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***Research article***

# EFFECT OF KINETIC ENERGY OF WATER DROPS ON SOIL AGGREGATES AT DIFFERENT LOCATIONS FROM SULAIMANI GOVERNORATE

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**ABSTRACT:** In this study eight locations were choice in Sulaimani Governorate, they were Gowezha, Bakrajo, Rania, Chamchemal, Dokan, Said Sadeq1, Said Sadeq2, Derbendixan. Soil Samples were taken from top soil for all locations and estimated organic matter, particle size distribution, and texture type. Water drop test carried out for soil aggregates by McCalla method, at 30 and 50 cm height for falling water drops. The result showed that there was a positive significant ($p<0.05$) relationship between kinetic energy and organic matter content at 30 cm and 50 cm height. The correlation coefficient value for 50 cm was ($r = 0.89$) slightly higher than the correlation coefficient ($r = 0.71$) for a height 30 cm. There was a positive correlation between KE and clay content and a negative correlation with silt content, but they were not significant at 0.05.

**Key words**: Water drops, soil, Locations, Kinetic energy

## INTRODUCTION

The raindrops release energy when they strike the soil surface and the energy dose three kinds of work, all of which are involved in the erosion process. First, it breaks aggregates and clods into smaller aggregates and individual particles. Second, it moves small soil grains (aggregates and individual particles) to new location as water splashes back into the air. Third, it compacts and puddles the surface layer of soil [1]. The combination of kinetic energy (KE) and peak intensity is almost closely related to the observed amount of soil loss [2].The organic matter (OM) and chemical constituents of the soil are important because of their influence on aggregate stability. Soil with less than 2% OM can be considering erodible [3]. The formation of aggregates by means of the cementing agents of the organic matter (litter and plant decomposition) explains the positive effect of more developed and dense vegetation cover on aggregate stability [4]. The extent of aggregate disintegration by wetting depends on aggregate stability which related to organic matter, sesquioxides and clay content [5]. The gradual increase the amount of energy required disintegrating soil aggregates over a range of soil organic matter content from natural soil organic matter content to about 9%, beyond which a slight decrease in the amount of required energy was observed in most of the investigated soil [6]. Soil erodibility is a measure of soil susceptibility to detachment and transport by the agents of erosion. It is the integrated effect of processes that regulate rainfall acceptance and the resistance of the soil to particle detachment and subsequent transport. These processes are influenced by soil properties, such as particle size distribution, structural stability, organic matter content, soil chemistry and clay mineralogy. Soil properties which affect soil structure, slaking, and water transmission characteristics also affect soil erodibility [7]. Vegetation cover is one of the key factors influencing soil erodibilty. This due to the positive feedback of the vegetation on soil quality due to the organic matter contribution by means of the litter [8].Different aggregate stability test were developed as indices of soil erodibility [9, 10, 11,12, 13,].The role of soil texture was shown that large particles are resistant to transport because of the greater force required entraining them and that fine particles are resistant to detachment because of their cohesiveness. The least resistant particles are silt and fine sand. Thus soils with high silt content are erodible [3].The fine to very fine pores common in medium and fine textured soils such as the loams, clay loams, and clays resist water movement [1]. The objective of this study is to evaluate the impact of the kinetic energy (KE) of falling water drops on soil aggregates and water erosion in many locations of Sulaimani Governorate.

## MATERIAL AND METHODS

**Soil samples** were taken from top soils at many locations of Sulaimani Governorate, Kurdistan, Iraq. Organic matter was determined by Walky and Black method as described by [14], and particle size distribution determined by pipette method (Table1).The water drop test carried out on soil samples at 30, 50 cm height to determined soil erodibility (Table 2).The principle of this experiment, when raindrops falling on soil aggregates release kinetic energy, which beginning soil erosion process, through destroyed aggregates to small units. This meaning that the quantity of soil loss with runoff depending on the ability of these aggregates to resistant water drops forces.The kinetic energy of falling drop water was calculated by [9].

$KE = ( N\pi\, d^3 \backslash 6 )\, \rho_w .\, g.\, h.$

Where:

KE : Kinetic energy to breakdown the soil aggregate in ( ergs ).
N: Number of drops required to breakdown.
d : Drop diameter ( cm ).
$\rho_w$ : Water density g $cm^{-3}$.
g : Acceleration due to gravity ( 981 cm $sec^{-2}$ ).
h : Falling height ( cm ).

