ISSN No.: 2454- 2024 (online)

International Journal of Technical Research & Science

CARBON SEQUESTRATION UNDER CONSERVATION AGRICULTURE IN SOYABEAN-PIGEONPEA INTERCROPPING UNDER RAINFED CONDITIONS OF CENTRAL INDIA

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Abstract-An investigation consisting ten treatments with focus to identify the effect of intercropping and tillage on carbon sequestration under soybean-pigeonpea cropping system was formulated during 2014-15 at Research Farm of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MH). The experiment has stressed on soil microbial biomass carbon, dehydrogenase activity (DHA), potassium oxidizable carbonunder minimum tillage and intercropping with green manure crop (sunhemp). Based on the data generated it was noticed that significantly increased the carbon dynamics. Similarly, other relevant soil properties were also significantly influenced. The maximum amount of soil microbial biomass carbon and DHA was found in treatment where, pigeonpea intercrroped with sunhemp under minimum tillage compared to sole pigeonpea under conventional tillage.
Key Words: Organic carbon, microbial biomass, carbon, DHA.

1. INTRODUCTION

Soil organic carbon (SOC) plays vital role in sustaining soil fertility and productivity. The carbon occurs in labile (easily decomposable) and non labile (resistant to microbial decay) forms that helps in maintaining the soil health. Soil organic carbon exists in two pools viz., active pool and passive pool. The active pool consists of living microbes and their products besides soil organic matter. The active pool has a short turn-over time and includes soil microbial biomass carbon and labile carbon; it is dependent on agro-ecosystem and management. The passive pool is comparatively more stable than the active pool and is slowly decomposable having a larger turnover time. Practices such as addition of organic manures or residues, green-manuring intercropping with pulses improves the content of soil organic carbon. Total organic carbon content is generally low under conventional tillage than minimum tillage. The distribution of SOC within different pools is an important consideration for understanding its dynamics and diverse role in ecosystems. Crop production, nutrient uptake, physico-chemical properties and microbiological properties of soil can potentially improved by chemical fertilizers along with FYM. Pigeonpea intercropped with green manure under crop MT influence enzyme activities, microbial biomass and carbon mineralization as compared to as copare to sole pigeonpea under CT The present study was carried out to study the effect of shaded biomass on active pools of SOC and corresponding properties under soybean-pigeonpea cropping system of Typic Haplustepts.

2. MATERIALS AND METHODS

The experiment was carried with on-going experiment on soybean-pigeonpea intercropping during the rainy season (kharif) 2014-15 started in 2010-11 at the experimental farm of Dr. PDKV, Akola. The experimental site has semi-arid with erratic climatic conditions (maximum temperature goes up to 43.9^0C in summer and 22^0C during winters). The mean annual rainfall of the area is 591.3 mm. The experimental soil was typic haplusterts, (pH 7.8), soil organic carbon (5.91 g kg^{-1}), available N (210 kg ha^{-1}), available P (15.80 kg ha^{-1}) and has a relatively high potassium(318 kg ha^{-1}).The ten treatments were replicated three times in randomized block design. The treatments comprising of T_1 Sole pigeonpea under CT,T_2 Sole soybean under C,T_3 Pigeonpea + soybean (1:2) under CT, T_4 Pigeonpea+sunhemp (GM) under CT ,T_5 Pigeonpea + soybean (1:5) under CT, T_6 Sole pigeonpea under MT,T_7 Sole soybean under MT,T_8 Pigeonpea + soybean (1:2) under MT, T_9 Pigeonpea + sunhemp (GM) under MT, T_{10} Pigeonpea + soybean (1:5) under MT. The present experiment was carried out with soybean- pigeonpea intercropping in kharif season only. Organic C (Nelson and Sommer,1982), SMBC (Jenkinson and Powlson,1976) DHA (Klien,(1971).

3. RESULTS AND DISCUSSION

The experiment was defined to study the behavior of carbon under minimum tillage and intercropping. Based on the observations and data generated the carbon dynamics has been computed. The quantum of biomass added by soybean- pigeonpea was really remarkable in all the treatments. Especially it was promising in pigeonpea + sunhemp under minimum tillage practices over sole pigeonpea in conventional tillage.

3.1 Organic Carbon

It was observed that the organic carbon varied from 6.00 to 6.83 g kg^{-1} in 0-15 cm and 5.00 to 6.75 g kg^{-1} in 15-30 cm depth under soybean-pigeonpea. The highest organic carbon was noted in Pigeonpea + sunhemp (GM) under MT (T_9). The treatment showed increasing trend of soil organic carbon in minimum tillage which might be due to higher yield of roots and plant residue. A larger proportion of the higher C content or C sequestration in Pigeonpea + sunhemp under MT plot was due to green manuring. The similar findings have also been noted by Singh et.al. (2004) soils sequestered significantly higher amount of SOC in the whole profile (0–50 cm soil depth) with more pronounced effect seen at 0–15 cm soil depth under no-tillage as compared with the SOC under conventional tillage. Crop residues added to no-tillage soils outperformed other treatment interactions. It is concluded that a rice–wheat system would serve as a greater sink of organic carbon with residue application under no-tillage system than with or without residue application when compared to the conventional tillage (Rajan Ghimire2011), Li Cheng-Fang (2012) and Seema et al. (2014).

