Original ResearchArticle

EFFECTOFORGANICAL
ROPPINGSYSTEMSONSOILPRO
D CORRELATION O
CARBONWITH SOIL PROP

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I suggest you change this topic to: Selected Soil properties and their correlation with organic carbon pools as influenced by Organically grown intercropping systems

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This should be intercropping

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I know of Randomized Complete Block Design (RCBD) as well as Completely Randomised Design (CRD). Which of this do you mean or is this an entirely new design?

ABSTRACT:

Organic agriculture is gaining vital significance, particularly f
diversity, sustainability, and its role in enhancing soil organic ca
advantages, astudywasconductedduringKharif 2021-22at theRe
Organic Agriculture Research and Training, Department of Ag
Deshmukh Krishi Vidyapeeth, Akola, to evaluate the effect of org
systems on soil organic carbon dynamics, and physical and c
clayey montmorillonite, hyperthermic vertisols. The experime
Randomized Block Design (RBD) with seven treatments consisti
T1: cotton (sole),T2:cotton+sunhemp (2:1), T3:cotton +blackgram
+ pigeonpea (3:1), T5: blackgram - chickpea (rabi), T6: greengra
T7: sunhemp (sole) which are replicated three times. Nutrients
FYM and vermicompost (50% N from each) with phosphorus
PROM (Phosphate Rich Organic Manure).

The resultsshowed that the Cotton + Sunhemp system recorded
(1.42 Mgm^{-3}),maximum hydraulicconductivity(0.76 cm hr^{-1}), ar
(0.73 mm). Soil pH (8.04-8.11) and electrical conductivity (0.13-0.15 dS m^{-1}) decreased compared to initial values (8.12 and 0.16 dS m^{-1}). The Cotton + Sunhemp system also showed significant improvement in soil organic carbon (6.09 g kg^{-1}). The highestavailable nitrogen (209.27 kg ha^{-1}), available phosphorus (22.28 kg ha^{-1}), and available potassium (354.26 kg ha^{-1}) were observed in the Soybean + Pigeonpea system. These findings highlight the potential of intercropping systems under organic management in enhancing soil health and carbon pools such asvery labile C (4.04 g kg^{-1}), labile C (1.29 g kg^{-1}), and less labile C (0.93 g kg^{-1}) were highest in surface soil (0-20 cm) under the Cotton + Sunhemp system, while non-labile C (5.13 g kg^{-1}) was highest in sole Cotton. The active pool contributed 44.96% and 45.54% of total organic carbon in surface (0-20 cm) and subsurface (20-40 cm)soils, respectively, whereasthe passive pool contributed 55.04% and 54.46%, respectively. Overall, higher carbon pools were observed insurface soil compared to subsurface soil, with the passive pool dominating the activepool (CNL > CVL > CL > CLL).

Keywords: Soil properties, Carbon pools, *Organic carbon, Organic farming, Sustainable agriculture*

1. INTRODUCTION:

Organic agriculture is a holistic production management syst
enhances agro ecosystem biodiversity, biological cycles and s
Organic farming is one of the ways to promote self-sufficiency
primary goal of organic agriculture is to optimize the heal
interdependent communities of soil life, plants, animals and
Hattam, FAO, 2002).

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This introduction did not capture the justification, problem statement (gap it intends to cover) and the objective ofthe study.

Soil carbon is an important part of the terrestrial carbon pool an
potentially viable sinks for atmospheric carbon (Lal, 1995). Soi
stock is comprised of labile or actively cycling pools and stable, re
pools with varying residence time (Chan *et al*., 2001). Parton *et al*.,
labilecarbon as thefractionof soil organic carbonwitha turnover time
years ascomparedto recalcitrant carbonwith aturnover timeof seve
The labile C pool of total organic carbon (TOC) has been the main
which influences the quality and productivity of the soil (Chan *et*
recalcitrant or passive C pool is slowly altered by microbial activitie
nature, it may not be a good soil quality parameter but contributes to
stock. Labile organic carbon is constituted of amino acids, simple
fraction of microbial biomass and other simple organic compounds and it changes substantially after disturbance and management (Chan *et al*., 2001).

