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Influence of Various Cropping Systems on Profile Water Storage and Crop Yields

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ABSTRACT

The field experiment was conducted at the College Agronomy Farm, Gujarat Agricultural University, Anand Campus, Anand to study the impact of different cropping systems on periodical soil profile water and yield. There were ten treatments consisted of sole crop of pearlmillet, pigeonpea, bidi tobacco and groundnut and their intercropping systems including cultivated and absolute fallow treatments.

The results revealed that incorporation of groundnut as intercrop with pearlmillet, pigeonpea and bidi tobacco crops increased the soil water storage and thereby yield, monetary returns and pearlmillet equivalent yield that from corresponding sole crops, respectively.

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INTRODUCTION

Assuring adequate supply of water is crucial not only for achieving greater production of agricultural crops but also for stabilising production under uncertain weather conditions. In Gujarat, only 23.4 per cent area is under irrigation (Anon. 1989) and after harnessing all the irrigation potentials and implementation of Sardar Sarovar Project, about 48 per cent area would remain under rainfed agriculture (Anon. 1991). Agriculture in dry lands is highly affected by aberrant rainfall. Precipitation is the only source of water for crop growth in this region. Thus, in order to sustain agricultural productivity in the arid and semi arid regions, every efforts should be made to conserve as much rain water as possible at a place where it falls. The most efficient way of doing this is to protect soil through vegetation cover, which improve water conservation by increasing infiltration and reducing evaporation (Ghildyal and Sharma, 1969). In view of this, the present study regarding the influence of different cropping systems on the soil profile water storage and crop yields was carried at the College Agronomy Farm, GAU, Anand.

MATERIALS AND METHODS

The field experiment was conducted on loamy sand soils with ten cropping systems consisted of sole crop of pearlmillet (SPM), pigeonpea (SPP), bidi tobacco (SBT) and groundnut (SGN) and their intercropping (PM + GN, PP + GN, BT + GN and PM + PP)

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including cultivated (CF) and absolute fallow (AF) with four replications in a randomised block design (plot size : 6.25 m x 2.4 m). The soil was loamy sand in texture (86.6% sand, 6.3% silt, 4.8% clay). It had bulk density 1.51 Mg m^{-3}, infiltration rate 3.4 cm hr^{-1}, field capacity 17.6% (w/w basis, pH (1:2.5) 7.7, EC (1:2.5) 0.11 dSm^{-1}, organic carbon 0.152%, Olsen's P 20.5 mg kg^{-1} and available K 115 mg kg^{-1}. There were 672 mm rainfall and 37 rainy days during 1992. The corresponding values during 1993 were 774.8 and 29, respectively.

Periodically, soil samples were collected in depth increments of 0-15, 15-30, 30-45, 45-60 and 60-75 cms with screw auger from each of the plots. The moisture content of soil samples was determined gravimetrically and soil water storage (0-75 cm depth) expressed in terms of mm. Plot-wise grain/pod/sured leaf and stalk/straw haulm yields were recorded at harvest. Yields of different crops were converted into pearlmillet equivalent based on the prevailing prices of different crops in respective years.

RESULTS AND DISCUSSION

Profile water storage

Results revealed that mean values of soil-water storage over cropping systems at various dates of sampling were found significant in both the years (Table 1) due to dry and rainy spell in seasonal rainfall distribution.

TABLE 1

Soil profile water storage (mm) at various time intervals under different cropping systems.

Cropping system	*Sampling date*				*Mean*
	4-7-92	*26-7-92*	*16-8-92*	*9-9-92*	
			1992		
Date of previous rainfall	22-6-92	25-7-92	14-8-92	7-9-92	
CF	120.0	123.9	139.5	137.2	130.1
AF	95.7	139.9	162.1	149.1	136.7
SPM	81.7	137.5	157.9	151.4	132.1
SPP	110.5	127.7	147.4	144.3	132.4
SBT	116.9	121.2	145.2	142.6	131.5
SGN	96.2	143.4	162.0	159.3	140.2
PM + GN	88.8	140.0	155.9	151.2	134.0
PP + GN	100.8	149.8	153.2	148.7	138.1
BT + GN	105.4	151.9	151.9	147.6	139.2
PM + PP	90.7	142.3	151.1	145.6	132.4
Average	100.7	137.8	152.6	147.7	—

