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Original Research Paper

Assessment of Soil Carbon Level After Application of Pressmud and Mulching Regarding Soil Carbon Sequestration

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ABSTRACT

Among the five carbon pools, soil carbon pool is one of the biggest pools having a potential of maximum carbon storage. Agriculture is a primary practice which deals with soil over the period of years. Positive amendments in agricultural practices can lead to a better soil carbon sequestration. Current study focuses on application of pressmud and organic mulching in standing crop. Pressmud is easily available at reasonable rate in Western Maharashtra as number of sugar industries are more. Mulching is also affordable to farmers, as it comprises leaves of local trees and bushes. The present study shows that there is 89.41% and 30.28% increase in soil carbon levels after application of pressmud and mulching respectively. Results show that both practices not only increase organic carbon content, but also responsible for the betterment of physical and nutritional status of soil. Thus, these agricultural practices can help to increase the rate of soil carbon sequestration. The results are discussed in the paper.

INTRODUCTION

With the increase in atmospheric CO_2 content there is a proven threat of global warming and climate change. Green house gases like CO_2, CH_4, NOx, etc. are major contributors to global warming. While understanding the mitigation solutions for global warming, minimization of CO_2 emission and its sequestration are on priority than others, as the concentration of CO_2 has increased by 30% and it remains in the atmosphere for centuries (IPCC 1995). As a result of prolonged political negotiations in between UNO member nations through international agencies on various political platforms, specific emission caps are now mandatory for nations according to their development status. Along with the international efforts it is necessary to carry out mitigation and adaptation programs at the local level to understand the dynamics of global warming and contribute to mitigating the climate change.

Agriculture is inherently sensitive to climate conditions and is among the most vulnerable sectors to the risks and impacts of global climate change (Smit & Mark 2002). Agriculture plays an important role in the carbon cycle. Agricultural activities serve as both, sources and sinks of greenhouse gases, so specific agricultural practices could slow down the pace of global warming (Miller et al. 2004). Land use patterns and agricultural practices define whether it will act as a source or sink. Agriculture soil is one of the unexplored carbon pools to be used for carbon sequestration.

Soil Carbon Sequestration

Soil carbon sequestration is the process of converting atmospheric carbon into soil organic carbon mainly through the medium of organic matter. Soil in general has significant potential to store carbon. Terrestrial ecosystems provide an active mechanism (photosynthesis) for biological removal of CO_2 from the atmosphere. They act as reservoirs of photosynthetically-fixed carbon by storing it in various forms in plant tissues, in dead organic material and in soils (IPCC 2001). Carbon sequestration in agricultural soils is accountable under Article 3.4 of the Kyoto Protocol (Padalkar et al. 2014). Harvesting the soil's potential of sequestrating carbon in agriculture ecosystems is an emerging mitigation tool as it accounts a lot if carried out extensively on a large scale.

Improved Agriculture Practices

In India, particularly in the Western Maharashtra, large area is under agricultural activities and contributes as a source of carbon due to its slash and burn practices. It is necessary to convert this source of carbon into sink by adopting improved agricultural practices. Some of the improved practices are; application of organic manure, mulching and conservation agriculture as no-till systems builds soil organic matter, which contains about 58 percent carbon (Miller et al. 2004), etc.

In case of application of organic manure, there is a problem of availability of organic manure at many places. The

current study area is situated in the sugarcane production belt having abundance of sugar industries. The cane sugar industry has several co-products with immense potential value. The co-products include pressmud (filter cake), molasses and spent wash. Out of these, pressmud is a product which can be used as good organic manure when composted properly. The application of sugarcane pressmud is also at low cost with a slower release of nutrients and trace element, high water holding capacity and mulching properties (Bhosale et al. 2012).

Another improved practice is mulching of organic material like crop residues, leaves, stubble, etc. It is also an effective and economic practice as fresh organic matter is easily available. Organic mulching directly provides organic carbon inputs to soil also, it has been used to suppress weeds and reduce soil erosion effectively in organic farming systems (Tu et al. 2006).

In the current study, comparative analysis has been done for field trails after the application of composted pressmud and organic mulching.

MATERIALS AND METHODS

Field Trails

In the present study, field trials were conducted in the village: Hanbarwadi, taluka: Karveer, district: Kolhapur, in three scudding cropping seasons i.e., kharif 2013, rabbi 2013 and kharif 2014.