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Very old citation

Farmers have been using organic manures for a long time. Organic manures provide humic substances and other metabolites formaintaining soil productivity. Organicmatter directly or indirectly influences the growth of crops. The direct effects related to the uptake of plant nutrients and absorption of humic substances by plants influence their metabolism. The indirect effects include the augmentation of beneficial microbial population and their activities such as organic matter decomposition, biological nitrogen fixation and improvement in the physical properties of soil.

The earthworm casting which acts as super manure could be used to improve soil conditions. The vermicompost application is one of the useful methods to renew the depleted soil fertility and augment the available pool of nutrients, conserve more water and maintain soil quality.The use of compostimprovesphysical, chemical and biological property of soil and physical properties by declining bulk density and i
holding capacity. Vermicompost has incredibly high porosity, aerat
water-holding capacity. They have an enormous surface area,
absorbability and maintaining the flow of nutrients. Vermicompost con
amylase, lipase, cellulase and chitinase to support thebreakdown of
liberate nutrients.

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2. MATERIALSANDMETHODS:

The experiment was conducted on organically certified field
Agriculture Research & Training (COART), Department of Agro
during kharif season of 2021-22 and analytical work was carried
Science and Agricultural Chemistry, Dr. PDKV, Akola, with the
impact of various organically grown cropping system on soil
properties; and correlation of organiccarbon with other soil prop
The soil of the experimental field comprised clayey montm
vertisols.

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Did you apply any statistical analytical measure in analysing your data? If yes, we need to know the approach or package that you used.

The nutrientswere supplied through FYM andvermicompost based on nitrogen - 50% N through FYM + 50% N through vermicompost. The compensation of phosphorus was madeavailablethroughPROM(Phosphaterichorganicmanure).Applicationof

Trichoderma, Rhizobium and PSB was done in all crops as seed treatment. Plant protection schedule was followed organically. Similarly, sunhemp was buried in soil after 35 to 40 days of sowing, while other intercrops were harvested and the residues of the same were incorporated in the soil after harvest. Soil samples were analysed after the crops harvest.

The representative soil samples were taken from 0-20 cm dept [illegible] and pulverized using a mortar and pestle and then homogenized [illegible] sieve. For mean weight diameter analysis, 8 mm sized aggregat[illegible] sieve and used. For analysis of organic carbon, the soil was pa[illegible] mesh sieve. The sieved soil was preserved in plastic bags a[illegible] subsequent analysis.

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Here you are making us to understand that the soil samples were collectedfrom just one depth but in your result especially the carbon pool result, you are presenting results of two different depths. Why?

The experiment was laid out in Randomized Block Design (RBD[illegible] shown below in treatment details which were replicated three tim[illegible]

List1-Selectedtreatments

	CroppingSystems		
T1	Cotton	Sole	Arboreum(HDPS)
T2	Cotton+Sunhemp	2:1	HirsutumandSunhempgreenmanuringat 35-40 DAS
T3	Cotton+Blackgram	2:1	HirsutumandinsitumulchingofBlackgram (After harvest)
T4	Soybean+Pigeon pea	3:1	InsitumulchingofSoybean(Afterharvest)
T5	Blackgram–Chickpea (*Rabi*)		InsitumulchingofBlackgram(Afterharvest)
T6	Greengram+Sorghum	2:1	InsitumulchingofGreengram(Afterharvest)
T7	Sole Sunhemp		Sunhempwasburiedat35-40DAS.

2.1 Soilanalysis

2.1.1 SoilPhysicalProperties

2.1.1.1 BulkDensity
DeterminedbytheclodcoatingtechniqueasdescribedbyBlakeandHartge(1986).

2.1.1.2 HydraulicConductivity
Measured using the constant head method on core soil samples fully saturated with distilled water, as described by Klute and Dirksen (1986).

2.1.1.3 MeanWeight Diameter
AssessedusingYoder'sapparatusmethodasoutlinedbyKemperandRosenau(1986).

2.2 SoilChemicalProperties

2.2.1 SoilReaction(pH)
Soil pH was determined in soil water suspension (1:2.5 soil:water ratio) by a glass electrode pH meter after equilibrating the soil with water for 30 minutes with occasional stirring (Jackson, 1973).

2.2.2 ElectricalConductivity(EC)
Electrical conductivity was determined in soil water suspension (1:2.5 soil:water) after equilibrating the soil with water and keeping the sample undisturbed till the supernatantis obtained and measured using a conductivity meter (Jackson, 1973).

