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Effect of Surface Soil Removal and Organic Amendment on Aggregate Stability and Erosion Indices of Soil Cultivating Sesame (*Sesamum indicum* L.)

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ABSTRACT

An experiment was conducted to study the effect of surface soil removal and organic amendment on soil cultivating sesame (*Sesamum indicum* L.) during *kharif* 2018. A split plot with three replications was designed. Surface soil removal of 0, 5 and 10 cm designated as D_0, D_1 and D_2 were carried out, respectively. The addition of different organic amendments was adopted vis, O_0- Control, O_1- Vermicompost @ 3 tonnes ha^{-1}, O_2- Poultry litter @ 3 tonnes ha^{-1} and O_3- Pig manure @ 3 tonnes ha^{-1}. Results revealed that highest percent aggregates was found with D_0 (89.66%) and on application of organic amendment O_2 (90.46%). Erosion index of soil however was highest with D_2 (47.43) and lowest with D_0 (39.25) and organic amendment application led to significant decrease in the erosion index with lowest in O_2 (35.98).

Keywords : Soil removal, Organic amendments, Soil aggregate, Erosion index.

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INTRODUCTION

Oilseed crops are cultivated all over the world predominantly for their edible oil. *Sesamum indicum* L. is native to India and has been cultivated since time immemorial. Among all the oilseeds, the production of sesame comes in third position contributing 27% of the total production in the world (Pusadkar *et al.* 2015). Water stability of aggregates is the indicator of soil resistance against disintegration (Mohanty *et al.* 2012). Detachment of soil from the surface, transportation and displacement of this detached soil elsewhere describes the process of erosion. Water erosion accounts for 56% out of the total area whereas by wind is 28%. The most apparent damage caused by erosion is the removal of the top soil which comprises of most of the nutrients required for the plant to grow hence rendering the plants to grow in the sub-soil layer. This susceptibility of soil to erosion can be estimated through erosion indices such as dispersion ratio and erosion index. The soil organic carbon content decreases with intensive cultivation, which corresponds to a decrease in aggregate stability by changing its structure (Krol *et al.* 2013). The impact of surface soil removal and organic amendment on soil aggregation and erosion indices under sesame cultivation in Nagaland has not been studied. Therefore the present investigation was carried out to evaluate the effect of simulated soil erosion and organic amendment on soil erodibility characteristics of soils in Nagaland.

MATERIALS AND METHODS

A field experiment was carried out in the experimental farm of the Department of Soil and Water Conservation School of Agricultural Sciences and Rural Development, Medziphema Campus, Nagaland University during 2018. The location of this institute is at 20045'43''N latitude and 93053'04''E longitude. It is at an altitude of 310 m above mean sea level (MSL). The climate of Medziphema is classified as humid and sub tropical. The soil texture of the experimental site was sandy loam and had an initial pH and organic carbon of 4.8 and 1.9%, respectively. The available Nitrogen, Phosphorus and Potassium content of the soil sample prior to sowing were 376.32, 21.71 and 134.40 kg ha^{-1}, respectively. Removal of the surface soil was done at depths of 0 cm, 5 cm and 10 cm whereas the application of organic amendment was done through addition of vermicompost, poultry litter and pig manure all at the rate of 3 t ha^{-1}. The spacing of the crop was kept at 30 cm × 15 cm. The total of 12 treatments laid in a split plot design with three removal depths as main plots and three organic amendments and a control as sub plots. The treatments in the main plots were D_0– 0 cm surface soil removal, D_1 – 5 cm surface soil removal and D_2 – 10 cm surface soil removal. The sub plots treatments were O_0 –Control, O_1 – Vermicompost @ 3 t ha^{-1}, O_2 – Poultry litter @ 3 t ha^{-1} and O_3 – Pig manure @ 3 t ha^{-1}. After harvest of the sesame crop, soil samples from individual plots were collected and processed for analysis.

Mean weight diameter and percent aggregates

For the determination of percent aggregates natural clod samples (200 g) were kept into the topmost sieve of a series of sieve of various sizes namely 5 mm, 3 mm, 2.5 mm, 2 mm, 1mm, 0.5 mm, 0.25 mm and 0.2 mm. The series of sieves was then immerzed in water in Yoder's apparatus for 5 minutes then it was made to shake for a total of 30 minutes with 10 minutes interval after 15 minutes of shaking. The soil fractions retained in each sieve were collected and oven dried. After drying these samples were weighed and expressed in percent. From these aggregates the percent aggregates > 0.25 mm was calculated.

Mean Weight Diameter was calculated from the equation given by Van Bavel (1949) :

$$MWD = \sum_{i=1}^{n} di\ wi$$

Where,

di= Mean diameter of each fraction,

wi=Proportion of the total sample weight occurring in the corresponding size fraction.

Dispersion ratio

The Dispersion Ratio value was computed by using the relationship given below :

$$DR = \frac{\%\ \text{water dispersed (silt + clay)}}{\%\ \text{(silt + clay) Particle – size analysis}}$$

This relationship for DR was suggested by Middleton (1930).

Erosion index

The Erosion Index was computed the relationship described by Sahi *et al.* (1970) which is given below:

$$EI = \frac{DR}{\text{(Clay/0.5 water holding capacity)}}$$

RESULTS AND DISCUSSION

Percent aggregates (> 0.25 mm)

A significant decrease in the percent aggregates was observed with the removal of surface soil (Table 1). The highest percent aggregates (89.66%) was found with no surface soil removal whereas the lowest (87.75%) was found with 10 cm removal depth. Removal of 5 and 10 cm of surface soil caused a decrease of 1.3% and 2.1% compared to the control. With removal of 10 cm of surface soil there was a decrease of 0.9% aggregate over 5 cm surface soil

Table 1. Effect of surface soil removal and organic amendment on percent aggregates and mean weight diameter.

