Soil losses as affected by raindrop impact and aggregate sizes under different soil water potentials.

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ABSTRACT

Soil losses of different aggregate sizes were studied under a range of raindrop sizes and matric potentials .A single raindrop device was used to produce four different sizes of drops namely ,2.45,3.34,4.0 and 4.93 mm in diameter with a constant height (163) cm. Soil losses were collected by aluminum foil cups. The effect of raindrop sizes and aggregate sizes on soil losses under a range of soil matric potentials were statistically significant at (0.01) level. Soil losses increased with increasing raindrop sizes and aggregate sizes with respect to matric potential. On the other hand, soil losses decreased rapidly as matric potential increased from (0) to 40 cm. The higher amount of losses at (0) potential as compared with higher potential. Soil losses gives good indication for the stability of soil aggregates.

INTRODUCTION

Soil losses has been related to raindrop kinetic energy and soil aggregate sizes .Single raindrop gives a good method to study the effect of raindrop impact on soil losses and aggregate stability.

Soil splash is increased as the raindrop kinetic energy increased (Al-Durrah and Bradford ,1981). McCalla ,(1944) examined the effect of raindrop number on aggregate stability. Cruse and Francis , (1984) indicated that soil strength can be related to the matric potential during raindrop impact . One size of aggregate was used by Francis and Cruse, (1983) over a range of soil tension with constant raindrop .Sharma and Gupta, (1989) pointed out the effect of raindrop size on sand detachment at a given matric potential .Single raindrop impact was used to estimate the total kinetic energy to break down soil aggregates (Wustamidian *et al.* ,1983). Mohammed *et al*., (1991) found that as the soil tension increased from (0) to (5) cm ,the aggregate stability increased markedly . A significant difference in stability was noticed for different soils. Mohammed *et al*., (1992) found in study of soil detachment by single raindrop impact that soil splash decreased rapidly as soil tension increased . At any given kinetic energy ,splash is higher at (0) cm tension compared with higher soil tension . Al-Soraihi, (2000) found a negative relationship with highly significant between soil splash and raindrop kinetic energy of two rainfall intensity . Soil splash increased as rainfall kinetic energy increased (Aggassi *et al*.,1994) .

The objective of this study was to determine the effect of aggregate sizes and raindrop sizes on soil losses under different matric potential for a loamy texture soil.

Material and Methods

Soil aggregate samples were collected from the surface of(0-15)cm of a bare loamy texture soil .The physical and chemical properties of soil are showen in Table (1). Four different sizes of aggregate were selected randomly weighing (0.33 ,0.67,1.00 and 1.71) gm. The aggregate weights are corresponding to the size of (7.6 , 9.5 , 13.4 ,15.3) mm in diameter respectively. Soil aggregates were air-dried before treated with raindrop. A range of soil matric potential, namely (0, 10, 20, and 40) cm were produced by using a sand box apparatus (Mohammed *et al.*,1991) . Four raindrop sizes of 2.45, 3.34, 4.00, and 4.93 mm in diameter were produced by using different plastic dripper sizes. A glass tube of 150 cm in length with (3.6) cm in diameter was used to prevent the drifting of the drops. The raindrops fall height was (163)cm which produced a drop velocity between 56-59 % of terminal velocity (Laws, 1944).

The soil aggregate was put above a blotting paper on the sand box and saturated before the falling started (Mohammed *et al.*,1991: Mohammed *et al.*,1992). Ten drops were allowed to hit the aggregate directly. Aluminum foil cups were used to collect soil losses during the raindrop impact as a splash(Cruse and Francis, 1984) .The cups were oven-dried after each run to determine the weight of soil losses .The process was repeated four times for each treatment. The layout was a randomized complete-block design in 4*4*4 factorial. L.S.D test at probability less than 0.01 was used to compare between means of treatments .

Table 1. Some Physical and Chemical Properties of The Used Soil .