2.2.3 OrganicCarbon

Estimated by the Walkley and Black method (Nelson and Somm... samples passed through a 0.5 mm sieve were oxidized with 1N ... and concentrated $H_2SO_4$to generate heat for the reaction. The ... back-titrated with 0.5N ferrous ammonium sulfate (FAS).

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Was this estimated or determined?

2.2.4 CalciumCarbonate

Measuredusingtherapidtitration(acidneutralization)method(Piper,1...

2.2.5 AvailableNitrogen

Determined using the alkaline permanganate method with an automatic distillation system (Subbiah & Asija, 1956).

2.2.6 AvailablePhosphorus

Estimated using Olsen's method with 0.5 M sodium bicarbonate ... extractant, and Darco-G-60 was used to remove organic matter from ... spectrophotometric analysis (Watanabe & Olsen, 1965).

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2.2.7 AvailablePotassium

Determined by aflame photometer using neutral normal ammonium a... an extractant (Jackson, 1973).

2.3 SoilBiologicalProperties

2.3.1 CO_2Evolution

Measured using the alkali trap method (Anderson, 1982). Soil samples were incubatedat 28°C for 24 hours in a closed vessel, where CO_2produced was absorbed in sodium hydroxide and quantified by titration.

2.3.2 DehydrogenaseActivity

AssessedbytheTTCmethod(Klein*etal*.,1971).A1gsoilsamplewasin... 0.2 ml of 3% triphenyl tetrazolium chloride (TTC) and distilled w... 28°C for 24 hours. Methanol was added to extract triphenyl f... absorbance was measured at 485 nm using a spectrophotometer...

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Should be written in full and subsequently, acronyms could be used

2.4 CarbonPools

Soil organic carbon (SOC) was determined using the Walkley and Black (1934) method with 36 N H_2SO_4, and a recovery factor of 1.298. The total SOC pool was divided into four sub-fractions: very labile(Pool I: CVL), labile (Pool II: CL), less labile (Pool III: CLL), and non-labile (Pool IV: CNL). Pools I and II form the active pool, while Pools III and IV constitute the passive pool. The analysis used different acid-aqueous solution ratios (0.5:1, 1:1, 2:1) as described by (Chan *et al*., 2001) for sub-fractionating SOC.

Table1.Initialsoilpropertiesbeforestartoftheexperiment

Sr.No.	Properties	Value
1	Bulkdensity(Mgm^{-3})	1.46
2	Hydraulicconductivity($cmhr^{-1}$)	0.68
3	MeanWeightDiameter(mm)	0.66
4	pH	8.12
5	Electricalconductivity(dSm^{-1})	0.16
6	OrganicCarbon(gkg^{-1})	5.20
7	Calciumcarbonate(%)	3.69
8	AvailableNitrogen($kgha^{-1}$)	194.20

9	AvailablePhosphorus(kgha^{-1})	13.37
10	AvailablePotassium(kgha^{-1})	334.60

3. RESULTSANDDISCUSSION

3.1 Effectoforganicallygrownintercroppingsystemsonsoilphysical properties

Soil physical properties have a profound influence on nutrient availability which are important attributes of soil quality. The important physical properties of soil viz., bulk density, hydraulic conductivity and mean weight diameter are generally considered as soil quality indicators. The data regarding the soil physical properties as influenced by organically grown intercropping systems is presented in Table 2.

Table2.Effectoforganicallygrownintercroppingsystems [illegible] properties

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Is this result just for 0 – 20 cm depth?

	Treatments	Bulk density (Mgm^{-3})	Hydraulic conductivity (cm hr^{-1})	[illegible]
T1	Cotton	1.46	0.69	[illegible]
T2	Cotton+Sunhemp	1.42	0.76	[illegible]
T3	Cotton + Blackgram	1.44	0.74	0.70
T4	Soybean+Pigeon pea	1.43	0.75	0.71
T5	Blackgram	1.45	0.72	0.69
T6	Greengram+ Sorghum	1.44	0.73	0.69
T7	Sole Sunhemp	1.42	0.76	0.72
	SE(m)±	0.009	0.008	0.012
	CDat5%	0.028	0.024	[illegible]
	Initial	1.46	0.68	[illegible]

