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Influence of Cattle Manure on Infiltration, Strength and Erosion of Soil by Water

Hassony J. Abdulla, Abdul-Jabbar Ch. Hassan and Munther M. Taj-Aldeen

Soil Science Department, College of Agriculture, University of Basrah, Basrah, Iraq

Abstract. The influence of cattle manure on infiltration and soil erosion by water was investigated for two soils, El-Hartha silty loam and El-Zubair loamy sand from the Basrah district. Manure was added at 0, 1 and 2% by weight. The results show decrease in runoff and penetration resistance, increase in infiltration and decrease in total soil loss for both treated soils. However, the response of El-Hartha to manure was greater. The decrease in amount of soil loss with manure added was statistically significant.

Introduction

The literature dealing with theoretical and practical effects of organic matter on soils in nature is rather extensive. Cattle manure and other sources of organic matter have been found to improve soil physical properties [1-4] due to the effect of microorganisms which stabilize the soil structure. Soil organic matter is the most important factor in the formation of a good soil structure which helps in increasing soil water intake and water holding capacity and in reducing runoff and soil loss [2,4-8]. Addition of organic matter also serves as a source of nutrients to crops and energy for the life processes of microorganisms [2,3,8].

The use of cattle manure for replenishing soil fertility is very common in Iraq [9,10,11]. Although there is a considerable work to show its usefulness as a supplier of plant nutrients, the effect of manure on erosion of soils has not yet been worked out in Iraq. Much time and expense can be saved by preliminary laboratory studies on the response of soils to soil amendments [12].

This investigation was undertaken to see whether cattle manure was effective in diminishing soil erosion by water.

Materials and Methods

Soil samples, from a depth of 0-45 cm, were collected from two locations, the first from El-Hartha silty loam soil and the second from El-Zubair loam sand soil.

The samples were prepared, and analyzed for properties according to the standard physical and chemical procedure [13,14]. The properties are given in Table (1).

Table 1. Some physical and chemical properties of the soils used

Soil property	Soil location	
	El-Hartha	El-Zubair
Particle - Size (Mm)		
2000-200, %	0.2	9.0
200 - 20, %	48.6	82.5
20 - 2. %	27.2	4.7
< 2, %	24.0	3.8
Total	100.0	100.0
Texture class	Silty loam	Loamy sand
Organic matter %	0.16	0.20
$CaCO_3$ %	25	N.D.

N.D. = Not determined

Partially decomposed cattle manure samples were dried, ground and passed through a 2mm sieve. The percentage organic carbon, C/N ratio, EC (mS cm) and PH of this manure were 18.7, 11.7, 9.6 and 8.5, respectively. Manure samples were mixed with soil in concentration of 0, 1 and 2% by weight. Water was added to these soils in an amount equivalent to their water-holding capacity. Then the untreated and treated soils were incubated at room temperature for a period of 15 days.

At the end of the incubation period, the untreated and treated soils were uniformly compacted at a density of about 1.29 and 1.43 g/cm^3 for El-Hartha and El-Zubair soils respectively. The depth of soil was 5 cm over washed sand in a metal pan (20cm by 40cm and 8cm deep) equipped with drainage and runoff ports (Fig. 1).

Soils were saturated by adding water from the bottom to prevent too rapid addition of water. Then the soils in the pans were tilted to a 9% slope.

The following determinations wre made:

1 – Starting time of initial runoff (min.)

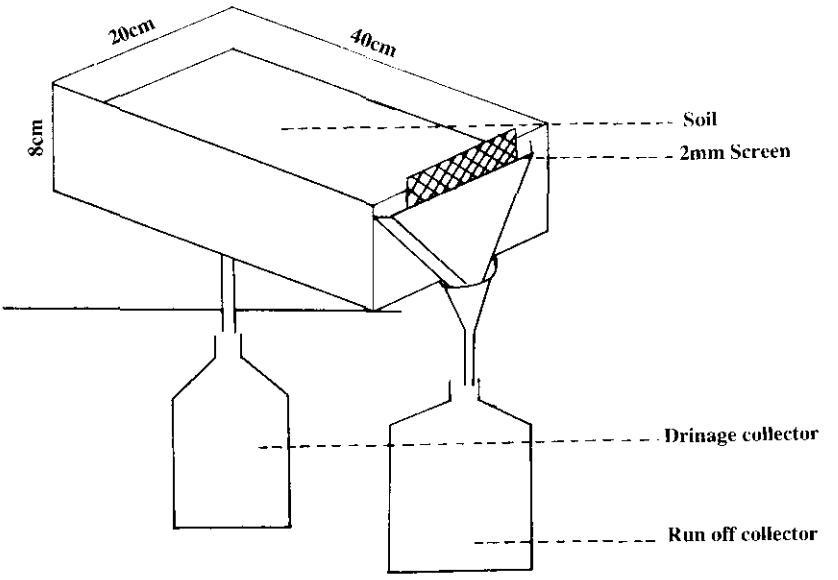

Fig. 1. A schematic diagram of soil try in position for sprinkler irrigation [15]

2 – Samples of runoff material were collected at 5 - minute intervals, three times after runoff began.

