International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

10.48047/IJIEMR/V13/ISSUE 05/65

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Volume 13, ISSUE 05, Pages: 593-604

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CORRELATION STUDIES ON DYNAMICS OF SOIL CARBON FRACTIONS UNDER INM PRACTICES IN MAIZE-GROUNDNUT CROPPING SEQUENCE IN RED-ALLUVIAL SOILS OF ANDHRA PRADESH

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Abstract

A field experiment entitled **“Dynamics of soil carbon under integrated nutrient management practices in maize - groundnut cropping sequence”** was carried out under field conditions during both *kharif* and *rabi* seasons of 2019-2020 and 2020-2021 at Field No. 50B of Wetland Farm, S.V. Agricultural College, Tirupati campus under the judicatory of Acharya N.G. Ranga Agricultural University. Correlation matrix of eleven soil attributes representing different soil carbon fractions like Total carbon, total organic carbon, total inorganic, labile, water soluble carbon and carbon stock properties and it reveals the significant correlation in which affecting maize-groundnut cropping system. All the fractions are highly correlation in (p=0.01). Total carbon had positive and significant correlation with all the fractions of carbon parameters with maximum for non-labile carbon (r=1.000), total organic carbon (r=901), MBC (r=0.819), less labile carbon (r=0.779), very less labile (r=0.672), easily oxidizable carbon (r=0.647), water soluble carbon (0.522), carbon stock (0.478) and labile carbon (r=0.412). The total organic carbon had highly significant correlation with non-labile carbon (r=.901), MBC (r=0.842), less labile carbon (r=0.697), very less labile (r=0.655), easily oxidizable carbon (r=0.670), water soluble carbon (0.563), carbon stock (0.507) and labile carbon (r=0.497). Water soluble carbon with had highly significant correlation with easily oxidizable carbon (r=0.970), easily oxidizable carbon (r=0.940), MBC (r=0.835), carbon stock (0.719), labile carbon (r=0.596), non-labile carbon (r=.522), and less labile carbon (r=0.495), very less labile (r=0.395), The easily oxidizable carbon had highest correlation with MBC (r=0.900), carbon stock (0.771), non-labile carbon (r=.647), labile carbon (r=0.578), and very less labile (r=0.543), less labile carbon (r=0.531), Very labile carbon had positive had highest correlation with MBC (r=0.682), non-labile carbon (r=.672) less labile carbon (r=0.623), carbon stock (0.497), and least with labile carbon (r=0.391), Labile carbon had maximum significant correlation with MBC (r=0.672), carbon stock (0.466), less labile carbon (r=0.415), and least with non-labile carbon (r=.412). Less labile carbon had maximum significant correlation with non labile carbon (r=0.779), MBC (r=0.670), and carbon stock (0.534). Non labile carbon had maximum significant correlation with MBC (r=0.819), and least with carbon stock (0.474). The present study indicates a positive and significant correlation between different fractions of SOC under INM practices in maize and groundnut cropping sequence.

Key words: *Maize, Groundnut, Kharif, rabi, Total carbon, total organic carbon and total inorganic carbon, FYM, Poultry manure, urban compost and NPK.*

1. Introduction

Soil organic matter is known as revolving nutrient fund that supplies mainly carbon, nitrogen, phosphorus and sulphur. Soil organic carbon governs the soil nutrient dynamics by influencing physical, chemical and biological properties. Soil organic carbon which is transient in nature, undergoes decomposition process but the rate of loss or retention in soil, depends on management practices and weather conditions. Decline in soil carbon generally decreases soil productivity. Recycling of crop residues and addition of organic wastes play a major role in global carbon and nitrogen cycling. Intensive cultivation of high yielding crops using only inorganic fertilizers and almost no recycling of organic residues have reduced soil organic carbon and other plant nutrients especially nitrogen, which leads to severe land degradation. The soil carbon is capable of enhancing agricultural sustainability and services as a potential sink of atmospheric CO_2 (Liu *et al.,* 2005). Magnitude of soil organic carbon fractions are critical in improving soil quality, crop productivity and offsetting carbon dioxide emissions. Soil carbon sequestration refers to transfer of atmospheric CO_2 into the soil as soil organic matter and as secondary carbonates through input of biomass carbon and the nutrients required to transform cellulose and lignin into humus and other end products. The general recommended management methods leading to increase in soil organic carbon stocks and carbon sequestration are the integrated nutrient management practices which include the use of crop residues, manures, bio solids, mulch farming, compost, agro forestry, diverse cropping system, conservation tillage and cover crops (Lal, 2004). Integrated nutrient management enhances the availability of applied as well as native soil nutrients and synchronizes the nutrient demand of the crop with nutrient supply from native and applied sources. It provides balanced nutrition to crops and minimizes the antagonistic effects resulting from hidden deficiencies and nutrient imbalance. Improves and sustains the physical, chemical and biological functioning of soil. Minimizes the deterioration of soil, water and ecosystem by promoting carbon sequestration, reducing nutrient losses to ground and surface water bodies and to atmosphere.