**Table 1: Locations study show soil classification, surface condition, organic matter content, particle size distribution, and texture.**

| locations | Soil Classification | Surface condition | OM g $kg^{-1}$ | Particle size distribution g $kg^{-1}$ | | | Texture |
|---|---|---|---|---|---|---|---|
| | | | | Sand | Silt | Clay | |
| Gowezha | Typical Calcixerolls | Oil live tree | 22.7 | 27.2 | 459.5 | 513.3 | SiC |
| Bakrajo | Chromic Haplxerets | natural grasses | 22.3 | 37.3 | 497.7 | 465.0 | SiC |
| Rania | Chromic Haplxerets | Wheat field | 17.7 | 50.2 | 452.4 | 497.4 | SiC |
| Chamchemal | Chromic Hapltorrerts | Cultivated previous | 15.7 | 49.2 | 572.7 | 378.0 | SiC |
| Dokan | Typic Argixerolls | Oil live tree | 25.5 | 34.6 | 343.2 | 622.2 | C |
| Said Sadeq /1 | Typical Calcixerolls | Vegetable | 22.3 | 210.0 | 350.7 | 439.3 | C |
| Said Sadeq /2 | Typical Calcixerolls | natural grasses | 18.9 | 238.7 | 376.2 | 384.9 | CL |
| Derbendixan | Typical Calcixerolls | Natural grasses | 9.9 | 274.8 | 367.8 | 357.4 | CL |

**Table 2: Numbers of water drops destroyed soil aggregates at height 30 and 50 cm.**

| Locations | No. of water drops destroyed soil aggregates | |
|---|---|---|
| | Height 30 cm | Height 50 cm |
| Gowezha | 11 | 6 |
| Bakrajo | 15 | 8 |
| Rania | 10 | 5 |
| Chamchemal | 9 | 5 |
| Dokan | 21 | 10 |
| Said Sadeq1 | 15 | 8 |
| Said Sadeq 2 | 20 | 9 |
| Derbedixan | 8 | 4 |

## RESULTS AND DISCUSSION

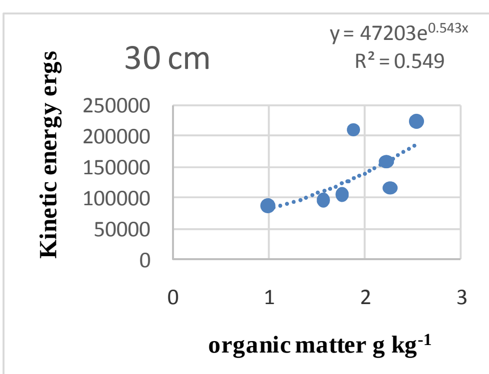
The results in Table (1) indicate the soil texture classes were ranged from silty clay to clay soils.The sand content generally were low and 5 soil samples the sand value was lower than 50 gkg-1 and the other 3 soil samples were between 210 to 274.8 gkg-1. Organic matter content was low and the values were ranged from 9.9 to 25.5 gkg-1.

The results in Table (2) showed that falling water drops at height 30 cm were higher than 50 cm height and the values were ranged from 8 to 21 drops. But the number of falling drops at 50 cm high was ranged from 4 to 10 drops with an average for all soils were 13.6 and 6.9 for 30 and 50 cm high respectively. This may be due to the impacts of the falling drops were less on the breakdown of aggregate at 30 cm. The speed of falling drops from 50 cm high were higher than speed of falling drops from 30 cm, because of shorter distance, so the impact of drops will be more in case of 50 cm than 30 cm high and consequently less number of drops needed to disperse aggregate at 50 cm high.Then, the KE for falling water drops at 50 cm high was less than the KE of falling water drops at 30 cm high.The KE of breakdown of soil aggregates were vary depending on the type of aggregation, which depend on the amount and type of organic matter, texture, type of vegetation, land use and managements[7].The KE to breakdown soil aggregates at 30 and 50 cm height for all locations showed in Table (3). The KE values were ranged from 85263 to 223817 ergs and from 40391 to 177632 ergs for 30 and 50 cm falling high of water drops respectively. The aggregates were easily destroyed by the beating action of rain, such as the KE of soil from Derbendixan area was the lowest values (85263 ergs at height 30 cm and 40391 ergs at 50 cm height). This may be due to low in organic matter content, which being 9.9 $gkg^{-1}$ and high content of sand particles (274.8g $kg^{-1}$) with a moderate silt content. It had been found that soils with 40 – 60% Silt content are the most erodible [15]. This is particularly true of soils low in organic matter and high in silt and very fine sand.

