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Influence of Moisture Conservation Practices and Soil Amendments on Moisture Content and Biological Properties in Soils under Semi-arid Climatic Conditions of Central India

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Abstract: An investigation was conducted during *kharif* 2016 and 2017, to assess the "Influence of moisture conservation practices and soil amendments on moisture content and biological properties in soil" at Integrated Farming System Research, Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola with seven treatments replicated thrice in randomize block design. The treatments consisted of normal sowing, recommended dose of fertilizer + opening of furrow at 30 DAS, recommended dose of fertilizer + opening of furrow at 45 DAS, 75% recommended dose of nitrogen and 100% P and K through chemical fertilisers + 25% N through green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 30 DAS, 75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 45 DAS, 75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow at 30 DAS, 75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow at 45 DAS. The moisture content and biological properties were significantly enhanced with application of 75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 30 DAS. The integration of moisture conservation practices and soil amendments have greater significance in improving the soil properties and sustainability of soil in changing climatic conditions of rainfed agriculture.

Key words: *Amendments, green leaf manuring, opening of furrow*

Introduction

Management of soil moisture has great significance under uncertain, undistributed and erratic rainfall conditions. The intermittent dry spells of longer duration and unavailability of sufficient moisture at critical growth stages of crops cause significant loss in yield and nutrients availability in soil and also in retaining under dry spells. Practice of making ridges by opening furrows may have an advantage in collection of more rain water on bed which enriches soil moisture content (Gidda and Morey 1981) beside allowing excess water to drain. Heavy erosion of upper layer of soil and substantial nutrient loss through erosion highlighted the urgency for adoption of site-specific moisture conservation practices. The incorporation of organic sources along with adoption of conservation practices have added advantage towards sustainability of soil. Further, intensive cropping system have hasten the mining of native fertility and leaving hardly any crop residue which is necessary to maintain organic matter content at an optimum level (Ghosh *et al*. 2002). Green manuring crop are known to fix atmospheric nitrogen, improve soil structure and recycle the nutrients. Decomposition of organic manure resulting in improved

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physical and biological properties of soil. Soil management and agronomic practices are tailored to store and conserve as much as rainwater is possible by reducing run-off and increasing the storage capacity. Therefore, the moisture conservation that can achieved through cultural or mechanical methods such as tillage operation, vertical mulch, ridges and furrow and opening of furrows, not only aids in reducing the soil and run-off losses but also raising of the rainfed crop more successfully in arid and semi-arid regions. With this view, the present investigation was framed and executed to identify the significance of moisture conservation practices and organic manures on content of moisture in soil and changes in biological parameters.

Materials and Methods

An experiment was conducted during *kharif* 2016 and 2017 to find out the "Influence of moisture conservation practices and soil amendments on moisture content and biological properties in soil at Integrated Farming System Research, Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola with seven treatments replicated thrice in randomize block design. The treatments were consisted of T_1- recommended dose of fertilizer (Normal sowing), T_2- recommended dose of fertilizer + opening of furrow at 30 DAS, T_3- recommended dose of fertilizer + opening of furrow at 45 DAS, T_4-75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through Green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 30 DAS, T_5-75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 45 DAS, T_6-75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow 30 DAS, T_7- 75% of recommended dose of fertilizer + Farm yard manure @ 2.5 tonnes after opening of furrow 45 DAS.

The soil (medium black) of the experimental field had with pH 7.60, medium content of organic carbon, available nitrogen (185.37 kg ha^{-1}), phosphorous (16.13 kg ha^{-1}) and available potassium (363.84 kg ha^{-1}). The variety JS-335 was sown @ 75 kg ha^{-1} with basal dose of fertilizers (30:75:30 kg NPK ha^{-1}). The green leaf manure (Glyricidia) was incorporated in between two rows of soybean at the time of sowing in treatment T4 and T5 while Farm yard manure was applied in treatment T6 and T7 at the time of sowing. The furrows were opened at 30 and 45 days after sowing as per treatments. The depth-wise (0-15 and 15-30 cm) moisture content at vegetative, flowering and pod formation stages of crop, while biological parameters (SMBC, SMBN, and Dehydrogenase activity) were also analysed at grand growth stage of soybean following the standard procedures. The data have been statistically analysed to draw the valid conclusion.