Maize (*Zea mays* L.) – Groundnut (*Arachis hypogaea*) is one of the important cropping systems in Andra Pradesh of India and maintenance of optimum soil fertility is an important consideration for obtaining higher and sustainable yield. The responses of the succeeding crops in a cropping system are influenced greatly by the preceding crops and the inputs applied there in. Therefore, recently greater emphasis is being laid on the cropping system as whole rather than on the individual crops in a sequence. Maintaining sustained crop production, balanced manuring is essential to build up soil health. Wide use of short statured high yielding varieties and hybrids is common in maize. The organic sources will improve the nutrient use efficiency of added chemical fertilizers by reducing nutrient losses and enhancing nutrient availability to plant. Integration and incorporation of organic manure (FYM, poultry manure and urban compost) in the cropping system helps to improve soil structure, soil microbial activity and soil moisture conservation and which in turn helps to stabilize the production and productivity of the crops. Integrated nutrient management is also important for marginal farmers who cannot afford to supply crop nutrients through costly chemical fertilizers.

2. MATERIAL AND METHODS

The field experiment entitled “Dynamics of soil carbon under integrated nutrient management practices in maize - groundnut cropping sequence” was carried out under field conditions during both kharif and rabi seasons of 2019-2020 and 2020-2021 at Field No. 50B of Wetland Farm, S. V. Agricultural College, Tirupati campus. which is geographically situated at 13.5°N latitude and 79.5°E longitude with an altitude of 182.9 m above mean sea level in the Southern Agro Climatic Zone of Andhra Pradesh. According to Trolls classification, it come under the Semi-Arid Tropics (SAT). The soil of experimental site was sandy clay loam with pH of 7.68, Electrical conductivity 0.85 dSm-1, low in organic carbon (0.42 %), low in available nitrogen (128 kg ha1) and high in phosphorus (52.8 kg ha-1) and medium in potassium (318.82 kg ha-1). The experiment was laid out in a split plot design for both the years with three main plots (M1)125%, (M2) 100%, (M3) 75% RDF and four sub plots (S1) control, (S2) FYM 10 t ha-1. (S3) Poultry manure 5 t ha-1 and (S4) urban compost 5 t ha-1 , total 12 treatments consisting of combinations of three replications. In kharif, maize hybrid (Kavery-55K) and in rabi, groundnut (K6) was sown on both (kharif 2019-20 and rabi 2020-21) adopting a spacing of 60 x 20 cm and 22.5 x 10 cm in maize and groundnut crops respectively .

Water soluble carbon (WSC)

Water soluble organic carbon in soil was determined as per the procedure outlined by Mc Gill et al. (1986). Ten grams of freshly drawn field-moist soil sample (within 24 hours of sampling) was shaken with 20 ml (1:2 soil : water) distilled water for 60 minutes followed by 30 minutes centrifugation at 10,000 rpm. The supernatant was then filtered and 5 ml aliquot was taken in conical flask and treated with 10 ml of 0.07 N $K_2Cr_2O_7$, 20 ml of concentrated H_2SO_4 and 5 ml of ortho-phosphoric acid. The sample was mixed carefully and digested at 150ºC for 30 minutes using digestion block and cooled to room temperature. Thereafter, 1ml of diphenylamine indicator was added and titrated against 0.01 N ferrous ammonium sulphate till the appearance of dark green colour as end point. Simultaneously a blank was also run and content was expressed mg kg-1.