**Table 3: The KE to breakdown soil aggregates at 30 and 50 cm height for all location.**

| Locations | Kinetic energy to breakdown soil aggregates (erg) | |
|---|---|---|
| | Height 30 cm | Height 50 cm |
| Gowezha | 115205 | 104731 |
| Bakrajo | 157098 | 139642 |
| Rania | 104732 | 87276 |
| Chamchemal | 94258 | 87276 |
| Dokan | 223817 | 177632 |
| Said Sadeq /1 | 157098 | 139642 |
| Said Sadeq /2 | 209464 | 157097 |
| Derbendixan | 85263 | 40391 |

The regression correlation between organic matter and KE of falling water drops at height 30 and 50 cm for all different soils were shown in Fig (1). The result showed that there was a positive significant correlation between organic matter and KE. In this case, applied fitted exponential equation.The effect of organic matter on the KE can be seen, when comparing the KE for soils from Derbendixan and Said Sadeq 2, but the two soils had similar content of silt and clay (Table 1, 3). With increasing organic matter from 9.9 g $kg^{-1}$ for Derbendixan to 18.9 g $kg^{-1}$ for Said Sadeq 2 the KE increased from 85263 to 209464 ergs for fallen drops at 30 cm and from 40391 to 157097 ergs for 50 cm height in spite of similarity in vegetation covers, and textures. On the other hand, there was significant negative correlation between silt and KE while the sand fraction was not correlated with KE for both highest.So, the least resistant particles were silt and fine sand, thus soil with high silt content was erodible [3].



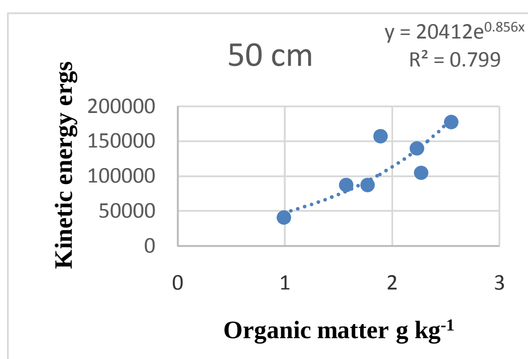




**Fig 1 The relationships between the Kinetic energy for fallen water at 30 and 50 cm height and organic matter content.**

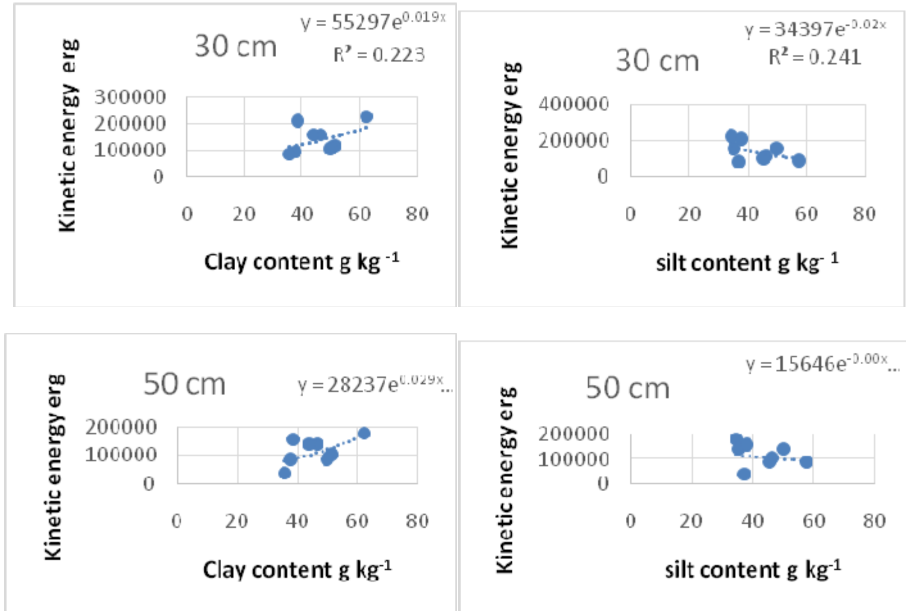



**Fig 2 The relationships between the Kinetic energy for fallen water drops at 30 and 50 cm height and clay and silt content.**