Sand	Silt	Clay	$CaCO_3$	O.M	PH	EC
gm/Kg				gm/Kg	1:2	dS/m
300	450	250	310	6.56	7.85	4.37

RESULTS AND DISCUSSION

The effect of aggregate sizes ,raindrop sizes, and soil matric potential in soil losses was illustrated in Table (2). There was a highly significant effect at 0.01 level on soil losses . All main effects (aggregate , raindrop ,and matric potential) and their interaction were highly significant at 0.01 level. The results in Table(3) showed that as the raindrop sizes increased from 2.45 mm in diameter to 4.93 mm soil losses increased with respect to aggregate sizes for all soil matric potential range. On the other hand, as soil matric potential increased from (0) cm to 40 cm soil losses decreased rapidly with respect to drop sizes .Soil aggregate stability increased with increasing matric potential as a results of increasing soil strength .Soil cohesion increased as a results of decreasing a film of water around the particles through increasing matric potential from saturation point (0) cm to (40) cm (Francis and Cruse ,1983) . Soil aggregates were very susceptible to soil matric potential particularly at (0) cm which the aggregates were saturated .The results also showed that soil losses decreased more than 7.0 fold as soil potential increased from (0) to (10) cm with small size of aggregate ,and the differences were low with higher potential because of increasing soil cohesion which decreased soil losses and increased aggregate stability. The results of Table(3) showed also as the aggregate size increased from 7.6 mm to 15.3 mm soil losses increased with respect to raindrop sizes .There was a highly significant effect of matric potential on soil losses, for instance, mean soil losses decreased from 27.58 gm at zero potential to 2.6 gm at 40 cm. Soil aggregates were also susceptible to raindrop impact at saturation because of decreasing soil cohesion with high soil moisture, and consequently , increasing soil losses (Francis and Cruse ,1983 : Mohammed *et al*.,1991 : Mohammed *et al*.,1992) .

Table 2. Source of Variation Among Treatments .

Source of Variation	Degree of Freedom	MS	Computed F-Value
Block	3	0.1756	1.93 **
Agg . size. (A)	3	316.76	3575.27 **
Drop Size (B)	3	1996.99	22540.52 **
A×B	9	121.13	1367.32 **
Soil potential. (C)	3	8548.54	96489.48 **
A×C	9	242.91	2741.74 **
B×C	9	764.97	8634.42 **
A×B×C	27	53.02	598.50 **
Error	189	0.0886	

The results in Table(4) showed that there were statistically significant effects at 0.01 level of the interaction between matric potential, aggregate sizes and raindrop sizes. The relationship between soil losses and aggregate sizes for different raindrop sizes at (0) cm matric potential are illustrated on Figure (1). Zero matric potential was used because of the susceptibility of all aggregates at this point. Soil losses increased with increasing raindrop sizes with respect to aggregate sizes. Soil7.6 mm are higher than of 9.5 mm for all raindrop sizes because of this size of aggregate is more susceptible to saturation losses of the compared with the other aggregate sizes .

Table 3. Soil losses mean as affected by aggregate ,raindrop sizes.

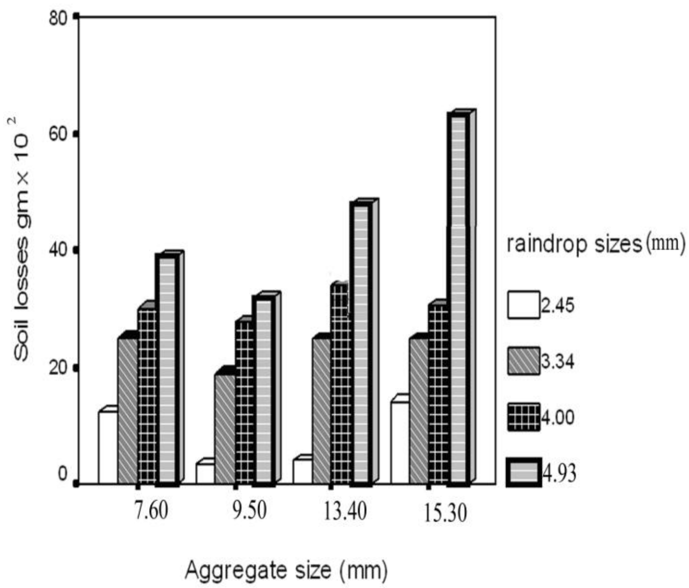
Agg . Size (mm) A	Drop Size (mm) B	Matric potential (cm) C Soil losses (gm*100) 0	10	20	40	A×C Interaction
7.6	2.45	12.50	2.10	1.90	1.50	4.50
	3.34	25.10	3.80	2.30	1.80	8.20
	4.00	30.20	3.90	2.50	2.00	9.65
	4.93	39.00	4.30	2.20	2.10	11.90
9.5	2.45	3.50	2.50	2.00	2.30	2.58
	3.34	19.00	6.50	3.40	2.70	7.90
	4.00	27.80	14.60	4.80	3.30	12.62
	4.93	32.10	16.30	5.00	1.00	13.63
13.4	2.45	4.10	1.50	1.10	0.50	1.80
	3.34	24.80	3.20	3.00	2.50	8.38
	4.00	35.50	6.90	4.60	2.90	13.73
	4.93	45.60	13.10	7.70	5.70	22.28
15.3	2.45	14.20	9.20	3.00	2.10	7.13
	3.34	25.00	15.10	4.20	2.50	11.70
	4.00	30.70	18.70	4.30	3.10	14.20
	4.93	60.20	23.00	6.40	5.50	20.03
Mean of C LSD at 0.01 for B = 0.0729		27.58	9.04	3.65	2.60	LSD at 0.01 A×C =0.0729 for