2.1 Potassium permanganate oxidizable carbon

Potassium permanganate oxidizable carbon was determined as per the procedure described by Blair et al. (1995). Weigh 3g of air dried (< 2 mm) soil in 50 ml centrifuge tube and 30 ml of 20 millimolar KMnO4 was added and a blank was run. Contents were shaken for 15 minutes and centrifuged for five min at 2000 rpm. Two ml aliquot of the supernatant was transferred into 50 ml volumetric flask and made up to 50 ml. The absorbance was noted at 560 to 565 nm and determined the concentration of KMnO4 from the standard calibration curve (plot concentration versus absorbance). The content was expressed in mg kg-1.

2.2 KMnO4 oxidisable carbon

Blair et al. (1995) suggested the method for determination of soil labile carbon using potassium permanganate which has been modified by Weil et al. (2003). Labile carbon by permanganate oxidation was based on the premise that the oxidative action of KMnO4 was comparable to the oxidative process associated with the microbiological decomposition of organic matter in the soil. 2.5 g of air dried soil (< 2 mm) was taken in a 50 ml centrifuge tube. To this 20 ml of 0.33 M KMnO4 was added. The contents were shaken for 15 minutes and centrifuged for 5 minutes at 2000 rpm. From this 1 ml aliquot of supernatant was transferred into 50 ml volumetric flask and made the volume to 50 ml with distilled water. Simultaneously a blank was run without taking soil. The absorbance was read using visible spectrophotometer at 560-565 nm and concentration of KMnO4 was determined by using standard calibration curve. transferred into 50 ml volumetric flask and made the volume to 50 ml with distilled water. Simultaneously a blank was run without taking soil. The absorbance was read using visible spectrophotometer at 560-565 nm and concentration of KMnO4 was determined by using standard calibration curve and the content was expressed in mg kg-1.

2.3 Soil organic carbon pools (very labile, labile, less labile and non labile)

Kolar et al, 2011 and chan et al suggested to take one grams 0.2mm sieved soil in 500 ml conical flask in three sets. For each set pipette 10 ml of 1 N potassium dichromate and dispense it in the conical flask. To one set add 5 ml of concentrated H2SO4 and swirl the flask for 2-3 times to ensure complete mixing of sample with the similar fashion. Similarly to third set add 20 ml of conc. H2SO4 and and swirl. Allow the flasks to cool for 30 minutes and then pour 200 ml of distilled water to each. Add 10 ml of 85% orthophosphoric acid and 1 ml of diphenylamine indicator and back titrate the solution with 0.5 N FAS till the colour flashes from violet through blue to green. Also determine blank titration in similar manner to determine quantity of FAS consumed for titrating 10 ml of 1 N potassium dichromate. Also measure the total carbon content in the sample through combustion method

2.4 Organic Carbon Stock

Calculation of SOC stock was done by multiplying OC content (%), bulk density (Mg m-3) and thickness (cm) of surface soil and expressed in Mg ha-1

3 RESULTS AND DISCUSSION

3.1 KMnO4 Oxidisable Carbon

Among the levels of NPK, M1 (125 % RDF) recorded significantly highest the KMnO4 oxidisable carbon (339.43 341.87 and 339.44 and 337.10 mg kg-1 in kharif, 2019-2020 and rabi, 2020- 2021, respectively) over all other treatments and the lowest (303.92, 307.20 and 301.43, 303.26 mg kg-1) content was recorded in M3 (75 % RDF) during both the years. Among the organic sources S2 (FYM @ 10 t ha-1) recorded significantly the highest KMnO4 oxidisable carbon (370.42, 372.86 and 369.31, 366.42 mg kg-1 kharif, 2019-20 and rabi, 2020-21, respectively) compared to all other sources and the lowest