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This and the SE(m)±should be explained at the foot note

3.1.1 Bulk Density

The effect of different cropping systems on bulk density wa[illegible] presented in Table 2. It was reduced from 1.46 to 1.42 Mg m^{-3} [illegible] systems. Numerically, lower bulk density (1.42 Mg m^{-3}) was [illegible] Sunhemp and sole Sunhemp. This might be due to the addition ofor[illegible] to enhance soil porosity and ultimately helps in aeration and reduce[illegible] The bacterial glue and other soil particle binding agents derived fr[illegible] decrease the soil bulk density by improving soil aggregation [illegible] Similarresult was reported by Hugar and Soraganvi (2014), [illegible] Khuspure*et al.*(2018) and Gawande *et al.* (2024).

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It is bogus/vague to say this without telling your reader what they worked on and their findings

3.1.2 Hydraulicconductivity

The hydraulic conductivity of soil as influenced by organically grow[illegible] wasfoundtobestatisticallysignificantaspresentedinTable2.Itrangedfrom[illegible] 0.76cm hr^{-1} indicatingthatthehighest (0.76cm hr^{-1}) hydraulicconductivi[illegible] Cotton + Sunhemp and lowest with sole Cotton (0.69 cm hr^{-1}). [illegible] andincreasedporosityduetotheadditionoforganicmanuredirectlyinfluen[illegible]

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I suggest you should be consistent with

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This is preferred to using “organics”

hydraulicconductivityandultimatelysoilwaterdynamics.Hydraulicconductivitywas enhancedduetothecontinuousadditionof organics. Similarresults
Manchala(2017),Khuspure*etal.*(2018)andGawande*etal.*(2024).

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Who worked on what and concluded what?

3.1.3 MeanWeightDiameter(MWD)

The MWD of soil in various treatments varied from 0.67 to 0.73
organic cropping systems (Table 2). From the data it is noticed tha
significantly higher in Cotton + Sunhemp treatment followed by s
Soybean + Pigeon pea intercropping system over the rest of the trea
observed that the MWD increased with increasing soil organic carb
werereportedbyKhuspure*etal.*(2018)andGawande*etal.*(2024)whorepor
thehighertheMWDthemoretheorganiccarboncontentinthesoil.

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Please check to confirm that this is the actual thing you have in mind. If not, please restructure to bring out what you have in mind.

3.2 Effectoforganicallygrownintercroppingsystemsonsoil
properties

**Table3.Effectoforganicallygrownintercroppingsystemsons
properties**

	Treatments	pH	EC (dSm^{-1})	OC (gkg^{-1})	$CaCO_3$ (%)	Available N ($kgha^{-1}$)	Ava P ($kgha^{-1}$)	K ($kgha^{-1}$)
T1	Cotton	8.11	0.13	5.36	3.57	198.33	16.68	338.30
T2	Cotton + Sunhemp	8.04	0.15	6.09	3.48	207.53	20.62	352.03
T3	Cotton + Blackgram	8.06	0.14	5.72	3.53	204.63	19.67	344.56
T4	Soybean + Pigeonpea	8.06	0.14	5.83	3.51	209.27	22.28	354.26
T5	Blackgram	8.09	0.13	5.58	3.56	201.87	18.44	342.23
T6	Greengram +Sorghum	8.08	0.13	5.65	3.55	202.10	18.89	343.84
T7	Sole Sunhemp	8.05	0.15	5.97	3.49	205.27	19.81	348.14
	SE(m)±	0.02	0.005	0.09	0.014	1.54	0.669	3.054
	CDat5%	NS	NS	0.27	0.043	4.77	2.061	9.410
	Initial	8.12	0.16	5.29	3.69	194.20	13.37	334.60

3.2.1 SoilpH

The pH of the soil varied from 8.04 to 8.11 over the initial 8.12 (Table 3). There was no significant difference in pH among treatments, which could be attributed to the buffering effect due to organic matter and secondly, due to the high buffering capacity of theclayey soil. McCauley *et al.* (2017) reported that the addition of soil organic matter pushesthesoilsolutiontowardsneutralpH.AslightdecreaseinsoilpHunder
croppingsystemswhereareductioninsoilpHcanbeobservedduetotheinc
oftheleguminouscrop. Theresultsisinconformitywiththefindingsof Baha
(2012),Bama*etal.*(2017)andGawande*etal.*(2024).

