http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 3 (2): 342-344, 2000

Water Retention in Some Eroded Soils of Rawalpindi Area

Mushtaq Ahmed Chaudhry and Wahid Bukhsh Naseem
University of Arid Agriculture, Rawalpindi, Pakistan

Abstract: It was revealed that saturation percentage and wilting point of different soil series did not show significant variation. Field capacity of Guliana series was higher and was found in order of Ap > B > C horizons. The available water holding capacity of Rajar soil series was significantly lower as compared with other soil series. The amount of plant available water was more in Ap than B and C horizons.

Key word: Water retention, eroded soils

Introduction

According to Chaudhry (1996) erosion causes a decline in soil fertility, water supply and crop yield and adversely affects the socio-economic conditions of the country. Erosion also causes floods, silting up of reservoirs and disruption of communication systems. Pothwar comprises about 1.82 m ha having a great heterogeneity in soils which have developed from residuum, loess and alluvium. Out of this 0.61 m ha are cultivated and the remaining 1.21 m ha are affected by various degrees of gully formation. About 60 percent of the land has severe gully erosion whereas the remaining area is subjected to sheet and rill erosion (Punjab Barani Commission, 1976).

Frye *et al*. (1982) found 4-5 percent lower water haling capacity in the surface layer of the eroded soils. Andraski and Lowery (1992) observed that the total quantity of plant extractable water that could be stored in the upper 1m of slightly eroded soils was 7 percent more than that of moderately eroded soil and 14 percent more than that of severely eroded soils. Lowery *et al*. (1988) found that the value of available soil moisture and effective rooting depth decreased with decreasing depth at three levels of past erosion. Williams *et al*. (1980) expressed that erosion causes degradation of physical soil characteristics.

Water is a limiting factor for crop production under rainfed conditions. The study was, therefore, undertaken to determine some characteristics of four eroded soils relating to water retention and availability.

Materials and Methods

The study was carried out on four eroded soil series namely Guliana (slightly eroded), Missa (moderateley eroded), Rajar (severely eroded) and Pirsabak (sediment deposition) which form a major proportion of the arable lands of Rawalpindi area. Soil samples were collected from A, B and C horizons of these soils with the soil auger. Saturation percentage (Page *et al*., 1982), field capacity, wilting point and available water holding capacity (Klute, 1986) of these samples was determined. The data collected for various characteristics were analysed statistically by Analysis of Variance technique using RCBD. The treatment means were compared by the least significant difference (LSD) test (Steel and Torrie, 1980).

Results and Discussion

Saturation Percentage: The saturation percentage values (Table 1) indicate that the highest amount of water (43.23 percent) was observed in the Ap horizon of Guliana series and a minimum of 37.37 percent was found in the C horizon of Pirsabak series. While comparing the average saturation percentage values of different series, it was observed that Guliana had the highest value of 41.39 percent followed by Missa series (40.76 percent) and the lowest saturation percentage of 39.12 percent was observed in the Rajar series. The average values of saturation percentage in Ap, B and C horizons were 42.02, 39.94 and 38.52 percent respectively. Statistical analysis of the data indicate that there was not significant effect of soil series and that of various horizons on the saturation percentage. The average values of different soil series also did not show significant variation but those of different horizons varied significantly. Saturation percentage of Ap horizon was significantly higher than those of B and C horizons. It was also observed that saturation percentage decreased with the severity of erosion problem and from Ap to C horizon which may be due to the change in soil structure, soil texture, decline in organic matter and degree of soil degradation. Organic matter improves aggregate formation which consequently improves moisture retention in the soil. Frye (1987) stated that soils having more organic matter form granular aggregates whereas those having more clay form blocky aggregates, which are less receptive to water as compared with granular ones.

Field Capacity: The data pertaining to the field capacity values of the selected soils (Table 2) indicate that the Ap horizon of Guliana series had 23.00 percent (highest) whereas the C horizon of Rajar series had 19.37 percent (lowest) water content The average values of field capacity of Guliana, Missa, Rajar and Pirsabak series were 21.22, 20.73, 19.98 and 21.60 percent respectively. While comparing the average field capacity values of various horizons, it was observed that Ap horizon had higher value (21.98 percent) as compared with those of other two horizons.

Table 1: Effect of different soil series and horizons on saturation percentage

Series	Ap	B	C	Average
Guliana	*43.23 [N.S.]	41.40 [N.S.]	39.47 [N.S.]	41.39 [N.S.]
Pirsabak	41.73	39.17	37.37	39.45
Missa	42.47	40.40	39.07	40.76
Rajar	40.53	38.67	38.07	39.12
Average	42.02 [a]**	39.94 [b]	38.52 [b]	

N.S. = Non significant
* = Average of three values
** = Means followed by a common letter in a row and a column are not significantly different at 5 percent level of probability

It is evident from statistical analysis, that the average field capacity values of different soil series were not significantly different. The average values of various horizons indicated that average field capacity of Ap horizon was significantly higher than that of C horizons.

