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National Academy of Agricultural Science (NAAS) Rating : 3.03

Sequestration of soil carbon through crop residue and microorganisms

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ABSTRACT: *An experiment was carried out to increase the soil organic carbon in situ recycling of crop residue in Rice-based cropping system. Field experiment was carried out during kharif and rabi season in rice and toria cropping sequence. Paddy straw is considered as a good source of nutrient. As a common practice, about 15 cm of Straw is left above the ground during harvesting of lowland rice. The initial pH values before sowing of the kharif rice was found to be 5.12 and after the harvest with a pH value of 5.00. The organic carbon was found to be 2.77 per cent in initial soil and organic carbon were 2.89 which were found to increase in the final soil sample before sowing of the rabi crop. The available nitrogen, phosphorus and potassium of the soils were found to be 98.00 and 101.00, 10.20 and 11.20 and 95.00 and 97.00 (kg/ha) respectively. The available nitrogen, phosphorus and potassium of the soils were found to be low in both the soil samples. The grain yield of kharif rice was found to be 1289 kg/ha. The grain yield of toria variety M-27 were found to in the range of 11.20-19.46 q/ha and dry matter yield were found to be 20.60 to 27.50 q/ha with a mean values of 15.46 and 23.55 q/ha respectively. The grain and dry matter yield increases significantly with different treatment employed. There is a decrease in pH of the soils after the harvest of the second crop. There was a wide variation in the organic carbon content of the soil and found to increase with different treatments except control. These may be due to the fact that there is a potential for Carbon sequestration through management of crop residues and assuming the mean carbon content of 45%, total carbon assimilated annually in the crop in the residue can be converted to humus fraction. The available nitrogen, phosphorus and potassium were found to increase in the soil samples with different treatments of crop residues and microorganisms which may be due to the solubilizing action of certain microorganism to solubilizes different forms of these nutrients and make them available.*

Keywords: *Crop residues, soil organic carbon, physico-chemical properties*

INTRODUCTION

Soil organic carbon (SOC) is considered to be one of the most important indicators of productivity of the low input farming systems and assessment of the soil health. It is the key to soil fertility, productivity and quality, as decline in SOC is considered to create an array of negative effects on land productivity. There is a growing interest in assessing the role of soil as a sink for carbon under different agricultural management practices and other land uses including forest ecosystems (Leite *et al.*, 2003), because some estimates claim that increase in soil organic carbon (SOC) content by 0.01% would lead to the C-sequestration equal to the annual increase of atmospheric carbon dioxide concentration (Lal et al., 1998). Northeastern region of India, by virtue of its strategic setting in the high rainfall eastern Himalaya, one of the mega-biodiversity hotspots in the world has unique place in India because of its richness in phytobiomass (above & below ground) in the form of forest and allied sources. Biomass is one of the most important sources to enrich the soil with organic carbon or organic matter. Extraordinary demands are being place in agricultural system to produce food, fibre & energy causing inevitable changes in the flow of carbon into or out of soil. Biomass burning & the removal of crop residue reduce carbon in soil & vegetation, which has implication for soil fertility and the global carbon cycle. Soil organic carbon pool is an important indicator of soil quality and has numerous direct and indirect impacts on it such as, improved structure and tilth, reduced erosion water purifications, increased water holding capacity, increased soil biodiversity improved yields and climate moderation.

There is a potential for C sequestration through management of crop residues. In Manipur the prevailing practice, in majority of the farmers' fields,

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is that of burning the crop residue particularly paddy. In such a backdrop the proposed investigation would attempt to generate information on soil health vis-à-vis soil organic carbon improvement through in situ crop residue incorporation in a rice-based cropping system with an objective to increase the soil organic carbon through in situ recycling of crop residue in Rice –base cropping system in long term basis and to study the changes in soil qualities both in physical and chemical parameters