3 – Infiltration (cm/h) was calculated as the difference between rainfall and runoff.

4–Total soil less (g) was measured by settling the material in the runoff water, oven drying, weighing and taking the sum of the weights for the three intervals.

5 – Penetration resistance at or near field capacity, was measured using a packet penetrometer El 28-670.

6 – Shear strength of the cohesive soil material was calculated by dividing the penetration resistance values by a factor of two, according to the operating instructions for the penetrometer.

Results and Discussion

Table 2 shows the effect of cattle manure on runoff, infiltration, soil loss and penetration resistance.

The clear effect of manure on both soils can be seen from these results. There were statistically significant decreases in runoff and penetration and significant increases in infiltration for 1% and 2% treated soils compared to untreated soils. These decreases in runoff and increases in infiltration were associated with decreases in total soil loss of both soils. The soil loss in the El-Hartha treated soil was 68.1 to 45.1 g compared with 86.9 g in the untreated soil. The values for El-Zubair treated soil were 50.2 g and 39.4 g compared with 70.2 g for the untreated soil. The effect of 2% manure was statistically significant.

Table 2. The effect of manure on runoff (cm/h), infiltration (cm/h), total soil loss (g/cm)^2) and penetration resistance.

Treatment	Runoff rate cm/h	Infiltration rate cm/h	Total soil loss g/800cm^2	Penetration resistance KPa
		El-Hartha		
Untreated	7.60	2.06	86.90	387
1 % manure	4.90	3.50	68.10	305
2 % manure	3.30	4.93	45.10	202
5 % LSD	0.25	0.16	24.16	197
		El-Zubair		
Untreated	5.90	3.00	70.20	336
1 % manure	4.80	5.50	46.10	220
2 % manure	4.40	5.70	39.40	188
5 % LSD	0.16	0.19	25.30	165

Therefore, manure could be added to the soils at the 2% rate to improve soil structure as measured by infiltration and penetration and to prevent soil erosion by water in both soils.

Correlations between soil structure as measured by aggregation indices, and soil erosion have been determined by many researchers [6,15-19]. It has been stated that erosion starts when an aggregate slakes under the beating action of rain drops, the soil particles are then carried along the slope of the field [16]. So manure plays a role in decreasing erosion probably by increasing the aggregate stability and the infiltration rate of soil, thus preventing surface water which renders the peds more vulnerable to raindrop impact.

Further examination of Table 2 shows that increasing rates of manure though not statistically significant decreased the penetration resistance, which can be corrlated with rate of root elongation [20-23]. In sandy soil at moisture contents drier

than field capacity, root elongation decreased steadily with increasing penetration resistance. A 50% reduction in root elongation was obtained at a penetration resistance of 720 KPa for cotton seedlings. In a silt loam soil root elongation had almost stopped at a penetration resistance of 5500 KPa for rye grass [20-23].

The soil loss (g/800 cm^2 (Y) is related to manure concentration added to the soils (x). This relation indicated that the soil erosion decreases with increase manure concentration (Fig. 2).

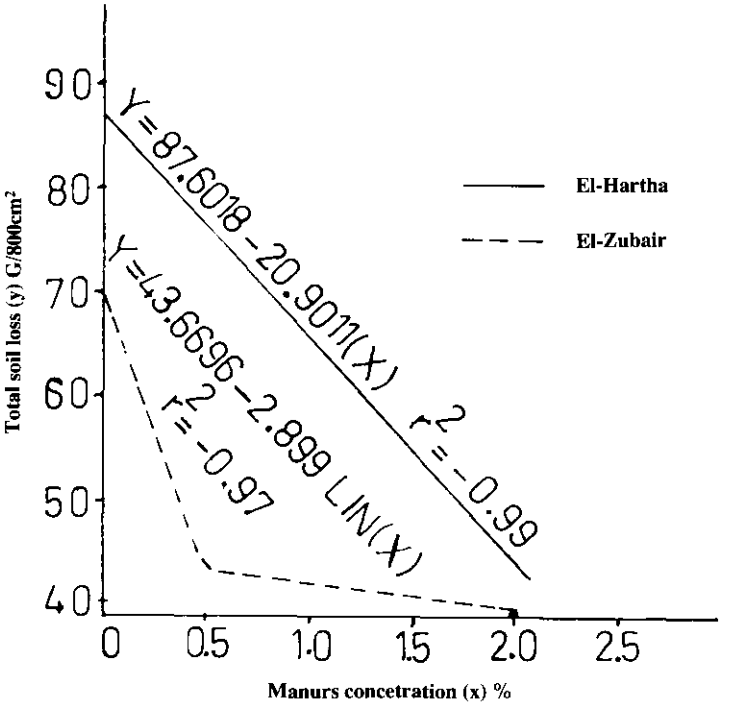

Fig. 2. Relationship between total soil loss and manure concentration

References

[1] Bunting, A.H. "Effects of Organic Manure on Soils and Crops". *Nutr. Soc. Proc.*, **24** (1965), 29-38.

[2] Kononova, M.M. *Soil Organic Matter, Its Nature, Its Role in Soil Formation and in Soil Fertility*. London, New York: Pergamon, 1961.