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		1993			
	14-7-93	3-8-93	26-8-93	28-9-93	
Date of previous rainfall	11-7-93	20-7-93	24-8-93	25-9-93	
CF	141.9	119.4	126.4	108.0	123.9
AF	160.1	94.0	153.4	96.1	125.9
SPM	163.1	77.6	140.3	78.3	114.8
SPP	149.9	99.9	129.4	93.8	118.2
SBT	148.3	116.2	127.1	95.0	121.6
SGN	165.0	94.4	148.3	85.5	123.3
PM + GN	159.2	83.7	144.6	88.1	118.9
PP + GN	157.2	98.7	144.0	89.5	122.3
BT + GN	155.7	104.7	139.7	92.3	123.1
PM + PP	154.8	87.8	137.2	88.5	117.1
Average	155.5	97.7	139.1	91.5	—
		S. Em.	**C. D. 5%**	**C.V.%**	
			1992		
Treatment		1.38	4.41	2.91	
Sampling		1.23	3.55	4.09	
Interaction		3.89	11.21	4.09	
			1993		
Treatment		0.71	2.27	3.19	
Sampling date		1.38	3.98	4.34	
Interaction		5.25	15.31	4.34	

Irrespective of sampling dates, soil water storage was significantly affected by different cropping systems in both the years (Table 1). Average soil-water storage was higher under cropped plots than cultivated fallow plots during both the years. This might be due to that growing crops maintained higher infiltration rate by dissipating energy of falling

raindrops resulting into reduced surface sealing and runoff velocity. Karad *et al.* (1991) also reported that cropping practices help in reducing runoff losses by intercepting raindrops and increasing water intake due to improvement in soil structure. The differences in soil water storage among cropping systems could be attributed to the ability of crops to intercept the raindrops and infiltrate the water into soil. This depends upon the types of crop and number of plants per unit area. These results confirmed the findings of Ghildyal and Sinha (1969) and Bhatia and Srivastava (1976).

Interaction effect of cropping systems and date of sampling on soil water storage was found significant during both the years

TABLE 2

Yield monetary returns and pearlmillet equivalent yield under different cropping systems.

Cropping systems	*Yield(kg/ha)*		*Pearlmillet euqivalent yield* (kg/ha^{-1})	*Net realization* ($Rs\ ha^{-1}$)
	Main product	*By product*		
SPM	2821	5115	2821	6205
SPP	863	2708	2784	5229
SBT	1724	359	3978	6270
SGN	1233	2955	3980	8066
PM + GN	2422 (244)*	4494 (671)	3206	6814
PP + GN	626 (622)	2145 (1691)	4027	7877
BT + GN	1132 (707)	240 (1977)	3858	7168
PM + PP	1812 (223)	4246 (889)	3033	6442
S. Em. ±	—	—	169	525
C. D. 5%	—	—	497	1541
C. V.%	—	—	19.6	12.3

*Figures in parenthesis indicate yield of intercrops.