MATERIALS AND METHODS

The field experiment were conducted at the Central Agricultural University, Iroisemba, Imphal during 2014 with the objective to increase the soil organic carbon in situ recycling of crop residue in Rice-based cropping system in long term basis and to study the changes in soil qualities both in physical and chemical parameters. The experiment was laid out in Randomized Block Design. Rice crop variety **JS-335** was sown during ***kharif*** season. The crops were harvested at full maturity and both grain yield and dry matter yield were recorded. After the harvest of rice crop Rabi crop toria variety **M-27** were sown during ***Rabi*** season on the same plots with different treatments as follows:

TREATMENT DETAILS

0 (Control) No treatment (Control)

T1 Paddy straw stubbles around six inch (normal condition) incorporate in the soil after rice crop were harvested

T2 Paddy straw stubbles along with CF(*Trichoderma viridi*)

T3 Paddy straw stubbles along with SSP

T4 Paddy straw stubbles along with CF(*Trichoderma viridi*) and SSP

T5 Paddy straw stubbles with CF(*Trichoderma viridi*), SSP and PSM(*Aspergillus niger*)

Considering the basic objectives, mechanical analysis of various soil samples for its sand, silt and clay fractions was carried outline by using hydrometer method (Buoyoucous, 1962). The organic carbon present in the soil samples was determined by Walkley and Black's rapid titration method as described by Walkley and Black (1934). The soil pH , available N, P, K using standard procedures described by Jackson (1973). Exchangeable Ca, Mg was determined by method given by (Chopra and Kanwar, 1976) and Al were determined before and after harvest of the kharif and rabi crops by meth

EXPERIMENTAL FINDINGS

The data on physico-chemical properties of soil are represented in table 1. The initial soil temperature before sowing of the kharif rice was found to be 28^0C and after the harvest and before the sowing rabi toria was found to be 27^0C. The initial soil before sowing of the kharif rice and after the harvest before the sowing rabi toria pH was found to be 5.12 and 5.00 respectively. The organic carbon was found to be 2.77 per cent and 2.89 in initial soil before and after harvest kharif crop respectively. The per cent organic carbon was found to increase in the final soil sample before sowing of the rabi crop. The available nitrogen, phosphorus and potassium of the soils were found to be 98.00 and 101.00, 10.20 and 11.20 and 95.00 and 97.00 (kg/ha) respectively. The available nitrogen, phosphorus and potassium of the soils were found to be low in both the soil samples i.e. before and after kharif rice crop.

Table 1
Physico-chemical properties of soil

Soil properties	*Initial*	*Final*
pH	5.12	5.00
Organic carbon	2.77	2.89
Available nitrogen (kg/ha)	98.00	101.00
Available phosphorus (kg/ha)	10.20	11.20
Available potassium(kg/ha)	95.00	97.00

GRAIN AND DRY MATTER YIELD

The data on grain and dry matter yield were presented in table no. 2. The data on grain yield of kharif rice was found to be 1289 kg/ha. The grain yield of toria variety M-27 were found in the range of 11.20-19.46 q/ha and dry matter yield were found to be 20.60 to 27.50 q/ha with a mean values of 15.46 and 23.55 q/ha respectively. The lowest yield was recorded from control with no treatment of and highest were recorded from T5 i.e. Paddy straw stubbles with CF (*Trichoderma viridi*), SSP and PSM (*Aspergillus niger*).

The grain and dry matter yield increases significantly with different treatment employed i.e T1- Paddy straw stubbles around six inch (normal condition) incorporate in the soil after rice crop were harvested, T2- Paddy straw stubbles along with CF (*Trichoderma viridi*), T3- Paddy straw stubbles along with SSP, T4- Paddy straw stubbles along with CF (*Trichoderma viridi*) and SSP, T5- Paddy straw stubbles with CF(*Trichoderma viridi*), SSP and PSM(*Aspergillus niger*).The highest grain and dry matter yield were found to be highest under the T5 treatment that is

Paddy straw stubbles with CF (*Trichoderma viridi*), SSP and PSM (*Aspergillus niger*) with a value of 19.70 and 27.50 q/ha respectively which was found to significantly higher than control with a C.D (5%) values of 4.32 and 3.98 respectively and the grain and dry matter yield were found to increase with other treatments but were found to be in par.