Treatments	Percent aggregates	Mean weight diameter
D_0 – 0 cm surface soil removal	89.66	1.68
D_1 – 5 cm surface soil removal	88.53	1.55
D_2 – 10 cm surface soil removal	87.75	1.40
Sem ±	0.03	0.01
CD (p=0.05)	0.13	0.04
O_0– Control	86.19	1.08
O_1 – Vermi-compost @ 3 t ha^{-1}	90.09	2.09
O_2 – Poultry litter @ 3 t ha^{-1}	90.46	1.77
O_3 – Pig manure @ 3 t ha^{-1}	87.85	1.24
Sem ±	0.22	0.05
CD (p= 0.05)	0.64	0.13

removal. Addition of organic amendments caused a significant increase in the percent aggregate of the soil. The highest percent aggregates (90.46%) in soil was with poultry litter and the lowest (86.19%) was with control. An increase of 4.7%, 4.5% and 1.9% aggregates was observed with poultry litter, vermicompost and pig manure, respectively compared to the control. The increase in the percent aggregates of soil with addition of these amendments might be because of the increase in the microbial biomass and activity which acts a good cement agent for soil aggregates. Dutta and Yhome (2012), Sanni and Adenubi (2015), Dutta *et al.* (2013) also reported that addition of FYM, poultry litter and forest litter with NPK significantly increased the percent macro-aggregates.

Mean weight diameter

A significant decrease in mean weight diameter was observed on removal of surface soil (Table 1). The highest mean weight diameter (1.68 mm) was with no surface soil removal and the lowest mean weight diameter (1.40 mm) was with the removal of 10 cm of surface soil. Removal of 5 and 10 cm of surface soil caused a decrease of 7.7% and 16.7% mean weight diameter as compared to the control. Suwalka (2018) also found a decrease in the mean weight diameter with the highest (1.9) in the top layer of 0–15 cm and lowest (1.82) at a depth of 15–30 cm. Application of organic amendments showed a significant increase in the mean weight diameter with highest mean weight diameter (2.09 mm) in vermicompost and lowest (1.08 mm) in control. Application of vermicompost, poultry litter and pig manure increased the mean weight diameter by 93.5%, 63.9% and 14.8% respectively. The increase in mean weight diameter might be because of the increase in soil organic carbon. Narjary and Aggarwal (2014) also reported an increase in the mean weight diameter on application of organic manure. Higher macro aggregates in the crop residue-and farmyard manure-treated soils resulted in a higher aggregate mean weight diameter, which also had higher soil organic C contents (Das *et al.* 2014).

Dispersion ratio

A significant increase in the Dispersion Ratio was observed with surface soil removal (Table 2). The lowest dispersion ratio (19.62) was in control whereas the highest dispersion ratio (23.72) was in 10 cm surface soil removal. Removal of 5 and 10 cm surface soil caused an increase of 12.6% and 20.9% dispersion ratio compared to the control. Removal of 10 cm surface soil resulted in an increase of 7.4% dispersion ratio over 5 cm surface soil removal. Addition of organic amendments caused a significant effect on the dispersion ratio of soil. The lowest dispersion ratio (17.98) was on treatment with poultry litter and highest (26.89) was in the control. Vermicompost, poultry litter and pig manure caused a decrease of 30.2%, 33.1% and 12.3% dispersion ratio on comparison to the control. A decrease in dispersion ratio on addition of FYM, poultry litter and forest litter was also reported by Longchar and Dutta (2014) on terrace cultivation.

Erosion index

Significant increase in Erosion index was observed

Table 2. Effect of surface soil removal and organic amendment on dispersion ratio and erosion index..

Treatments	Dispersion ratio	Erosion index
D_0 – 0 cm surface soil removal	19.62	39.25
D_1 – 5 cm surface soil removal	22.09	44.18
D_2 – 10 cm surface soil removal	23.72	47.43
Sem ±	0.03	0.07
CD (p=0.05)	0.12	0.27
O_0– Control	26.89	53.78
O_1 – Vermicompost @ 3 t ha^{-1}	18..77	37.53
O_2 – Poultry litter @ 3 t ha^{-1}	17.98	35.98
O_3 – Pig manure @ 3 t ha^{-1}	23.60	47.20
Sem ±	0.37	0.72
CD (p= 0.05)	0.10	2.14

with removal of surface soil (Table 2). The lowest erosion index (39.25) was in the control whereas the highest erosion index (47.43) was with 10 cm surface soil removal. Removal of 5 and 10 cm surface soil caused an increase of 12.6% and 20.8% erosion index compared to the control. Higher erosion ratio is indicative of more susceptible to gully erosion once the top layers being eroded (Sharma and Kumar 2010). A significant effect decrease in erosion index was observed on application of organic amendment in the soil. Similar observation was also reported by Longchar and Dutta (2014). The lowest erosion index (35.98) was observed on treatment with poultry manure and the highest erosion index (53.78) was in control plots. A decrease of 33.1%, 30.2% and 12.2% erosion index was observed with application of poultry litter, vermicompost and pig manure, respectively compared to the control. The decrease found in the erosion index when treated with organic amendments is because of the decrease in the dispersion ratio of the soil as the two are positively correlated.

CONCLUSION

Plots with no surface soil removal showed more stable aggregates and lesser erosion index compared to plots with 5 cm and 10 cm soil removal. The application of poultry litter as an amendment increased the percent aggregates and mean weight diameter whereas it decreased the dispersion ratio and erosion index of the soil compared to control as well as other amendments. Therefore addition of organic amendments may be helpful in maintaining the physical health.

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