(236.03, 238.47 and 236.04, 238.70 mg kg-1) was recorded in S1 (control). The interaction effect between inorganic and organic sources (INM) over two years (kharif, 2019-20 and rabi, 2020-21,) in maize-groundnut cropping sequence was significant. KMnO4 oxidisable carbon was significantly highest on application of 125 % RDF with FYM @ 10 t ha-1. The increased soil KMnO4-C is a clear indication of synergistic effect of organic manures on soil microflora which improved the organic carbon pool over time. Sohan and Kler 2007. The results of the experiment revealed that the application of organic sources with inorganic fertilizer significantly increased KMnO4 – carbon content over control. Similar findings were reported by Purakayastha et al. (2008) and Verma et al. (2010) who attributed it to labile pool of SOC increase with increasing level of added manures. Further they reported that the incorporation of FYM enhanced the labile of SOC as compared to green manure and crop residue. It is suggested that active organic carbon obtained through oxidation with potassium permanganate was very sensitive to changes in soil management because of its rapid/fast turnover time (Leinweber et al., 1995) and had been recommended as a useful indicator for assessment of soil quality.

3.2 K2Cr2O7 -Carbon

Among the levels of NPK, M1 (125 % RDF) recorded significantly the highest K2Cr2O7-carbon (5.70, 5.97 and 6.60, 6.70 g kg-1 in kharif, 2019-2020 and rabi, 2020- 2021, respectively) over all other treatments while the lowest (5.11, 5.53 and 6.10, 5.80 g kg-1) was recorded in M3 (75 % RDF) during both the years. Among the organic sources, S2 (FYM @ 10 t ha-1) recorded significantly the highest K2Cr2O7 carbon (5.96, 6.43 and 7.20, 6.80 g kg-1 kharif, 2019-20 and rabi, 2020-21, respectively) compared to all other sources while the lowest (4.51, 4.98 and 5.20, 5.00 g kg-1) was recorded in S1 (control) Pooled analysis data on K2Cr2O7 carbon in maize – groundnut cropping sequence also followed the similar trend. The interaction effect between inorganic and organic sources (INM) over two years (kharif, 2019-20 and rabi, 2020-21,) in maize-groundnut cropping sequence was significant. K2Cr2O7 carbon was significantly highest on application of 125 % RDF with FYM @ 10 t ha-1. Sohan and Kler (2007) conducted a field experiment with maize-wheat and moong / soybean-wheat system was reporded that KMnO4-oxidizable C was more in organic farming treatments (FYM 20 t ha-1 to maize, 20 t ha-1 to wheat and incorporation of residues of both the crops) ranging from 1.16 to 1.41 mg g-1 as compared to 0.56 mg g-1 in alone fertilizer treatment. The long-term experiment on rice-wheat cropping system at Ludhiana indicated that FYM application increased KMnO4-oxidizable carbon to 40-70% relative to control after 20 years. In the other treatments, whereas total C increased by 17 % on average (Tirol et al., 2007).

3.3 Water Soluble Carbon

The term water soluble organic carbon is defined as the entire pool of water soluble organic carbon either sorbed on soil or sediment particles or dissolved in interstitial pore water (Tao and Lin, 2000). Hot water soluble carbon represents easily degradable fraction of carbon and has been suggested as a stability indicator of soil organic matter (Schulz et al., 2003). Water soluble carbon during both the years of study (kharif 2019-2020 and rabi 2020-2021) on maize-groundnut cropping sequence was significantly affected by the levels of NPK and by the application of organic sources.

Among the levels of NPK, M1 (125 % RDF) recorded significantly the highest water soluble carbon (34.44, 37.40 and 36.42, 37.01 mg kg-1 in kharif, 2019-2020 and rabi, 2020- 2021, respectively) over all other treatments whereas the lowest (32.04, 35.0

and 35.67, 35.61 mg kg-1) was recorded in M3 (75 % RDF) during both the years. Mineral fertilization escalated the decomposition process and influenced WSC, which represented easily decomposable part of the SOC (Moharana et al., 2017). Among the organic sources the treatment S2 (FYM @ 10 t ha-1) recorded significantly the highest water soluble carbon (41.67, 44.63 and 43.13, 43.32 mg kg-1 kharif, 2019-20 and rabi, 2020-21, respectively) compared to all other sources and the lowest (18.59, 21.55 and 25.35, 26.50 mg kg-1) was recorded in S1 control Pooled analysis data on water soluble carbon in maize – groundnut cropping sequence also followed the similar trend. Increase of WSC by FYM application could attribute to a higher plant biomass as well as addition of organic manures.