Table 4. Soil loss means as affected by aggregate size , raindrop size and soil matric.

Matric potential (C) Agg.Size(A)			0 Soil losses (gm*100)	10	20	40	Mean of factor A
7.6			26.70	3.53	2.23	1.85	8.58
9.5			20.60	9.98	3.80	2.35	9.18
13.4			34.25	6.17	4.10	2.90	11.85
15.3			28.78	16.50	4.48	3.30	13.25
Matric potential (B) drop (C) sizes			0 Soil losses (gm*100)	10	20	40	Mean of factor B
2.45			8.58	3.83	2.00	1.60	4.00
3.34			23.48	7.15	3.23	2.37	9.06
4.00			32.30	11.03	4,05	2.83	12.55
4.93			45.98	14.14	5.33	3.60	17.27
LSD	A	B	C	A B	BC	A C	A B C
0.01	0.0212	0.00212	0.0212	0.0217	0.0217	0.0217	0.0868

Treatment Kinetic energy impact causing soil losses was related to mass and velocity of raindrop, as long as the velocity was constant in this study, so the differences in energy impact among raindrops was due to the drop mass. As a result of that; as drop size increased , kinetic energy impact increased causing highly soil losses particularly at saturation.

In conclusion, this study explained that the most effective factors on soil losses were raindrop sizes and aggregates were highly sensitive to raindrop at zero potential. Also, this study can be used as a good indicator for aggregate stability at different soil moisture levels .



Figure(1): The relationship between soil losses and Aggregate sizes for different raindrop sizes at (0) cm soil matric potential.

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فقد التربة وتأثره بصدمات قطرات المطر وحجم تجمعات التربة تحت جهود ماء تربة مختلفة .

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الخلاصة

درس فقد التربة لمختلف حجوم التجمعات تحت مدى من حجوم القطرات المطرية وجهد ماء التربة. استخدم جهاز خاص لإنتاج أربعة حجوم من القطرات المطرية وهي , 4.93 , 4.00 , 3.34 2.45 ملم قطر ، وأسقطت من ارتفاع ثابت مقداره (163) سم . وجمعت التربة المفقودة بواسطة أكواب من رقائق الألمنيوم .

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كان تأثير حجوم القطرات المطرية المفردة و حجوم التجمعات في فقد التربة ذو معنوية إحصائية عالية عند مستوى (01.) أظهرت النتائج إن فقد التربة يزداد مع زيادة حجم قطرات المطر وحجم التجمعات عند ثبوت جهد ماء التربة . أما في الجانب ألآخر فأن فقد التربة قل بصورة سريعة مع زيادة جهد ماء التربة من (0) سم إلى (40) سم .أعلى كمية لفقد التربة سجلت عند الإشباع (جهد 0 سم) مقارنة مع الجهود الأعلى بسبب أن تجمعات التربة تكون أكثر حساسية للتفتت عند الإشباع . بينت الدراسة أن فقد التربة يعد ذو علاقة وثيقة مع ثباتية تجمعات التربة.