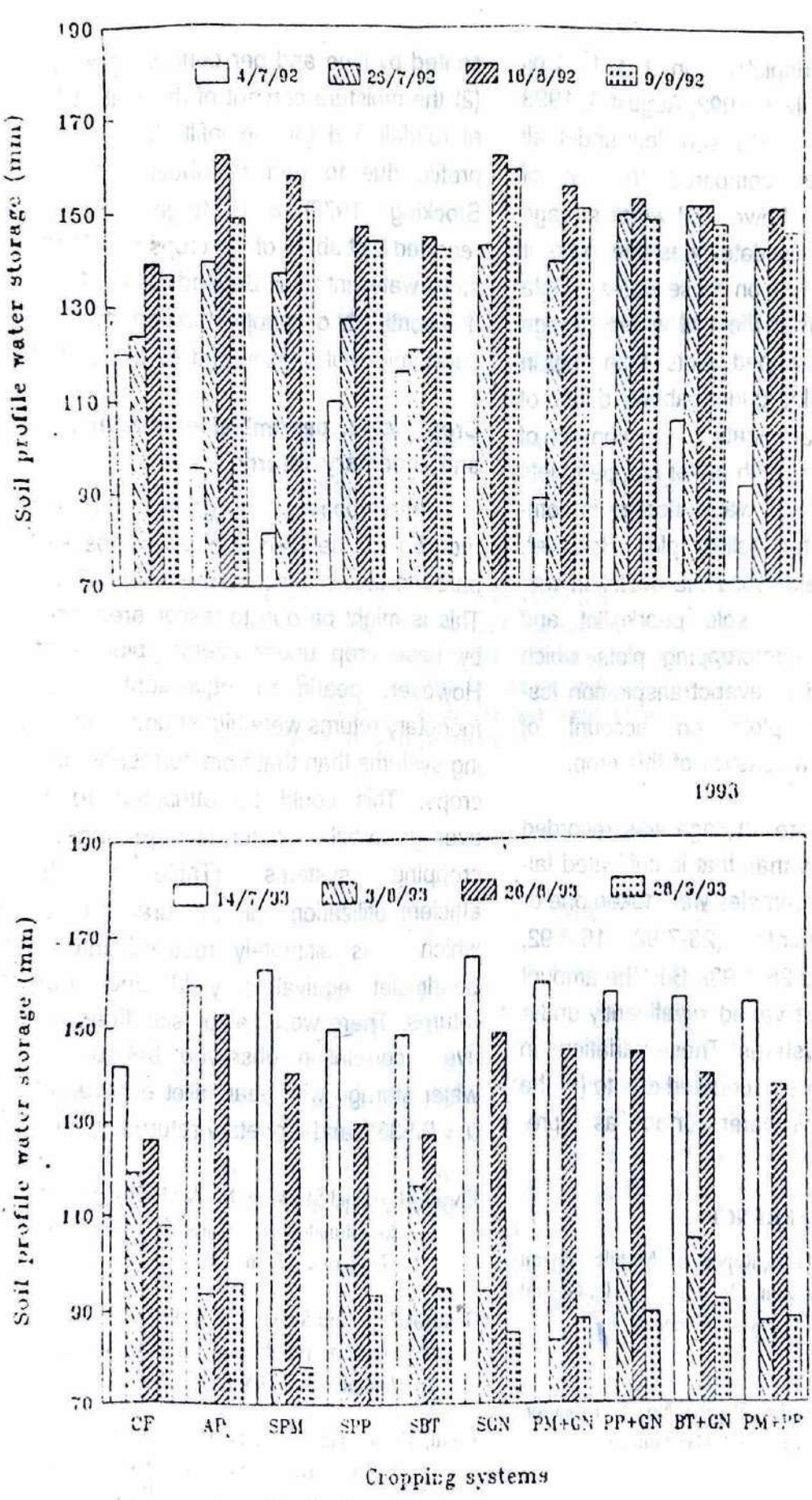

Fig. 1 : Soil profile water storage at various sampling dates.

(Table 1) and depicted in Fig. 1. Soil water storage on July 4, 1992; August 3, 1993 and September 28, 1993 were low under all the treatments as compared to rest of the sampling dates. Lower soil water storage during these particular dates was due to no or less rainfall occurred on those dates. Data further revealed that the soil water storage was lower under cropped plots than that in cultivated fallow plot during above dates of sampling. The transpiration component of evapotranspiration is high under cropped plots which reduced the soil water storage in comparison to cultivated fallow plot. However, among different field crops the depletion was more pronounced in sole pearlmillet and pearlmillet based intercropping plots which could be attributed to evapotranspiration losses from these plots on account of morphological characteristics of this crop.

Higher soil water storage was recorded under cropped plots than that in cultivated fallow plots when soil samples were taken one or two days after rainfall (26-7-92, 16-8-92, 9-9-92, 14-7-93 and 26-8-93). But, the amount of soil water storage varied significantly under various cropping systems. These variations in soil water storage are accounted due to (1) the condition of the soil water surface as represented by type and per cent of canopy cover, (2) the moisture content of the soil at the time of rainfall and (3) the infiltrability of the soil profile due to root distribution. Elwell and Stocking (1976) and Morgan (1979) also reported that ability of the crops to infiltrate and store water into soil depends upon the height and continuity of canopy, the density of canopy cover and root density and its distribution.

Crop yields, pearlmillet equivalent yield and monetary returns

Intercropping, in general, caused a reduction in the yield of based crops as compared to their respective sole crops (Table 2). This is might be due to lesser area occupied by base crop under intercropping systems. However, pearlmillet equivalent yield and monetary returns were higher under intercropping systems than that from corresponding sole crops. This could be attributed to higher average profile water storage under intercropping systems (Table 1) thereby efficient utilization of natural resources which is ultimately resulted into higher pearlmillet equivalent yield and monetary returns. There were also significantly positive correlation observed between profile water storage with pearlmillet equivalent yield ($r = 0.533^*$) and monetary returns ($r = 0.612^*$).

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