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What did they work on and what was their findings?

3.2.2 ElectricalConductivity(EC)

TheECofsoilvariedfrom0.13to0.15overtheinitial0.16andwasnon-signific
(Table3).AslightdecreaseinsoilECwasobservedduetotheincorporation

leguminous crops and leaching of soluble salts. In addition to this, the organics on decomposition released various organic acids which helped to solubilize the saltspresent in the soil hence, a slight reduction in EC may be observed. These findings coincide with the results reported by Bahadur *et al.* (2012), Bama *et al.* (2017)
(2024).

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What were their results and after which experiment?

3.2.3 Organiccarbon

The data in Table 3 revealed that organic carbon content in soil incre
value of 5.29 g kg^{-1} to 6.09 g kg^{-1}. The highest organic carbon was
Sunhemp (6.09 g kg^{-1}) followed by Sole Sunhemp (5.97 g kg^{-1}). The
and root activity of cotton till its harvest must have supplied mea
carbon to the soil. A relatively higher proportion of carbon observed
supply and the availability of mineralizable and readily hydrolysable carbon resultingfrom microbial activity because of the addition of FYM, vermicompost an
intercropping. The increase in organic carbon content under treatme
the direct incorporation of organic matter, better root growth and
addition. These results are in agreement with the findings of Ga
Rakhondeet *al.* (2021) and Gawande *et al.* (2024).

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Did they work on the same intercrop as you did or they had a different mix? You should let us know this.

3.2.4 Calciumcarbonate

Data on calcium carbonate as influenced by various organic interc
presented in Table 3. The calciumcarbonate in soilreduced from3.57
initial 3.69 %. The results indicated significant differences and a
calcium carbonate under various treatments. Reduction in $CaCO_3$ma
to the incorporation of leguminous crops. The decrease in Ca
treatments might be due to the dissolution of carbonates by the org
during the decomposition of organic materials which might have rea
release CO_2thereby reducing the $CaCO_3$content in the soil. Similar res
by Sharma *et al.* (2004), Mubark and Nortcliff (2010).
The highest reduction in calcium carbonate (3.48%) was found in
treatment followed by Sole Sunhemp (3.49%) and Soybean + Pigeo
(3.51%). The higher amount of $CaCO_3$was assigned with depth whic
theprocessof leachingof calcium andsubsequentlyprecipitatedasc
depth. Theleachingof $CaCO_3$might beduetohighpermeability andhig
soluble nature of $CaCO_3$, variation in its amount in profile (Kumar *et al*

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Who worked on what and made what conclusions?

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This is hanging. Kindly do the needful.

3.2.5 AvailableNitrogen

The data in Table 3 showed that the available nitrogen increased from an initial 194.20kg ha^{-1} to 209.27 kg ha^{-1} under organically grown cropping systems.
improvement in available nitrogen status was observed in all the
involved the combined application of crop residues and intercroppi
attributed to improved microbial activity due to the availability of org
results were reported by Singh *et al.* (2015). Also, the increased
thepresent research supports this result. Available nitrogen wa
significantly higher in Soybean + Pigeon pea (209.27 kg ha^{-1}) and it
par with Cotton + Sunhemp (207.53 kg ha^{-1}), Sole Sunhemp (205.27
+ Black gram (204.63kg ha-1).Theincrease inavailable nitrogen du
can beattributed to greater multiplication of soil microbes, which co
nitrogen into inorganic form. Legumes are advantageous for soils du
relationship with nitrogen-fixing bacteria. Thus, legume intercrops ca
nitrogen levels to optimize soil nutrient availability. The findings
resultsreported by Bama *et al.* (2017), Choudhury *et al.* (2018), Ra
andGawande *et al.* (2024).

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Which result?

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Maybeyoucouldstructurethissentence to

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After working on what?