[3] Thompson, L.M. and Troeh, F.R. *Soil and Soil Fertility*, New York: Mc. Graw Hill, 1973.

[4] Williams, R.G.B. and Cooke, G.W. "Some Effect of Farmyard Manure and of Grass Residues on Soil Structure", *Soil Sci.*, **92** (1961), 30-39.
[5] Aspiras, R.B. Allen, O.N., Harris, R.F. and Chester, G. "Aggregate Stabilization by Filamentous Micro-Organisms". *Soil Sci.*, **112** (1971), 282-284.
[6] Gasperi-Mago, R.R. and Troeh, F.R. "Microbial Effects on Soil Brodibility", *Soil Sci. Soc. Am. Jour.*, **43** (1979), 765-768.
[7] Greenland, D.J., Lindstrom, G.R. and Quirk, J.P. "Organic Materials which Stabilize Natural Soil Aggregates". *Soil Sci. Soc. Am. Proc.*, **26** (1962), 366-371.
[8] Simpson, K. *Soils*. London and New York: Longman, 1983.
[9] Al-Obaidy, K.S. "Effect of Organic Matter Residues on Superphosphate Fertilizer Reaction and Efficiency in some Calcareous Soils". *M.Sc. thesis* (in Arabic), University of Baghdad, (1982).
[10] Hardan, A. and Abdul Halim, R.K. "Effect of Gypsum and Organic Matter on Leaching of Undistrubed Saline, Alkali Soil Columns". *Iraqi J. Agric. Sci., University of Baghdad* **3** No. 1 (1968), 13-24.
[11] Hussain, I.A. "Soil Properties and Wheat Growth as Affected by Different Organic Wastes". *M.Sc. Thesis*. College of Agriculture, University of Baghdad (in Arabic). Baghdad, Iraq, (1980).
[12] Fireman, M. "Permeability Measurements on Disturbed Soil Samples", *Soil Sci.*, **38** (1944), 337-352.
[13] Jackson, M.L. *Soil Chemical Analysis Advance Course,* 2nd (Ed.), Madison: University of Wisconsin, 1969.
[14] Piper, C.S. *Soil and Plant Analysis*. Australia: Univ. of Adelaide Press, 1950.
[15] Adams, J.E., Kirkman, D. and Scholtes, W.H., "*Iowa State College J. Sci.*, **32** (1958), 485-540.
[16] De Boodt, M. "Soil Conditioning for Better Soil Management". *Outlook on Agriculture,* **10** (1979), 63.
[17] Roth, C.B., Nelson, D.W. and Romkens, M.J. "Prediction of Subsoil Erdibility Using Chemical Minerological and Physical Parameters", *U.S. Environmental Protection Agency Report,* **660/2** (1974), 74-43.
[18] Smith, D.D. and Wischmeier, W.W. "Factors Affecting Sheet and Rill Erosion". *Trans. Am. Geophys. Union,* **38** (1957), 889-896.
[19] Yamaoto, T. and Anderson, H.W. "Splash Erosion Related to Soil Erodibility Indicies and Other Forest Soil Properties in Hawaii", *Water Resour. Res.*, **9** (1973), 336-345.
[20] Gooderham, P.T. and Fisher, M.M. "Soil Conditions and Crop Production". *NAFF Technical Bulletin.*, **29** (1975), 469-80.
[21] Taylor, H.M. and Ratliff, L.F. "Root Elongation Rates of Cotton as a Function of Soil Strength and Soil Water Content". *Soil Sci.*, **108** (1969), 113-9.
[22] Taylor, H.M., Robertson, G.M. and Parker, J.J. "Soil Strength Root Penetration Relations for Medium to Coarse Textured Woil Materials", *Soil Sci.*, **102** (1966), 18-22.
[23] Taylor, H.M. and Burnett, B. "Influence of Soil Strength on the Root Frowth Banits of Plants", *Soil Sci.*, **98** (1964), 174-80.

تأثير مخلفات الماشية على بعض صفات التربة الفيزيائية وعلى قابليتها للتعرية بواسطة الماء

حسوني جدوع عبدالله، عبدالجبار جلوب حسن، منذر ماجد تاج الدين

قسم التربة، كلية الزراعة، جامعة البصرة، البصرة، العراق

ملخص البحث. تم دراسة تأثير مخلفات الماشية على نفاذية التربة وتعريتها المائية لتربتين هما الهارثة الغرينية المزيجية وتربة المزيجية الرملية في منطقة البصرة. أضيفت المخلفات العضوية إلى التربة بمستويات صفر، ١، ٢٪ على أساس الوزن الجاف.

أظهرت النتائج أن السيح انخفض وزادت نفاذية التربة المعاملة، وقد رافق ذلك انخفاض بكمية التربة المفقودة لهاتين التربتين ولوحظ أيضًا أن مقاومة التربة للتغلغل قلت بزيادة نسبة المخلفات وكان تأثير إضافة المواد العضوية كبيراً على تربة الهارثة. ووجد أن العلاقة بين تركيز المخلفات وفقد التربة معنويًا.