly in their erosion resistance as their species and planting pattern influence detachability of soil aggregates by rain drop impact and thereby on the losses of soil, water and nutrients (Hudson 1971). Need of growing erosion resistant crops for *in situ* soil and moisture conservation has been reported by Kanitkar *et al.* (1966). Keeping this in view, the investigation was carried out to evaluate the erosion resistance of locally important arable crops, in terms of surface runoff, soil and nutrients losses.

Materials and methods

Field trials in randomised block design (RBD) were conducted at Central Research Station, Dr. P.D.K.V., Akola during the period 1994-95 to 1996-97 on a black soil belonging to fine, montmorillonitic, hyperthermic family of Aridic Haplusterts. The soils were moderately deep (60 cm depth), moderately alkaline (pH 8.5), low in total N (0.042%) and available P_2O_5 (9.49 kg ha^{-1}) and high in available K_2O (342 kg ha^{-1}). Bulk density, field capacity and PWP were 1.47 Mg m^{-3}, 42.5 per cent and 18.5 per cent (by volume), respectively. The climate of the area is tropical dry semi-arid with annual precipitation of 800 mm, of which 85 per cent is received during June to September. The rains during the period October to May are very meagre and uncertain.

The treatments comprised of Hybrid Cotton (Var. AHH-468, spacing 90 × 90 cm), sorghum (Var. CSH-9, spacing 45 × 10 cm), Pigeonpea (Var. C-11, spacing 60 × 20 cm) and Greengram (Var. Kopergaon, spacing 45 × 10 cm) followed by safflower (Var. Bhima, spacing 45 × 20 cm). Recommended doses of fertilizers were applied to all the crops. The slope gradient of the experimental plots was 1.5 per cent and surface runoff was measured by automatic stage level recorders and 'H' flumes. Runoff soil samples collected during various events of rainfall were analysed for N,P and K contents using standard methods (Jackson 1967) and then the losses per hectare were calculated.

Results and discussion

Runoff and soil loss

Surface runoff recorded under various crop covers varied from 67.9 to 152.7 mm (Table 1). Within the various crop canopies, maximum surface runoff was noticed in wider

spaced crop of hybrid cotton, whereas least runoff was estimated in the closer spacing crop of greengram - safflower and sorghum. Pigeonpea and sorghum, however, were found intermediate in this respect. Growing of greengram - safflower cropping sequence and sorghum reduced surface runoff significantly over hybrid cotton to the extent of 55.5 and 27.4 per cent, respectively and same trend was true with regard to soil loss. It is obvious that greengram being a cover crop reduced the soil loss to the extent of 56.9 per cent over hybrid cotton. Introduction of greengram even as an intercrop in pearlmillet was found to reduce the soil loss to the extent of 40 per cent as reported by Bhushan (1984). Cultivation of pigeonpea marginally reduced the surface runoff (11%) and soil loss (6.5%) over hybrid cotton.

Table 1. Surface runoff and soil loss (Average of 1994-95 to 1996-97)

Cropping system	Surface runoff (mm)	% Decrease	Soil loss (t ha^{-1})	% Decrease
Hybrid cotton	152.7	—	1.662	—
Sorghum	110.8	27.4	1.218	26.7
Pigeonpea	135.9	11.0	1.558	6.5
Greengram-Safflower	67.9	55.5	0.715	56.9
CD (P=0.05)	38.7	0.483		

Nutrient loss

The losses of total nitrogen, phosphate and potash through surface runoff recorded in the four arable systems were in the range of 12.89 to 30.52, 1.87 to 4.88 and 13.58 to 38.92 kg ha^{-1}, respectively (Table 2). The losses of N&K were much higher than the loss of P_2O_5. Jayaraman *et al.* (1982) also observed a comparatively higher loss of both N and organic matter than P_2O_5. Within the four cropping systems, the nutrient loss through surface runoff was maximum in the case of hybrid cotton and minimum in greengram - safflower sequence. The loss of NPK through surface runoff costed Rs. 423, 304, 335 and 168 ha^{-1} $year^{-1}$ in the cotton, sorghum, pigeonpea and greengram-safflower cropping sequences, respectively. Thus, the cultivation of greengram followed by safflower reduced the loss of soil and nutrients through surface runoff providing higher resistance to erosion.

Table 2. Nutrient losses (Average of 1994-95 to 1996-97)

Cropping system	N (kg ha^{-1})	% decrease	P_2O_5 (kg ha^{-1})	% decrease	K_2O (kg ha^{-1})	% decrease
Hybrid cotton	30.52 (218)	—	4.88 (95)	—	38.92	—
Sorghum	23.37 (167)	23.7	3.25 (63)	33.4	26.11 (74)	32.9
Pigeonpea	25.82 (185)	15.4	3.75 (73)	23.2	27.18 (77)	30.2
Greengram-Safflower	12.89 (92)	57.4	1.87 (36)	61.7 (38)	13.58	65.1
CD (P=0.05)	6.98	—	1.58	—	8.72	—

Note: Figures in bracket indicates the cost of NPK in the form of Urea, SSP and MOP @ Rs. 330, 315 and 170 per quintal.

Table 3. Monetary returns (Average of 1994-95 to 1996-97)

Cropping system	Cotton/ grain yield (q ha^{-1})	Straw/ fodder yield (q ha^{-1})	Monetary return (Rs ha^{-1})
Hybrid Cotton	5.38	11.95	11,169
Sorghum	37.15	69.03	20,240
Pigeonpea	5.35	39.55	9,505
Greengram	3.64	9.55	6604
Safflower	6.13	13.37	7226

Prices: Seed Cotton	Rs. 1965 q^{-1}	Cotton stalk	Rs. 50 q^{-1}
used Sorghum	Rs. 359 q^{-1}	Fodder	Rs. 100 q^{-1}
in the Pigeonpea	Rs. 1333 q	Stalk	Rs. 60 q^{-1}
calcu- Greengram	Rs. 1657 q^{-1}	Stalk	Rs. 60 q^{-1}
lation Safflower	Rs. 1048 q^{-1}	Stalk	Rs. 60 q^{-1}

Monetary returns

Highest monetary returns were obtained with the cultivation of sorghum followed by greengram - safflower sequence (Table 3). Additional benefit obtained from sorghum and greengram-safflower system over sole hybrid cotton was of Rs. 9071 and 2661 ha^{-1}.

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