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Brief Article

Determination of Soil Aggregate Stability in Different Types and Amounts of Organic Matter in Khuzestan Plain, Iran

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ABSTRACT

In soils under wheat cultivation, soil aggregates stability is increased and destructive effects of erosion decreased, due to organic matters (OM) application. This trail was conducted in Shavoor agriculture research station to determine of mean weight diameter (MWD) under different organic matter sources and amounts in Khuzestan province (at south west of Iran) via a split plot experiment based on randomized complete blocks design with three replications during three year. Main factor included seven kind of manure (Cattle and hen manures, sugarcane filtercack and baggass, wheat straw and green manure which compared with control, without any organic manures) and three amount of manure (2.5, 5 and 10 $t.ha^{-1}$) belonged to sub factor. Result of analysis of variance showed effect of different source of OM and interaction effect of treatments (Different sources and amounts OM) on MWD was significant at 5% probability level but effect of year and sub factor on mention trait was not significant. Finally, in order to increase soil aggregates stability under climate and soil in the studied area, is advised before wheat planting at least 2.5 $t.ha^{-1}$ of organic matter cellulose such as cereal residues and or sugarcane bagasse to be used. Compliance with this recommendation, after at least 4 to 5 years, the positive effect of OM increase in aggregate stability is evident.

Keywords*: Mean weight diameter, Cellulose residues.*

INTRODUCTION

Soil aggregate stability is a key factor of soil resistively to mechanical stresses, including the impacts of rainfall and surface runoff, and thus to water erosion (Canasveras *et al*., 2010). When soil aggregates break down, finer particles are produced, which are easily carried away by wind and water flow and which upon re-sedimentation tend to clog soil pores, leading to the formation of soil crusts (Yan *et al*., 2008). Various indicators have been proposed to characterize and quantify soil aggregate stability, for example percentage of water-stable aggregates, mean weight diameter and geometric mean diameter of aggregates, and water-dispersible clay content (Calero *et al*., 2008).

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Soil organic matter and aggregation are affected by various factors, among them parent materials, landscape position, climate, vegetation and management practices (Hoyos and Comerford, 2005). Soil organic matter is known to have a significant relationship with aggregate formation and stabilization (Six *et al*., 2000). Soil organic matter can be also associated with primary mineral soils i.e., sand, silt, and clay. Such associations, which physically and chemically protect organic matter, are considered as the controlling factors of carbon storage and retention in soils. It is reported that in many soils, most of the organic matter is stored in primary particles, particularly in the clay size fraction (Shukla *et al*., 2007). For agricultural soils, variability of soil organic matter due to changes in the size of the secondary particles has been reported in some studies (Denef *et al*., 2004). Aggregate is produced in two stages, the formation and stability of aggregates. There are many factors such as organic matter (OM) effective on formation and stability of soil aggregates. Aggregate formation in the upper soil horizon is due to decomposition and microbial decay of organic matter. Optimum situation for microbial activity had positive effect on formation and stability of soil aggregate. Type of organic matter is effective on soil aggregate stability. For example if one gram of sugar mixed completely with 500 grams of cultivating soil and then inoculated, led to formation aggregate but gradually will be decomposition. But instead of one g sugar, 2 grams of alfalfa straw is used, the rate of formation soil aggregate is slower but it has higher stability (Baybordi, 1990). Organic matter more than 2% is effective to formation soil aggregate, although different type of OM had different effect on soil aggregate stability (Tisdall and *et al*., 1997). Bryan (1968) believed stable aggregate had more than 0.5 mm diameter and it's valid for Soil erosion index. Therefore, this research was carried out to evaluate different type and amount of OM in wheat cropping on mean weight diameter in Khuzestan province.

MATERIALS AND METHODS

Field and treatment information

This trail was conducted in Shavoor Research Station to determine of mean weight diameter (MWD) under different organic matter sources and amounts in Khuzestan province (at south west of Iran) via a split plot experiment based on randomized complete blocks design with three replications during three year. Main factor included seven kind of manure (Cattle and hen manures, sugarcane filtercack and baggass, wheat straw and green manure which compared with control, without any organic manures) and three amount of manure (2.5, 5 and 10 $t.ha^{-1}$) belonged to sub factor. Place of research was located in 70 km North of Ahvaz city at longitude 48 27′E and latitude 31 50'N in the Khuzestan province (southwest of Iran). The altitude, average annual rainfall, temperature, and evaporation in the region is 32m, 240 mm, 22 C and 3000 mm, respectively. Soil properties such as unit of physiographic alluvial soil of the river, soil family; fine mixed hyperthermic Aeric Haplaquept, soil series Shavoor, surface soil texture is silty clay loam type and soil depth texture silty clay was reported. Another soil characteristic was mentioned in Table 1. Fertilizers after determine the moisture content and dry matter accordance with the rates in treatments, weighted and then were mixed with soil by disc. An area of each sub plots was 18 square meters, distance between sub plots, main plot and replication was 1m, 2m and 5m respectively.

Table 1. Some soil characteristics analysis

Depth (cm)	ECe ($ds.m^{-1}$)	pH	O.C (%)	Soil texture	P (ppm)	K (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)
0-30	3.10	7.6	0.51	Clay Loam	10.9	239	9.6	1.3	8.5	0.6

Trait measure

After harvest wheat yield, soil samples were taken to determine aggregate stability. Soil samples were collected from depth of 15 to 20 cm and put them on paper (In order to dry samples), and after soil samples were crushed by hand. After drying the crushed soil completely, it passed through the sieve of 4 mm and then was placed in clamshell containers 200 grams for send to lab of soil and water institute. The wet method was used to determine the MWD. Samples from a series of sieves with a size of 2, 1, 0.5, 0.212, 0.106, 0.075 mm were passed. An after, residue soil on every sieve was weighted . Below equation was used to determine the MWD (Kemper and Rosenau, 1986): **Equation 1.** $MWD=\sum_i^n (X_i.W_i)$

X_i= Mean diameter of soil aggregate remains on each sieve (mean diameter of soil particles between two sieves).