The data further indicate that field capacity varied according to the gravity of the erosion problem to which the soils were exposed. The field capacity was found in order of Pirsabak> Guliana> Missa> Rajar series and Ap horizon had higher field capacity than B and C horizons respectively. This variation in field capacity may be due to the variation in soil texture, structure and organic matter contents of soil. As the relative proportion of macro and micro pores is disturbed by erosion, it causes a reduction in water retention in soil. Organic matter increases the capillary pores which are responsible for the increase in water storage capacity of the soil. The field capacity in the eroded soils and that of the lower horizons was reduced due to higher clay content and the low organic matter content. The lower field capacity value in the soil series where erosion hazard is more needs water conservation practices like deep tillage, terracing and improvement of soil organic matter contents. The sowing of water resistant crops on these series will give good returns. Putman and Alt (1987) stated that erosion decreased the soil water holding capacity by changing texture, as the topsoil was mixed with the subsoil. Lowery *et al*. (1988) found that the volume of soil moisture decreased with decreasing depth on the three levels of past erosion. Nizami *et al*. (1977) found more field capacity (20.3 percent) in Guliana series while lower (17.6 percent) in Missa series. It was further observed that the P requirements decreased as field capacity increased.

Table 2: Effect of different soil series and horizons on field capacity 1%)

Series	Ap	B	C	Average
Guliana	*23.00$^{N.S.}$	20.50$^{N.S.}$	20.17$^{N.S.}$	21.22$^{N.S.}$
Pirsabak	22.93	21.77	21.10	21.60
Missa	21.63	20.80	19.77	20.73
Rajar	20.33	20.23	19.37	19.98
Average	21.98^{a**}	20.82a^{b}	19.85^{b}	

LSD value 1.30
N.S. = Non significant
* = Average of three values
** = Means followed by a common letter in a row and a column are not significantly different at 5 percent level of probability

Wilting Point: It is revealed from the data (Table 3) pertaining to wilting point of different soil series and their horizons that the highest value of wilting point (9.57%) was observed in C horizon of Rajar series whereas, the lowest moisture level (7.30%) was observed in the Ap horizon of Guliana series. While comparing the average values of wilting point of different soil series, it was observed that values were almost equal in case of Guliana and Rajar series which were higher as compared with those of Missa and Pirsabak series. The average moisture levels for wilting points in the Ap B and C horizons were 7.81, 7.86 and 8.71 percent respectively.

Statistical analysis of the data indicate that the differences in the average moisture values for wilting point both in the series and the horizons did not vary significantly. The increase in moisture level for wilting point from Ap to C horizon may be due to the presence of more clay contents in the subsoil which holds more water at wilting point. Shafiq *et al*. (1988) observed higher moisture (11.92%) in 15-30 cm soil depth and lower value of wilting point (11.05%) was observed in the soil at 0-15 cm depth. It can be inferred from the data that there is more likely hood of recurrence of wilting point on eroded soil series (Rajar). Short duration and drought resistant crops could be sown successfully on such soils. Deep cultivation would help in enhancing of storage of rain water to avoid frequent and early wilting.

Available Water Holding Capacity: Available water holding capacity (AWHC) of the selected soil series and their Ap, B and C horizons (Table 4) show that maximum AWHC (15.70) was observed in the Ap horizon of the Guliana series whereas lowest value (9.8 percent) was found in the C horizon of Rajar series. The average AWHC values of different soil series were 13.01, 12.98, 10.58 and 13.73 percent for Guliana, Missal, Rajar and Pirsabak respectively.

Table 3: Effect of different soil series and horizons on wilting point (%)

Series	Ap	B	C	Average
Guliana	*7.30$^{N.S.}$	9.10$^{N.S}$	8.77$^{N.S.}$	8.39$^{N.S.}$
Pirsabak	7.53	7.93	8.37	7.94
Missa	7.47	7.7	8.13	7.77
Rajar	8.93	6.73	9.57	8.41
Average	7.81$^{N.S.}$	7.86	8.71	

NS = Non significant
* = Average of three values

The data pertaining to the average values of different horizons indicated that highest value of AWHC (14.18%) was observed in the Ap horizon followed by 12.35 and 11.20 percent in B and C horizons respectively.

Statistical analysis of the data show that AWCH values of Guiana, Missa and Pirsabak series did not show significant differences. However, the value of Rajar series was significantly lower as compared with all the other soil series.

