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Temperature Sensitivity of Soil Organic Carbonde Composition

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SUMMARY

Excessive use of very high amount of organic matter along with improper management practices can results in the degradation of soil organic matter. Temperature is the most dominant factor that governs the sensitivity of SOC decomposition irrespective of land uses, management practices and soil types. Organic C present in lower soil depths as well as recalcitrant C shows more temperature sensitivity to soil organic carbon decomposition. Therefore, Conservation Agriculture, Site specific nutrient management along with inclusion of organics and N fertilization can be considered as better management practices as they will reduce the temperature sensitivity of SOC decomposition.

INTRODUCTION

Soil organic carbon (SOC) has often been used as a primary indicator of soil health andquality. The decline in soil organic carbon (SOC) is the major hurdle in attaining sustainability ofagricultural systems. During attainment of green revolution, decline in SOC is the most criticalsecond generation problem faced by the agricultural community. Intensive agriculture for morethan four decades declined the SOC content. The worldwide implementation of conservation agriculture (CA) based alternative soil and crop management options showed promising results towards sustainment, as well as build-up of SOC over time.

Temperature sensitivity, usually indicated by Q10 represents the in crease in decomposition rate of SOC with increase of the temperature by 10 °C. With increase in the recalcitrance of organic carbon compounds results in rise in the temperature sensitivity of SOC decomposition. The SOC associated with mineral fraction showed lessthermal sensitivity compared to free C. Therefore, an attempt has been made to examine the decomposition of soil organic carbon under various management practices as affected by temperature sensitivity.

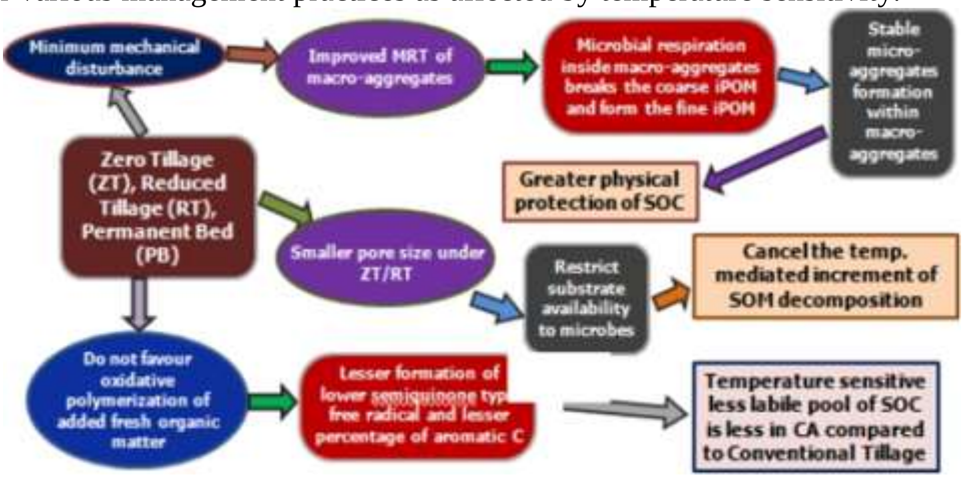

Fig1:Effect of conservation agriculture (CA) on temperature sensitivity of soil organic carbon decomposition.

The conservation agriculture (CA) is a production system involving least disturbance of soil, organic cover on soil surface and crop diversification for achieving higher productivity with efficient resource use reported higher concentration of SOC in surface soil of zero tilled (ZT) flatbeds and permanent beds (PB) than conventional tilled plots. Generally, an increase in ambient temperature increased mineralization and decay rates of SOC. Apparent temperature sensitivity of SOC mineralization depends on biophysical and biochemical factors. Higher temperature enhances dissolution and diffusion of C substrates towards activesites of enzymes. Thus, substrate availability towards microbial decomposition enhances. Desorption of otherwise recalcitrant SOM–humate complexes were also favoured at elevated temperatures. These phenomenons in variably reduce physical protection and accelerate SOM decomposition. Elevations of temperature of ten successfully solubilize waxes and lipids from the cellmembranes of dead microbes, which were otherwise resistant to degradation normally (Davidsonand Janssens, 2006). Decreasing substrate quality (i.e. degree of resistance to microbial attack) with soil depth might be responsible for the rise in Q10 values in sub-surface soils