Table 2
Data on yield of rapeseed

Treatments	*Grain weight (q/ha)*	*Straw weight (q/ha)*
T0- No treatment (Control)	11.20	20.60
T1- Paddy straw stubbles around six inch (normal condition) incorporate in the soil after rice crop were harvested	12.50	20.90
T2-Paddy straw stubbles along with CF(*Trichoderma viridi*)	16.70	23.20
T3- Paddy straw stubbles along with SSP	17.30	24.50
T4-Paddy straw stubbles along with CF(*Trichoderma viridi*) and SSP	15.40	24.60
T5-Paddy straw stubbles with CF(*Trichoderma viridi*), SSP and PSM (*Aspergillus niger*)	19.70	27.50
Mean	15.46	23.55

CHANGES IN THE PHYSICO-CHEMICAL PROPERTIES OF SOIL

Soil pH

The data on soil pH were represented in table no. 3. The pH of the soils after the harvest of the second crop were found to be in the range of 5.26 to 4.75 and the highest were recorded from soils with no treatment and lowest were recorded from T4 plot treated with paddy straw stubbles along with CF(*Trichoderma viridi*) and SSP. It was found that the pH of the soil decreases with different treatment except the control which may be due to the fact that treatment of crop residues and microorganisms there is secretion of certain organic acid from the decomposition process of organic matter carried out due to the action of microorganisms.

Soil organic carbon

The data on soil organic carbon were represented in table no. 3. It was observed that there was a wide variation in the organic carbon content of the soil. The data ranges from as high as 3.81 and as low as 2.89. The lowest organic carbon were recorded from plot with no treatment of crop stubbles and microorganisms and highest were recorded from the plot treated with Paddy straw stubbles along with CF (*Trichoderma viridi*) and SSP. These may be due to the fact that there is a potential for sequestration through management of crop residues and assuming the mean carbon content of 45%, total carbon assimilated annually in the crop in the residue can be converted to humus fraction, it may lead to carbon sequestration at the rate of 0.2 Pg/yr or 5.0 Pg of cumulative C sequestration which was reported by Lal (1997).

Table 3
Changes in the physico-chemical properties of soil

Treatment	*Soil pH*	*Organic carbon (%)*	*Available N (kg /ha)*	*Available P (kg/ha)*	*Available K (kg/ha)*
0 (Control)	5.26	2.89	100.00	11.25	97.50
T1	5.20	2.91	103.40	11.29	97.91
T2	4.93	2.99	104.00	13.40	99.00
T3	4.93	3.11	103.50	12.19	99.20
T4	4.75	3.81	105.12	12.20	100.10
T5	4.83	3.09	109.10	15.00	100.95

Soil available N, P and K

The data on soil available N, P and K were represented in table no. 3. The available nitrogen were found to be in the range of 100.00 to 109.10 kg/ha, 11.25 to15.00 kg/ha and 97.50 to 100.95 kg/ha. The available nitrogen, phosphorus and were found to increase in the soil samples with different treatments of crop residues and microorganisms which may be due to the solubilizing action of certain microorganism to solubilizes different forms of these nutrients and make them available.

CONCLUSION

Using crop residues for competing uses (e.g., fuel, fodder, industrial and construction material) has adverse impacts on soil quality and agronomic productivity. The on field impact of burning includes removal of a large portion of the organic material, denying the soil an opportunity to enhance its organic matter and incorporate important chemicals such as nitrogen and phosphorus, as well as, loss of useful micro flora and fauna. It is thus essential to mitigate impacts due to the burning of agricultural waste in the open fields and its consequent effects on soil, ambient air and living organisms. Because of serious environmental effects due to burning is not desirable. In addition, residue incorporation resulted in considerable increases in soil organic matter content, which would lead to favorable nutrient balances and improved yields. The adoption of this practice by farmers will prove immensely useful because of reduced air pollution and recycling of nutrients. Thus the present investigation on the objectives to increase the soil organic carbon through in situ recycling of crop residue in Rice –base cropping system in long term basis and to study the changes in soil qualities both in physical and chemical parameters may be concluded that the use of crop residues and microorganism will increase the yield of crops by maintaining the fertility as well as the physico-chemical properties of soils.

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