The interaction effect between inorganic and organic sources (INM) over two years (kharif, 2019-20 and rabi, 2020-21,) in maize-groundnut cropping sequence was non significant. However, water soluble carbon was higher on application of 125 % RDF with FYM @ 10 t ha-1. Manna et al. (2005 and 2007) reported that water soluble organic carbon increased significantly with application of NPK + FYM as compared to NPK alone. They advocated that use of FYM/lime with 100 per cent NPK is mandatory for enhancing crop productivity and maintaining soil health.

Water soluble organic carbon (WSOC), an active pool of soil organic matter, varied from 36.2 mg kg−1 in control to 57.2 mg kg-1 in the soil receiving poultry manure as amendment along with chemical fertilizers for NPK (Khursheed et al., 2013). Gangamrutha, (2016) reported that water soluble organic carbon was higher in treatment 100 % NPK + FYM + Lime (26.2 and 27.6 mg kg-1) followed by 100 % NPK + FYM (25.3 and 26.6 mg kg-1) irrespective of depth during 2013 and 2014, respectively. The organic nutrient management practice recorded significantly higher WSC content in soil due to increased SOC. The WSC content was considered as the most active component of. Higher amount of WSC content in soil due to organic treatments could be due to greater C input through FYM and enhanced crop productivity (Kumari et al., 2013).

3.4 Labile or Active Carbon Pool

To describe exactly the SOC mineralization and turnover rate, SOC pool are divided into two pool i.e active carbon pool and slow carbon pool according to the turnover time. The active carbon pool are most rapidly mineralized by the soil microorganisms. The slow carbon pool are the most slowly mineralized (Paul et al. 2001). The distribution of SOC within different pool is an important consideration for understanding the dynamics of SOC and their diverse role in ecosystems (Jenkinson, 1990). Active carbon pool (ACP) during both the years of study (kharif 2019-2020 and rabi 2020-2021) on maize-groundnut cropping sequence was significantly affected by the levels of NPK and by the application of organic sources. Among the levels of NPK, M1 (125 % RDF) recorded significantly the highest active carbon pool (14.73, 17.15 and 16.50, 21.00 g kg-1 in kharif, 2019-2020 and rabi, 2020-2021, respectively) over all other treatments and the lowest (13.60, 9.59 and 10.73 and 13.60, 17.00 g kg-1) was recorded in M3 (75 % RDF) during both the years. Among the organic sources, the treatment S2 (FYM @ 10 t ha-1) recorded significantly the highest active carbon pool (14.70, 16.55 and 17.40, 23.80 g kg-1 kharif, 2019-20 and rabi, 2020-21, respectively) and was significantly superior over other treatments S3 (Poultry manure @ 5 t ha-) and S4 (Urban compost @ 5 t ha-1) while the lowest was recorded in S1 (control). Pooled analysis data on active carbon pool in maize – groundnut cropping sequence also followed the similar trend. The interaction effect between inorganic and organic sources (INM) over two years (kharif, 2019-20 and rabi, 2020-21,) in maize-groundnut cropping sequence was non significant. However, active carbon pool was high on application of 125 % RDF with FYM @ 10 t ha-1.

Active carbon pool is believed to be derived from plant roots, litter and soil humus and is a labile substrate for microbial activity (Khan et al., 2010). The concentration of active carbon pool varied widely among all the treatments and a marginal increase was observed in surface soils under different fertilizer treatments compared with control and imbalanced fertilizer treated plots. In the long-term, the quantities of organic residues are the main factors influencing the amount and composition of ACP. ACP in subsurface soils may be a result of decomposition of crop residues or translocation from surface soil. In general increased management intensity has been found to increase the humification index and proportion of highly decomposed and microbially derived ACP in soil.