The results in Table (1) indicate that the KE was higher for the soil from Dokan area than the soils from Gowezha. This may be due to higher clay content with lightly higher organic matter content in soils from Dokan in spite of similarity in vegetation covers (Olive trees) in both areas.It had been found for the local soils that the required energy for disintegration tended to increase with clay content [6].Generally, it had been found that the soil with less than 20gkg-1 organic matter can be considering erodible [3].
The results showed that there were positive significant ( $P< 0.005$) correlation between KE and organic matter content and the value of correlation coefficient of KE for fallen water drops at 30 and 50 cm were shown in Fig ( 1). The value of correlation coefficient of KE for fallen water drops at 50 cm was slightly higher than KE for 30 cm height. The relationship between KE and OM was exponential. But similar effect was observed for clay content on the KE but the correlation coefficient was non-significant.On the other hand, different trend was obtained when take into account the silt content. There was a negative non-significant correlation between KE and silt content. So, organic matter and clay content had important role in aggregate stability.

## CONCLUSION

The KE for falling water drops at height 30 cm for all locations were more than the KE for falling water drops at 50 cm height. The KE was a positive correlated with organic matter and clay content and negatively correlated with the silt content.

## REFERENCES

[1] Frederick, R; J. Arthur Hobbs; R. L. Donahue. 1980. Soil and Water Conservation for Productivity and Environmental Protection. Prentice – Hall, Inc., Englewood Cliffs, New Jersey.
[2] YaBofen, 2003. Erosion and Precipitation.Encyclopedia of Water Sci. Ed. Marcel and Bakker. Australia.
[3] Morgan, R. P. C., 1980. The Topics in Applied Geography.Soil Erosion. Longman House. U.K
[4] Zhang, H., 1994. Organic Matter Incorporation Affects Mechanical Properties of Soil Aggregates. Soil Tillage Res. 31, pp. 263 – 275.
[5] Kay, B. D. and D.A. Anger, 1999. Soil Structure: IN: Sumner M.E. (Ed.) Handbook of Soil Science.CRC Press. New York: 229 – 269.
[6]Karim T. H; K. SH. Qadir; and S. A. Aziz. 2013. Rate of Soil Aggregation Disintegration as Affected by Type and Rate of Manure Application and Water Quality. International Journal of Plant, Animal and Environmental Sciences. 3, (2), 94 – 102.
[7] Lal, R., 1994. Soil Erosion Research Methods. Soil and Water Conservation Society (Ankeny), 3rdedn. St. Lucie Press, Delray Beach, 340 pp.

[8] Cerda, A., 1998. Soil Aggregate Stability Different Mediterranean Vegetative Types. Catena 32, pp. 73 – 86.
[9] McCalla, T. M., 1994. Water Drop Method of Determining Stability of Soil Structure. Soil Sci. 58, 117 – 121.
[10] Low, A. J., 1954. The Study of Soil Structure in the Field and the Laboratory. J. Soil Sci. 5 (1), 19 – 54.
[11] Bergsma, E., Valenzuela, C. R., 1981. Drop Testing Aggregate Stability of some Soils near Merida, Spain. EarthSurf.Processes Landforms 6, 309 – 318
[12] Armas, C. M; C. D. Arbelo; J. A. Querra; J. L. Mora; J. S. Notar; and A. R. Rodriguez. 2004. Erodibility of Forest Andosols and Soil Properties. 13th International Soil Conservation Organization Conference.
[13] Samuel C. Jimba and Birl Lowery. 2010. Automation of the Water – Drop Method for Soil Aggregate Stability Analysis. SSSAJ. Vol. 74 No. 1, Pp. 38 – 41
[14] Richards, L. A. 1954. Diagnosis and Improvement of Saline and Alkali soils. Agric. Handbook No. 60, USDA Washington.
[15] Richter, G. and Negendank, J. F. W., 1977. Soil Erosion Processes and Their Measurement in the German Area of the Moselle River. Earth Surface Processes 2, 261 – 78.