Results and Discussion

Soil moisture

The data indicated that the soil moisture content (%) at different stages of soybean was significantly influenced by various treatments (Table 1, Fig. 1 & 2). The moisture content in soil was maximum at flowering stage, followed by vegetative and pod formation stage of soybean. The highest moisture content (32.33%) in 0-15 cm and 31.30% in 15-30 cm was noticed due to integration of 75% recommended dose of nitrogen and 100% P and K through chemical fertilizers and 25% nitrogen through Glyricidia at the time of sowing and opening of furrows at 45 days after sowing, followed by 75% recommended dose of nitrogen and 100% P and K through chemical fertilizers and 25% nitrogen through Glyricidia at the time of sowing and opening of furrows at 30 days after sowing. The similar trend of increase was also recorded at vegetative and pod formation stages of soybean. The minimum moisture content was found in treatment T1. Among the different conservation treatments, the application of Glyricidia along with chemical fertilizers and opening of furrows at 30 and 45 days after sowing found effective in conserving higher moisture content over inorganic fertilizers. Gidda and Morey *et al.* (1981) reported that the practices of opening of furrow in between row of crop is beneficial for improving drainage system in field during early monsoon. The practices of making ridge by opening furrow may have an advantage in concentration of more rain water on bed which enriches soil moisture content. (Pakhale *et al.* 2009).

Table 1. Effect of moisture conservation practices and soil amendments moisture content of soil at different growth stages of crop

Treatment		Depth (cm)	Moisture content (%)		
			Vegetative stage	Flowering stage	Pod formation stage
T1	Recommended dose of fertilizer (Normal sowing)	0-15	26.61	27.34	25.98
		15-30	25.61	26.38	24.64
T2	Recommended dose of fertilizer+ opening of furrow at 30 DAS	0-15	26.87	27.60	26.23
		15-30	25.53	26.57	24.68
T3	Recommended dose of fertilizer + opening of furrow at 45 DAS	0-15	27.65	28.38	27.02
		15-30	26.32	27.68	25.90
T4	75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 30 DAS	0-15	31.39	32.12	30.72
		15-30	30.06	30.92	30.09
T5	75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 45 DAS	0-15	31.67	32.33	30.97
		15-30	30.33	31.30	30.24
T6	75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow 30 DAS	0-15	31.35	32.08	30.52
		15-30	30.02	31.05	29.38
T7	75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow 45 DAS	0-15	31.42	32.16	30.29
		15-30	30.09	31.16	29.46
SE (m) +		0-15	1.26	1.35	1.33
SE (m) +		15-30	1.32	1.28	1.33
CD at 5%		0-15	3.89	4.17	4.12
CD at 5%		15-30	4.06	3.95	4.12

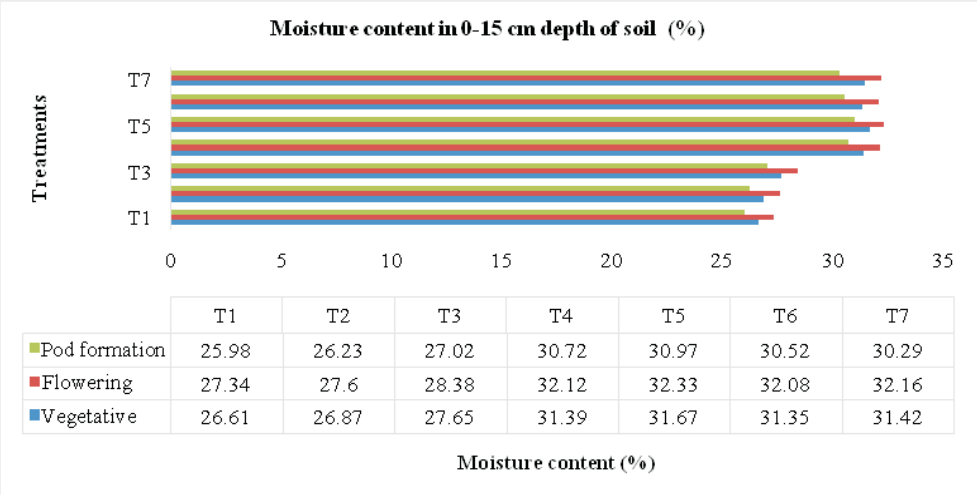
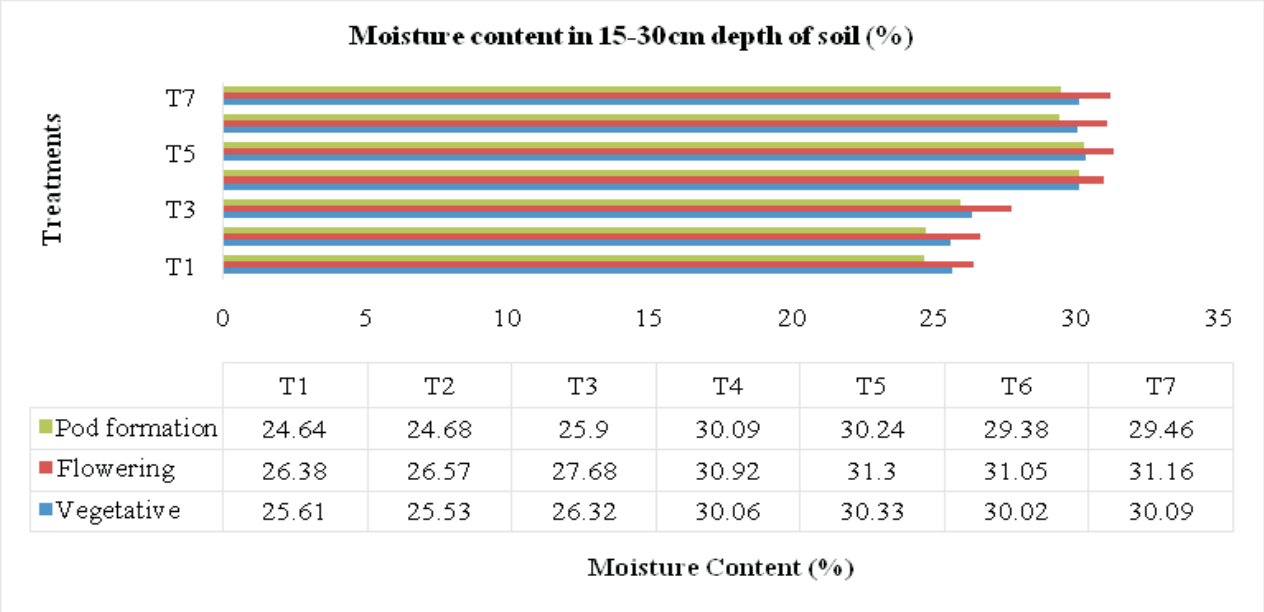