3.4 Passive or Slow Carbon Pool

Passive carbon pool (PCP) during both the years of study (kharif 2019-2020 and rabi 2020-2021) on maize-groundnut cropping sequence was significantly affected by the levels of NPK and by the application of organic sources. Among the levels of NPK, M1 (125 % RDF) recorded significantly the highest passive carbon pool (6.76, 5.97 and 7.64, 9.32 g kg-1 in kharif, 2019-2020 and rabi, 2020- 2021, respectively) over all other treatments and the lowest (3.47, 4.29 and 6.10, 8.53 g kg-1) was recorded in M3 (75 % RDF) during both the years. Whereas, among the organic sources S2 (FYM @ 10 t ha-1) recorded significantly the highest passive carbon pool (5.29, 5.88 and 9.45, 10.73 g kg-1 kharif, 2019-20 and rabi, 2020-21, respectively) and was significantly superior over other treatments S3 (Poultry manure @ 5 t ha-) and S4 (Urban compost @ 5 t ha-1) and lowest was recorded in S1 (control). Pooled analysis data on passive carbon pool in maize – groundnut cropping sequence also followed the similar trend. The interaction effect between inorganic and organic sources (INM) over two years (kharif, 2019-20 and rabi, 2020-21,) in maize-groundnut cropping sequence was non significant. However, passive carbon pool was high on application of 125 % RDF with FYM @ 10 t ha-1. Yan et al. (2007) reported that the continuous application of manure, fertilizer NPK and rice straw plus N for 25 years in a loamy soil increased PCP. The NPK and straw plus nitrogen treatment had higher PCP than control. Application of manure further increased the PCP due to lower C: N ratio and the larger proportion of recalcitrant organic compounds in the manure than the crop residues. Compared to control, the application of manure, fertilizer NPK, and rice straw plus N increased PCP by 23.4, 10.3, and 8.3%. The results showed that PCP was a sensitive indicator of changes in soil organic matter quality than soil organic C. The results of Khan et al. (2017) revealed that the long - term application of 175 % NPK + 25% FYM showed that highest POC (5.39 mg kg-1) when compared to 100% NPK (4.17 mg kg-1). There was 33.5% increase in PCP over control due to integrated nutrient management in rice-rice cropping system.

3.5 Microbial Biomass Carbon

Microbial biomass carbon (MBC) is an important component of soil organic matter that regulates the transformation and storage of nutrients. The soil microbial carbon regulates soil organic matter transformations and is considered to be the chief component of the active pool of soil organic matter. Although microbial carbon content in soil represent a small fraction (i.e. about 1 to 5%

of total organic carbon), variation in this pool due to management and cropping systems indicate about the quality of soil, because the turn–over of soil organic matter is controlled by this pool which can provide an effective early warning of the improvement or deterioration of soil quality as a result of different management practices (Powlson et al., 1987). It plays a critical role in regulating the C and N cycling processes in the soil.

During both the years of study (kharif 2019-2020 and rabi 2020-2021) on maize-groundnut cropping sequence, MBC status in soil was significantly affected by the levels of NPK and by the application of organic sources. The pooled analysis results also showed similar trend. The interaction effect was significant between inorganic and organic sources during both the years (Table 3 and 4). Among the levels of NPK, M1 (125 % RDF) recorded significantly the highest MBC (322.76, 330.05 and 334.70, 341.99 mg kg-1 in kharif, 2019-2020 and rabi, 2020-2021, respectively) over all other treatments and the lowest (246.96, 254.25 and 258.96, 266.26 mg kg-1) was recorded in M3 (75 % RDF) during both the years. Among the organic sources during both the years of study, S2 (FYM @ 10 t ha-1) recorded significantly the highest MBC (342.66, 349.95 and 355.94, 363.3 mg kg-1kharif, 2019-20 and rabi, 2020-21, respectively) and significantly superior over S3 (Poultry manure @ 5 t ha-) and S4 (Urban compost @ 5 t ha-1) and the lowest was recorded in S1 (control). Pooled analysis data on MBC in maize – groundnut cropping sequence also followed the similar trend. The interaction effect between inorganic and organic sources (INM) over two years (kharif, 2019-20 and rabi, 2020-21,) in maize-groundnut cropping sequence was significant. MBC was significantly the highest on application of 125 % RDF with FYM @ 10 t ha-1 Hao et al. (2008) reported that microbial biomass carbon was considerably greater in soils receiving FYM along with NPK fertilizer than in plots receiving merely NPK in three subtropical paddy soils. It is suggested that the greater biochemical recalcitrance of root litter might have also increased the MBC contents in soil depending root biomass produced. Geetha Kumari et al. (2013) noticed that application of FYM alone or in combination with chemical fertilizers significantly increased the soil microbial biomass carbon as compared to application of only inorganic fertilizers. They also reported that the microbial biomass carbon followed a trend similar to that of microbial biomass carbon.