Details of the plots:
Dimensions: 20×40 ft
Crop: Groundnut (Kharif)-Onion (Rabbi) rotation
Variety: Groundnut: Chitra
Onion: Furasungi Local

Improved practice:
1. Application of organic mulch
2. Application of pressmud

Organic mulching: Mulching is a practice of covering the soil surface with the help of various materials. Plastic or various other types of inorganic material can be used for the mulching purpose. Mulching reduces the evaporation from soil which results in long term moisture retention in soil. It also helps to suppress the growth of weeds by cutting its sunlight. In case of organic mulch, along with the above benefits it gives one more advantage, i.e. addition of organic matter to the soil. In the current study, mulching is done twice in a cropping season by using leaves of *Gliricidia sepium* and *Pongamia pinnata.*

Application of pressmud: Pressmud is a bi-product of the sugar industry. Composted pressmud is rich in nutrients and contains total nitrogen (%) 2.76 ±0.10, total phosphorus (%) 2.9 ±0.15, total potassium (%) 2.8 ±0.03, organic matter (%) 70.08 ±1.52 7 and total organic carbon (%) 40.65 ±0.64 (Bhosale et al.). Application of composted pressmud not only increases organic carbon but also enriches the fertility of soil. In the current study, application of composted pressmud has been done twice in the season for every crop.

Analysis of Parameters

Organic carbon: Organic carbon (%) is a prime parameter needed to measure for carbon sequestration estimation. Organic carbon is measured by using Walkley and Black (1934) method based on wet oxidation principle.

Total nitrogen: Total nitrogen is another important parameter to assess the nutritional quality of soil. Total nitrogen is analysed by using automatic Kjeldahl digestion and distillation unit.

C/N ratio: C/N ratio is calculated from the values of organic carbon and total nitrogen. C/N ratio is an indicator of the rate of decomposition of organic matter in soil.

Table 1: Level of organic carbon (%) after application of organic mulch and pressmud.

Sr. No.	Type of Agricultural Practice	Organic Carbon (%)			
		Initial	Kharif 2013	Rabbi 2013	Kharif 2014
1	Mulching	1.09	1.85	2.05	2.2
2	Pressmud	0.66	1.65	2.25	2.94

Table 2: Level of total nitrogen (%) after application of organic mulch and pressmud.

Sr. No.	Type of Agricultural Practice	Total Nitrogen (%)			
		Initial	Kharif 2013	Rabbi 2013	Kharif 2014
1	Mulching	0.11	0.5	1.1	2.0
2	Pressmud	0.10	0.85	1.8	2.3

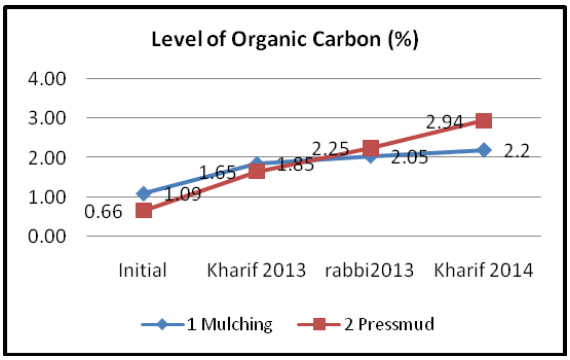

Fig. 1: Level of organic carbon (%) after application of organic mulch and pressmud.

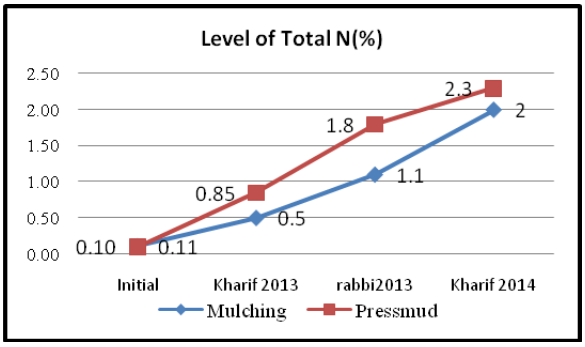

Fig. 2: Level of total nitrogen (%) after application of organic mulch and pressmud.