Fig. 1. Effect of moisture conservation practices and soil amendments on moisture content of soil at different growth stages of soybean



	T1	T2	T3	T4	T5	T6	T7
Pod formation	24.64	24.68	25.9	30.09	30.24	29.38	29.46
Flowering	26.38	26.57	27.68	30.92	31.3	31.05	31.16
Vegetative	25.61	25.53	26.32	30.06	30.33	30.02	30.09

Fig. 2. Effect of moisture conservation practices and soil amendments on moisture content of soil (15-30cm) at different growth stages of soybean

Table 2. Effect of moisture conservation practices and soil amendments on physical properties of soil

Treatments		BD (Mgm^{-3})	HC ($cm\ hr^{-1}$)	MWD (mm)
T_1	Recommended dose of fertilizer (Normal sowing)	1.67	0.61	0.41
T_2	Recommended dose of fertilizer + opening of furrow at 30 DAS	1.67	0.62	0.42
T_3	Recommended dose of fertilizer + opening of furrow at 45 DAS	1.66	0.61	0.42
T_4	75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through Green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 30 DAS	1.64	0.64	0.43
T_5	75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through Green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 45 DAS	1.65	0.63	0.42
T_6	75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow 30 DAS	1.67	0.63	0.42
T_7	75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow 45 DAS	1.66	0.63	0.41
	SE (m) $\pm$	NS	0.007	0.005
	CD at 5%	NS	0.021	0.016
	Initial values	1.67	0.60	0.40

The moisture conservation practices and organic amendments had significant bearing on mean weight diameter and hydraulic but it was not significant for bulk density. The highest mean weight diameter (0.43 mm) was reported in treatment T4 and lower value of mean weight diameter was noted in treatment T1 (0.41 mm). The mean weight diameter was slightly enhanced (0.42 mm) where 75% recommended dose of nitrogen and 100% P and K was given through chemical fertilizers and opening of furrows after 45 days of sowing. The highest (0.64 cm hr^{-1}) hydraulic conductivity was registered where Glyricidia was incorporated in the soil at the time of sowing along with 75% recommended dose of nitrogen and 100% P and K applied through chemical fertilizers and furrows were opened after 30 days of sowing. The hydraulic conductivity was improved by 7% over the initial value owing to formation of porus structure, enhancement in surface area of clay particles and proper gradient thereby, increasing the vertical flow of water in soil. Guled *et al.* (2002) reported that application of organic manures and inorganic fertilizers resulted in increased mean weight diameter of soil.

The organic carbon in soil was slightly changed due to application of Glyricidia at the time of sowing (Fig 3). The lower value (5.61g kg^{-1}) of organic carbon was reported in treatment T1, while it was higher in treatment T2 (5.62 g kg^{-1}), but it did not improve in treatment T3 (5.61 g kg^{-1}). The organic carbon in treatment T4 was 0.53% more than treatment T1 and it was higher where organic sources were used. Similar observation was reported by Kaur *et al*. (2005).