3.6 Carbon Stock

Carbon stock during both the years of study (kharif 2019-2020 and rabi 2020-2021) on maize-groundnut cropping sequence was significantly affected by the levels of NPK and by the application of organic sources. The pooled analysis results also showed similar trend. The interaction effect was significant between inorganic and organic sources during both the years (Table 3 and 4).

Among the levels of NPK, M1 (125 % RDF) recorded significantly the highest carbon stock (28.94, 29.25 and 29.10, 30.99 Mg ha-1 in kharif, 2019-2020 and rabi, 2020- 2021, respectively) over all other treatments and the lowest (26.70, 27.70 and 27.31, 29.37 Mg ha-1) was recorded in M3 (75 % RDF) during both the years. Among the organic sources during both the years of study, the S2 (FYM @ 10 t ha-1) recorded significantly the highest carbon stock (30.89, 31.98 and 31.88, 34.07 Mg ha-1 kharif, 2019-20 and rabi, 2020-21, respectively) and significantly superior over S3 (Poultry manure @ 5 t ha-) and S4 (Urban compost @ 5 t ha-1) and the lowest was recorded in S1 (control). Pooled analysis data on carbon stock in maize –

groundnut cropping sequence also followed the similar trend. The interaction effect between inorganic and organic sources (INM) over two years (kharif, 2019-20 and rabi, 2020-21,) in maize-groundnut cropping sequence was significant. Carbon stock was significantly the highest on application of 125 % RDF with FYM @ 10 t ha-1. Brar et al. (2012) reported that the rice–wheat cropping even without any fertilization (control) contributed toward carbon sequestration (1.94 Mg C ha−1). The soil organic carbon pool, carbon sequestration and rate of carbon sequestration as observed in balanced fertilization (100% NPK) were significantly increased from 9.19 to 9.99 Mg C ha−1, 3.30 to 4.10 Mg C ha−1 and 0.37 to 0.46 Mg C ha−1 yr−1, respectively when farmyard manure was applied in conjunction with 100% NPK. Kumara et al. (2014) Increase in carbon sequestration rate of soil with the addition of organic manures along with NP fertilizers might be due to better crop growth with concomitant higher root biomass generation and higher return of left over surface plant residues. Parmer et al. (2016) reported that maximum soil organic carbon (0.48%), soil carbon stock (12.5 t ha-1 yr-1), plant carbon stock (65.8 t ha-1 yr-1), carbon sequestration (3 t ha-1 yr-1), total carbon stock (78.3 t ha-1 yr-1), marketable yield (7.9 t ha-1), crop biomass (7 t ha-1) were observed in treatment receiving 50% N supplemented with farmyard manure enriched rock phosphate and 50% N supplemented with vermicompost under tomato – cauliflower – radish / pea cropping pattern.