3.2 Soil Microbial Biomass Carbon

Significantly highest (283.93µg g^{-1}) microbial biomass carbon was recorded in treatment T_9 (Pigeonpea + sunhemp (GM) under MT) followed by treatment T_{10} (278.65µg g^{-1}) Pigeonpea + soybean (1:5) under MT. The rate of increase in SMBC was more under intercropping with green manure using minimum tillage. The values of SMBC obtained under treatment T_4 and T_{10} were at par with each other. The rate of SMBC increased in treatment T_4 was comparatively higher than $T_{1,}$ both the treatment were under conventional tillage but, treatment T_4 comprises pigeonpea intercropped with sunhemp. Similar trend was also followed in respect of T_6 and $T_{9.}$ The content of SMBC was significantly increased in treatment T_9 followed by T_4.Hence, the addition of organics and conservation practices i.e. intercropping with green manuring under minimum tillage improved the soil microbial biomass carbon. The data indicates simple application of only organics significantly increased the soil microbial biomass as compared to conventional.

3.3 Dehydrogenase Activity

The generated data reveled that significantly highest DHA (69.70 µg TPF/g/h) was noted in treatment T_9(Pigeonpea + sunhemp (GM) under MT) followed by treatment T_{10} (68.61 µg TPF/g/h). This significant increase in DHA was must be due to intercropping of pigeonpea with higher biomass producing sunhemp under minimum tillage. Dehydrogenase activities noted under in all the treatments (T_6, T_7, T_8, T_9 and T_{10}) under minimum tillage 10.95%, 14.66 %,17.29 %, 23.03% and 21.80% respectively, increase over treatment T_1 where pigeonpea was grown under conventional tillage. The enzymatic activities in soils are always significantly influenced by the application of crop residues over no residue. The crop residue application recorded about 35, 48 and 33% higher DHA, b-glucosidase, acid and alkaline phosphatise activities respectively. Tillage and crop establishment techniques significantly influenced the dehydrogenase activity (DHA) and phosphatise activity in the surface soil, but not the b-glucosidase activity (DHA) in soil varied from 14 to 21 µg 2, 3, 5 triphenyl formazan (TPF)/g/h. (Seema et al. 2014). Zero or minimum tillage caused an increase of 20.6, 8.0 and 6.1% in DHA, acid and alkaline phosphatise activities, respectively, over conventional tillage.Conservation agriculture improves productivity and soil quality. Similarly, the plots under zero tillage had 20.6, 8.0 and 6.1 % higher dehydrogenase and alkaline phosphatase activities respectively, over conventional tillage (Seema et al. 2014).

CONCLUSIONS

In pigeonpea higher seed yield and straw per plant yield was found in pigenpea + sunhemp under minimum tillage. Total biomass was also maximum in pigeonpea + sunhemp under minimum. Higher total leaf litter biomass (881.61 kg h^{-1}) were found in pigeonpea + sunhemp under MT) and lowest in sole soybean. Significantly lower pH, EC and higher organic C, available NPK, SMBC and DHA was found in pigenpea + sunhemp under MT. Execution of intercropping with green manuring (sunhemp) under minimum tillage is having tremendous potential to improve physical, chemical and biological properties of soil. Which thereby, resulting into enhancement in soil quality as well as increased crop.

Table-1 Effect of Tillage and Intercropping on Leaf Biomass, Vertical Distribution of Organic Carbon, Dehydrogenase Activity and Soil Microbial Biomass Carbon of Soil

S. No.	Treatment	Leaf litter Cumulative biomass (kg ha^{-1})	Organic carbon (g kg^{-1})		Soil microbial biomass carbon (µg g^{-1} soil)	DHA (µg TPF /g/h)
			0-15 cm	15-30 cm		
T_1	Sole pigeonpea under CT	833.22	6.43	5.57	264.43	53.65
T_2	Sole soybean under CT	772.49	6.00	5.00	260.53	58.23
T_3	Pigeonpea + soybean (1:2) under CT	821.90	6.40	6.00	268.20	60.87
T_4	Pigeonpea + sunhemp(GM) under CT	838.35	6.77	6.57	278.23	63.63
T_5	Pigeonpea + soybean (1:5) under CT	805.43	6.37	5.67	274.36	62.05
T_6	Sole pigeonpea under MT	876.43	6.60	6.70	272.57	60.25
T_7	Sole soybean under MT	783.24	6.57	6.50	267.73	62.87
T_8	Pigeonpea + soybean (1:2) under MT	816.37	6.67	6.57	271.33	64.87
T_9	Pigeonpea + sunhemp (GM) under MT	881.61	6.83	6.75	283.93	69.70
T_{10}	Pigeonpea + soybean (1:5) under MT	793.76	6.53	6.33	278.65	68.61
	SE(m)±	5.60	0.08	0.09	2.05	1.48
	CD at 5%	16.8	0.24	0.27	6.15	4.44
	Initial		5.91	5.72		

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