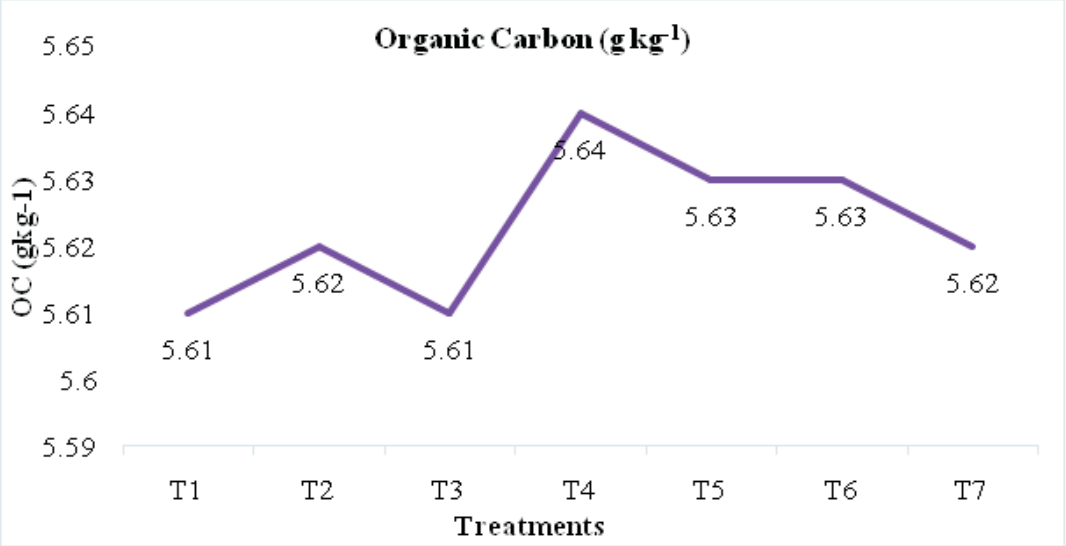


Fig. 3. Effect of moisture conservation practices and soil amendments on organic carbon in soil

The highest microbial biomass carbon was recorded in treatment T_4 (156.46 mg kg^{-1} soil) followed by T_6 (230.92 mg kg^{-1} soil) while lowest soil microbial biomass carbon was observed in treatment T_1 (156.46 mg kg^{-1} soil). The significant changes in SMBC recorded in the treatments having organics which might have soil microbial biomass carbon *via* of transformation of organic matter. The highest soil microbial biomass nitrogen was registered in treatment T_4 (48.26 mg kg^{-1}) followed by treatment T_5 (47.26 mg kg^{-1}) while lowest soil microbial biomass nitrogen was obtained in treatment T_1 (38.32 mg kg^{-1} soil). Relatively higher values of SMBN than T1 and T2 treatments were recorded with the co-joint application of farm yard manure with inorganic fertilizers after 30 and 45 days after sowing.

Table 3. Effect of moisture conservation practices and soil amendments on biological properties of soil

Treatments		SMBC	SMBN	Permanganate oxidizable carbon
		(mg kg^{-1})		
T_1	Recommended dose of fertilizer (Normal sowing)	156.46	38.32	157.33
T_2	Recommended dose of fertilizer+ opening of furrow at 30 DAS	187.92	41.42	158.66
T_3	Recommended dose of fertilizer + opening of furrow at 45 DAS	192.61	42.19	152.00
T_4	75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through Green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 30 DAS	234.69	48.26	186.66
T_5	75% recommended dose of nitrogen and 100% P and K through chemical fertilizer + 25% N through Green leaf manuring (Glyricidia) at the time of sowing and opening of furrow 45 DAS	227.84	47.23	181.66
T_6	75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow 30 DAS	230.92	43.2	162.00
T_7	75% of recommended dose of fertilizer + farm yard manure @ 2.5 tonnes after opening of furrow 45 DAS	210.16	42.61	161.33
	SE (m) $\pm$	11.93	0.55	7.37
	CD at 5%	36.76	1.71	22.71

The maximum amount of permanganate oxidizable carbon was measured in treatment T4 (186.66 mg kg^{-1}) followed by treatment T5 (181.66 mg kg^{-1}) while the lowest permanganate oxidizable carbon was noted in treatment T1 (157.33 mg kg^{-1} soil). The significant changes in permanganate oxidizable carbon were recorded in the treatments where organic sources were used. The similar findings were referred by Kumari *et al.* (2011) and Wang *et al*. (2014).

Conclusion

It can be concluded that the adoption of moisture conservation practices and incorporation of organic manures significantly influenced the moisture content in soil at various growth stages of soybean. It also helped in increasing the organic carbon, soil microbial biomass carbon, soil microbial biomass nitrogen and permanganate oxidizable carbon. Hence, integrated use of moisture conservation practices and soil amendments have greater influence in sustaining soil health under vulnerable climatic conditions of semi-arid regions of central India.

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