Correlation matrix of eleven soil attributes representing different soil carbon fractions like Total carbon, total organic carbon, total inorganic, labile, water soluble carbon and carbon stock properties and it reveals the significant correlation in which affecting maize-groundnut cropping system. All the fractions are highly correlation in (p=0.01). Total carbon had positive and significant correlation with all the fractions of carbon parameters with maximum for non-labile carbon (r=1.000), total organic carbon (r=901), MBC (r=0.819), less labile carbon (r=0.779), very less labile (r=0.672), easily oxidizable carbon (r=0.647), water soluble carbon (0.522), carbon stock (0.478) and labile carbon (r=0.412). The total organic carbon had highly significant correlation with non-labile carbon (r=.901), MBC (r=0.842), less labile carbon (r=0.697), very less labile (r=0.655), easily oxidizable carbon (r=0.670), water soluble carbon (0.563), carbon stock (0.507) and labile carbon (r=0.497). Water soluble carbon with had highly significant correlation with easily oxidizable carbon (r=0.970), easily oxidizable carbon (r=0.940), MBC (r=0.835), carbon stock (0.719), labile carbon (r=0.596), non-labile carbon (r=.522), and less labile carbon (r=0.495), very less labile (r=0.395), The easily oxidizable carbon had highest correlation with MBC (r=0.900), carbon stock (0.771), non-labile carbon (r=.647), labile carbon (r=0.578), and very less labile (r=0.543), less labile carbon (r=0.531), Very labile carbon had positive had highest correlation with MBC (r=0.682), non-labile carbon (r=.672) less labile carbon (r=0.623), carbon stock (0.497), and least with labile carbon (r=0.391), Labile carbon had maximum significant correlation with MBC (r=0.672), carbon stock (0.466), less labile carbon (r=0.415), and least with non-labile carbon (r=.412). Less labile carbon had maximum significant correlation with non labile carbon (r=0.779), MBC (r=0.670), and carbon stock (0.534). Non labile carbon had maximum significant correlation with MBC (r=0.819), and least with carbon stock (0.474). The present study indicates a positive and significant correlation between different fractions of SOC under INM practices in maize and groundnut cropping sequence.

	Total carbon	Total organic carbon	Inorganic carbon	Water soluble carbon	easily oxidizable carbon	very labile C	labile C	less labile C	non labile C	MBC	Carbon stock
Total carbon	1										
Total organic carbon	.901**	1									
Inorganic carbon	0.097	-.345*	1								
Water soluble carbon	.522**	.563**	-0.161	1							
easily oxidizable carbon	.647**	.670**	-0.136	.940**	1						
very labile C	.672**	.655**	-0.047	.395*	.543**	1					
labile C	.412*	.497**	-0.248	.596**	.578**	.391*	1				
less labile C	.779**	.697**	0.084	.495**	.531**	.623**	.415*	1			
non labile C	1.000**	.901**	0.097	.522**	.647**	.672**	.412*	.779**	1		
MBC	.819**	.842**	-0.159	.835**	.900**	.682**	.672**	.670**	.819**	1	
Carbon stock	.474**	.507**	-0.136	.791**	.771**	.497**	.466**	.534**	.474**	.733**	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table1. CORRELATION STUDIES ON EFFECT OF INM PRACTICES ON DYNAMICS OF SOIL CARBON FRACTION

4. CONCLUSION

water soluble carbon, microbial biomass carbon, various carbon pools (active and slow pools), and carbon stocks during kharif (2019-2020) and rabi (2020-2021) in maize-groundnut cropping sequence, were highest in M1 (125 % RDF) followed by M2 (100% RDF) and the lowest in M3 (75% RDF) while among organic sources S2 (FYM @ 10 t ha-1) was significantly superior over other treatments S3 (poultry manure @ 5 t ha-1) and S4 (urban compost @ 5 t ha-1) and the lowest was in S1 (control). The trend was similar for the interactions between inorganic and organic combination (INM) over the two years.

Integrated application of fertilizer and organic manures has played an important role in improving total SOC and labile C pools in the soil. SOC concentrations and storage were higher with application of NPK + FYM. Application of inorganic fertilizer in combination with organic manure is the most efficient management system for sequestering SOC. water soluble carbon, microbial biomass carbon and various carbon pools (active and slow pools) are high when applied with the combination of organic manure and inorganic fertilizers. By adopting INM practices soil physical properties viz; bulk density, particle density and aggregate stability were improved apart from increasing the nutrient availability in the soil. INM also helps in maintaining soil biological health like microbial population and enzyme activity which helps for mineralization and mobilization of plant nutrients. Significantly highest maize yield was obtained in 125% RDF with poultry manure @ 5 t ha-1 which was on par with FYM @ 10 t ha-1. In succeeding groundnut crop, 25% recommended fertilizers can be saved by adopting INM practices. Integrated use of organic and inorganic fertilizers is the best practice for improving soil physical, chemical and biological properties apart from crop yields.

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