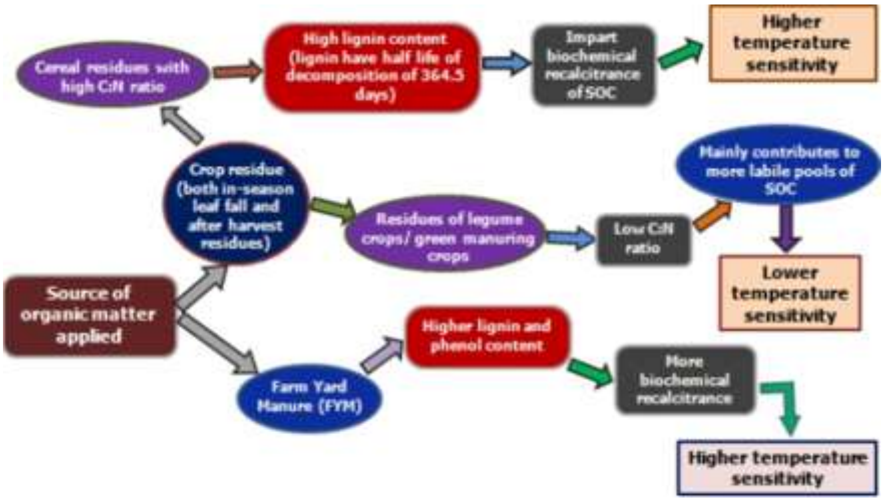

Fig 2: Effect of quality of organic matter on temperature sensitivity of soil organic carbon decomposition.

Under CA-based systems, crop residue retention and cropping system has profound effect on SOC dynamics. The bio-chemical make-up of the crop residue determines the decomposition rate, and in-turn the lability of the SOM, which further reflects in over-all C sequestration. The stabilization of SOC under these two cropping systems i.e., MMuMb (Maize-Musturd- Mungbean) and MWMb (Maize-Wheat-Mungbean) depended on the differential bio-chemical properties of mustard and wheat crop residues. The mustard residue had lower lignin contents compared with the wheat residues. Higher lignin concentrations were reported to hinder residue decomposition by virtue of an extremely long half-life of lignin (364.5days).Furthermore, the green leaves of mustard added during active crop growth, had more degradability owing to high water soluble nitrate and sulphate content compared with the after-harvest added crop residues of wheat and mustard. The higher in-season leaf fall from mustard crop compared with wheat, provided significantly higher decomposability of crop residues and in turn SOC of more lability. Decomposition rates of mustard residues were generally reported higher as compared to cereal residues, by virtue of low C:N and C:S ratio of mustard leaves. Higher microbial build-up might have occurred after mustard residue addition compared with wheat residue. These in turn resulted in a lesser build-up of recalcitrant SOC pools, i.e., LLSOC and NLSOC under MMuMb compared with MWMb. The reverse trend was followed for SOC pools with higher decomposability i.e., VLSOC and LSOC. Although the differences in these pools were not statistically significant, the combined augmentation of LLSOC and NLSOC under MWMb reflected in a significantly higher total SOC content compared with MMuMb, in all the soil depths (Fig2).

CONCLUSIONS

The SOC from lower soil depth in CT and unfertilized plots was more temperature sensitive compared to those under CA-based PB/ZT and SSNM based balanced nutrition. A significant fraction of relatively labile SOM is clearly subject to temperature-sensitive decomposition, but another significant fraction of SOM remains under environmental constraints that often obscure the intrinsic temperature sensitivity of its decomposition. Moreover, dividing SOM into only temperature-sensitive and apparently temperature insensitive pools is far too simplistic.

REFERENCES

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