The data indicate that AWHC values were higher in the uneroded soils as compared with those of eroded soil series. The decreasing trend of available water holding capacity was found in C and B horizons. This variation may be due to the textural change and the reduction in organic matter content due to erosion. Frye *et al*. (1982) revealed that the detrimental effect on the AWHC of soils is an important change brought about by erosion with respect to crop productivity. White *et al*. (1983) argued that soils with high clay content or high sand content have lower plant available water holding capacities than soils high in silt or well proportioned in sand silt and clay. Therefore, tillage of an eroded soil mixes clayey subsoil with silty topsoil and the plant AWHC decreases. Stony or gravely soils have low water supplying capacity because of less soil volume due to the stones and many large pore spaces which do not hold water. The available water holding capacity of a shallow soil is reduced drastically, as the soil is removed by erosion. Degradation of soil structure decreases infiltration rate and

Table 4: Effect of different soil series and horizons on available water holding capacity (%)

Series	Ap	B	C	Average	LSD value
Guliana	*15.70$^{N.S.}$	11.93$^{N.S.}$	11.40$^{N.S.}$	13.01^{a**}	
Pirsabak	15.40	13.83	11.97	13.73^{a}	
Missa	14.17	13.13	11.63	12.98^{a}	1.432
Rajar	11.43	10.50	9.8	10.58^{b}	
Average	14.18^{b}	12.35^{b}	11.20^{b}		

LSD value 1.240
N.S. = Non significant
* = Average of three values
** = Means followed by a common letter in a row and a column are not significantly different at 5 percent level of probability

increases runoff rate, thereby decreasing the storage of water in the soil from a given rainfall. Midkiff *et al.* (1985) reported decreased plant available water holding capacity with increased erosion. Frye *et al*. (1982) found 4-5 percent lower water holding capacity in the surface layer of eroded soils. The decrease in AWHC was due to increase in bulk density, higher levels of clay content and decrease in organic matter content by the erosion.

Reference

Andraski, B.J. and B. Lowery, 1992. Erosion effects on soil water storage, plant water uptake and corn growth. Soil Sci. Soc. Am. J., 56: 1911-1919.

Chaudhry, M.A., 1996. Soil Erosion and Conservation. In: Soil Science, Bashi, E. and R. Bente (Eds.). National Book Foundation, Islamabad.

Frye, W.W., 1987. The Effects of Soil Erosion on Crop Productivity. In: Agricultural Soil Loss (Processes, Policies and Prospects), Herlin, J.M. and G.M. Beradi (Eds.). Westrien Press, Inc., USA., pp: 151-171.

Frye, W.W., S.A. Ebelhar, L.W. Murdock and R.L. Blevins, 1982. Soil erosion effects on properties and productivity of two Kentucky soils. Soil Sci. Soc. Am. J., 46: 1051-1055.

Klute, A., 1986. Water Retention: Laboratory Methods. In: Methods of Soil Analysis, Part I: Physical and Mineralogical Methods, Klute, A. (Ed.). Agronomy Monograph No. 9, American Society of Agronomy, Madison, WI. USA., pp: 635-662.

Lowery, B., B.J. Andraski and J.L. Shults, 1988. Effect of Erosion on Soil Physical Properties and Crop Growth. American Society of Agronomy, Madison, USA., Pages: 280.

Midkiff, D.V., W.W. Frye and R.L. Blevins, 1985. Soil Erosion Effect on Soil Proporties and Crop Yield in Farmer Fields in Kentucky during 1983-84. American Chemical Society, Madison, USA., Pages: 209.

Nizami, M.M.I., M.S. Zia and M. Salim, 1997. Phosphoru requirement of maize (*Zea mays*) under three tillage practices in different soil series in rainfed conditions. Pak. J. Soil Sci., 13: 66-69.

Page, A.L., R.H. Miller and D.R. Keeney, 1982. Methods of Soil Analysis. 2nd Edn., Amercen Society of Agronomy, Madison, WI., USA.

Punjab Barani Commission, 1976. Punjab Barani commission report. The Government of the Punjab, Pakistan.

Putman, J. and K. Alt, 1987. Erosion Centro: How does it change farm income? J. Soil Water Conserv., 42: 265-268.

Shafiq, M., M.I. Zafar, M.Z. Ikram and A.Y. Ranjha, 1988. The influence of simulated soil erosion and restorative fertilization on maize and wheat production. Pak. J. Scient. Ind. Res., 31: 502-505.

Steel, R.G.D. and J.H. Torrie, 1980. Priciple and Proceduces of Statistics. 2nd Edn., McGrew Hill Book Co. Inc., New York, pp: 188-189.

White, A.W., R.R. Bruce and G.W. Lengdale, 1983. Effect of Soil Erosion on Soybean Production in the Southern Piedment of Georgia. American Society of Agronomy, Madison, USA.

Williams, J.R., R.R. Allmaras, K.G. Renard, L. Lyles and W.C. Moldenhauer *et al*., 1980. Soil erosion effects on soil productivity: A research perspective. J. Soil Water Conserv., 321: 258-259.