W_i= Ratio of aggregates weight each sieve to the total weight of soil.

n= Number of sieves

Statistical Analysis

Analysis of variance and mean comparisons were done by MSTAT-C software and Duncan multiple range test at 5% probability level.

RESULT

Result of analysis of variance indicated effect of different source of organic matter (OM) and interaction effect of different source and amount of OM on trait of mean weight diameter (MWD) was significant at 5% probability level but effect of year and different amount of OM was not significant (Table 2). According to the results of mean comparison, the highest amount of MWD belonged to sugarcane baggass (1.1860), Control (1.1660) and Wheat straw residue and (1.1210) treatments, respectively. Other treatments such as cattle manures (0.9967) green manure (0.9826), hen manure (0.9800) and sugarcane filtercack (0.9404) had lower effect on Mean Weight Diameter index respectively (Table 3). Because of according analysis of variance there was not significant differences between different amount of OM treatments, It means to increase soil aggregate stability used more than 10 $t.ha^{-1}$ OM or used the same amount of OM for more than 3 consecutive years (Table 2). Other researchers such as Shirani *et al*. (2002), Vaezi and Bahrami (2014), Rasoulzadeh and Yaghoubi (2010) confirmed that result.

Table 2. Combined analysis of variance of measured trait

S.O.V	df	Mean weight diameter
Year	2	1.017^{ns}
Year*replication	6	0.161^{ns}
Different source of OM	6	0.275*
Year* different source of OM	12	0.119^{ns}
Error	36	0.095
Different amount of OM	2	0.040^{ns}
Year* different amount of OM	4	0.038^{ns}
Different source of OM*different amount of OM	12	0.040*
Year*different source of OM*different amount of OM	24	0.017
Error	84	0.037
CV(%)	1.85	

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively. OM: organic matter.

Table 3. Mean comparison of effect of different source of OM on measured trait

Treatments	Mean weight diameter
Cattle manures	0.9967[bc]
Hen manures	0.9800[bc]
Sugarcane bagasse	1.1860[a]
Sugarcane filtercack	0.9404[c]
Wheat straw	1.1210[b]
Green manure	0.9826[bc]
Control	1.1660[ab]

*Similar letters in each column show non-significant difference at 5% level in Duncan's multiple rang Test. OM: organic matter.

Mean comparison of interaction effect of treatments revealed the highest and the lowest amount belonged to treatments of 10 ton per hectare sugarcane baggass (by amount of 1.3170) and 2.5 $t.ha^{-1}$ green manure (0.8989) respectively (Table 4). In general, interaction effect of treatments showed used 2.5 $t.ha^{-1}$ cattle manure is appropriate although there was not significant differences between 2.5 and 10 $t.ha^{-1}$ but due to the economic aspects and lower cost (In terms of preparation and transfer to farm), treatment of 2.5 $t.ha^{-1}$ it possible to advised. By the same reasoning, it possible conclude that 2.5 $t.ha^{-1}$ hen manure, 10 $t.ha^{-1}$ sugarcane filtercack and baggass, 5 $t.ha^{-1}$ wheat straw and green manure are suitable treatments for use. Asgari (2014) Asadi *et al.* (2012) reported same result.

Table 4. Mean comparison interaction effects of different source and amount of OM on measured trait

Treatments		Mean weight diameter
Different source of OM	Different amount of OM ($t.ha^{-1}$)	
Cattle manures	2.5	1.0390[bc]
	5	0.9267[cd]
	10	1.0240[bc]
Hen manures	2.5	0.9822[cd]
	5	1.0290[bc]
	10	0.9289[cd]
Sugarcane bagasse	2.5	1.1230[ab]
	5	1.1180[ab]
	10	1.3170[a]
Sugarcane filtercack	2.5	0.9244[cd]
	5	0.9133[cd]
	10	0.9833[cd]
Wheat straw	2.5	1.0510[bc]
	5	1.1920[b]
	10	1.1190[ab]
Green manure	2.5	0.8989[d]
	5	1.0500[bc]
	10	0.9989[c]
Control		1.1660[ab]

*Similar letters in each column show non-significant difference at 5% level in Duncan's multiple rang test. OM: Organic matter.

DISCUSSION

The treatments used in this study are included of all three groups of organic manure such as sugarcane filtercack (residual matter after extracted of sugarcane) belonged to the first group (early biodegradable polysaccharide), green manure, hen and cattle manure belonged to the second group (polysaccharides average degradation rate), sugarcane baggass and wheat straw belonged to third group (Cellulosic polysaccharides are biodegradable late).

After adding the sugarcane filtercack to the soil in October each year, soil aggregate reached to maximum stability after few weeks and due to decomposition of the material, the pace of aggregate stability was reduced, but due to decomposition of the material, the pace of aggregate stability was reduced. But in hen manure, cattle manure and green manure maximum aggregate stability after past 4 to 5 months is obtained and then gradually decreased. Also after using sugarcane bagasse and wheat straw treatments during a few weeks aggregate formation and its stability gradually has taken place. So it seems in order to create soil sustainable aggregates more time (than three year) is required.

CONCLUSION

In south west of Iran climatic conditions (Khuzestan province) to increase soil aggregate stability, it is necessary annually at least 2.5 tons per hectare cellulosic organic manures such as wheat straw or sugarcane bagasse used before wheat planting. According this recommendation is expected after at least 4 to 5 years, the positive effect of organic manures to increasing soil aggregate stability will be appeared.

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