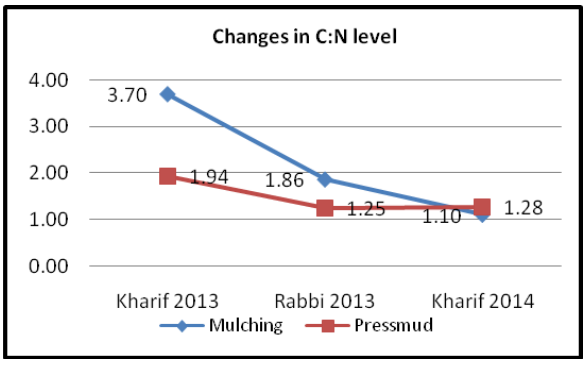

Fig. 3: Changes in level of C:N ratio.

RESULTS AND DISCUSSION

Change in Level of Organic Carbon

Level of organic carbon after application of organic mulch and pressmud is given in Table 1 and Fig. 1.

Mulching: Application of organic mulch increased the amount of organic carbon by 69.72%, 10.18% and 7.32% in kharif 2013, rabbi 2013 and kharif 2014 respectively. It shows highest increase in the first application of mulch as the initial organic carbon content in soil is comparatively low i.e., 1.09%. In next two applications in succeeding cropping season the rate of increase in carbon content goes on decreasing, but there is a net increase in the total amount of organic carbon content in soil.

Table 3: Changes in level of C: N ratio.

Agriculture Practice	C:N Ratio		
	Kharif 2013	Rabbi 2013	Kharif 2014
Mulching	3.70	1.86	1.1
Pressmud	1.94	1.25	1.28

Application of pressmud: Application of pressmud as an organic manure shows 150% increase in organic carbon after first application, as level of initial organic carbon in soil is very low, i.e. 0.66% and it has the potential to store more carbon. During subsequent cropping season it shows the increase in organic carbon content by 36.36% and 30.67% respectively. Here also, the rate of increase of organic carbon is decreased after second and third application, but there is a net increase in organic carbon content by 0.74% than application of organic mulch.

Change in Level of Total Nitrogen

Level of total carbon after application of organic mulch and pressmud is given in Table 2 and Fig. 2.

Mulching: Application of organic mulch increases the amount of total nitrogen by 354.55 %, 120 % and 57.69 % in kharif 2013, rabbi 2013 and kharif 2014 respectively. It shows the highest increase after the first application of mulch as the initial nitrogen content in soil is comparatively low i.e., 0.11%. In the next two applications in succeeding cropping season the rate of increase in total nitrogen goes on decreasing, but there is a net increase in the total amount of total nitrogen content in the soil.

Application of pressmud: Application of pressmud as an organic manure shows 750 % increase in total nitrogen after first application, as the level of initial nitrogen in soil is very low i.e., 0.1%. During subsequent cropping season it shows the increase in total nitrogen content by 111.46% and 21.74% respectively. Here also, the rate of increase of total nitrogen decreased after second and third application, but there is a net increase in total nitrogen content by 2.20% than the initial nitrogen level.

C/N Ratio

Changes in level of C: N ratio are shown in Fig. 3 and Table 3. It shows the decrease in C/N level of soil, though the level

of organic carbon and total nitrogen has increased. C/N ratio is an important factor affecting the composting process (Nengwu Zhu 2007). Humus, the final material after decomposition of organic matter has a C/N ratio around 9:1-12:1. Less C/N ratio reduces the rate of decomposition, in conclusion reduces the amount of CO_2 emission from soil in the process of decomposition. Thus, there is a net increase in the amount of organic carbon due to the addition of organic matter, such as a mulch and pressmud, and decrease in CO_2 emission from soil.

CONCLUSION

From the three years cropping cycle it can be concluded that application of mulching and composted pressmud in fields are useful practices to fulfil the objective of soil carbon sequestration in agriculture soils. Higher rates of organic carbon content are observed after application of pressmud. 3.5 times increase in level of organic carbon is achieved after application of pressmud and one time increase in level of organic carbon than the initial level after the use of organic matter as mulch. It proves that by adopting improved agricultural practices one can boost the rate of soil carbon sequestration and elucidate the role of organic matter in farming practices, not only for the betterment of soil, but also for mitigating climate change.

It also shows increase in total nitrogen content in soil in both cases, i.e. 23 times increase after application of pressmud and 18 times increase after mulching. However, application of pressmud also shows the growth of weeds in the field while mulching of organic matter hinders weed growth due to cutting of sunlight.

Thus, it will be very functional to combine both practices simultaneously to amplify the rate of soil carbon sequestration along with other nutrients and to get beneficial output from cropping system.

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