3.2.6 AvailablePhosphorus

It is evident from the data as presented in Table 3that the available P content of the soil under organic cropping systemsvaried significantly and it rangedfrom 16.68 to 22.28kg ha^{-1} indicating that the soil was low in available phosphorus. Significantly higheravailable phosphorous (22.28 kg ha^{-1}) was recorded in Soybean + Pigeon pea intercropping system which was observed to be at par with Cotton + Sunhemp intercroppingsystem (20.62 kg ha^{-1}). Thelowest available phosphoruswasfound insole Cotton. The black soils which had high phosphorus fixation problems are specifically becoming deficient under the intensive cropping systems. Under these circumstances, the cropshaving a potential of addingconsiderable biomassthrough intercropping tothe soil havespecial significance inblack soils. Theincrease in available phosphorus due to legumes could be ascribed to the development of phosphorus-solubilizing organisms in the root zone. The decomposition of leaf litter is useful for a slight reduction in pH … availability of phosphorusin these soilsbyincreasing acidity. The resu… with the findings reported by Gabhane*et al. (*2013), Bama et al. (201… (2018) Hadke*et al.* (2020) and Gawande *et al.* (2024).

3.2.7 AvailablePotassium

There was an increase in available potassium in soil due to the additi… was observed to increase from an initial value 334.60 kg ha^{-1} to 3… organically grown cropping systems (Table 3). Significantly higher a… (354.26 $kgha^{-1}$) recordedinSoybean+ Pigeon pea intercropping syste… Cotton + Sunhemp (352.03 kg ha^{-1}) and Sole Sunhemp (348.14 kg … lowest available potassium content was recorded with sole cotton (3… showed higher available potassium values with slight variatio… treatments because the experimental soil was rich in available … increase in potassium could be attributed to the direct addition of … FYM, vermicompost and incorporation of intercrops and shaded leaf … the potassium pool of the soil, besidesthe reduction inpotassium fixation and release of potassium due to the interaction of organic matter with clay wa… Theresults are in conformity with thefindings reported by Gabh… JayakumarandSurendran(2017), Choudhury *et al.* (2018), Rakh… andGawande*etal.* (2024).

3.3 Effectoforganicallygrownintercroppingsystemsonsoilbi… properties

Table4.Effectoforganicallygrownintercroppingsystemsons… properties

	Treatments	CO_2evolution ($mg100g^{-1}soil$)	[illegible]
T1	Cotton	25.43	[illegible]
T2	Cotton+Sunhemp	35.37	[illegible]
T3	Cotton+Blackgram	31.75	[illegible]
T4	Soybean+Pigeon pea	32.42	44.62
T5	Blackgram-Chickpea(Rabi)	28.08	41.61
T6	Greengram+Sorghum	30.87	42.84
T7	Sole Sunhemp	34.80	46.98
	SE(m)±	1.049	1.036
	CDat5%	3.231	[illegible]

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What was their experiments and findings?

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From where?

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Having worked on …

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Should be explained in your foot note.

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Explain this andSE(m)±in your foot note.

3.3.1 CO_2 Evolution

The data pertaining to CO_2evolution as influenced by organically grown cropping systemswasfoundtobesignificant (Table4). It rangedfrom 25.4to35.4mg100g^{-1}soil. Higher CO_2evolution wasobservedin Cotton+ Sunhempintercropping system (35.4mg 100 g^{-1} soil) which emanated at par with Sole Sunhemp (34.9 mg 100 g^{-1} s
Pigeon pea intercropping system (32.4 mg 100 g^{-1} soil). The increase
and metabolically active substances could have resulted in an increa
rate. Similar findings were reported by Casals *et al.* (2000). The
decompose the organic matter and make soil a net source of c
CO_2into the atmosphere. The rate of CO_2evolution release has aline
the organic carbon content of the soil. The addition of cropresidue mi
acids upon decomposition and further enhance microbial respiration
(Chi *et al.*, 2012) and Ray *et al.* (2020).

3.3.2 Dehydrogenaseactivity(DHA)

The dehydrogenase activity as influenced by organically grown cro
found to be significant (Table 4). It was found to vary from 39.42 to 4
hr^{-1}. Higher DHA (47.66 µg TPF g^{-1} 24 hr^{-1}) was recorded in Cotton +Sunhemp intercroppingsystemwhich wasfound tobeat par with SoleSunhemp(46.98µgTPF g^{-1} 24 hr^{-1}), Soybean + Pigeon pea (44.62 µg TPF g^{-1} 24 hr^{-1}). The stronger effects of an application of FYM, vermicompost and incorporation of crop residue on dehydrogenase activity might bedue tothemoreeasily decomposablecomponents of cropresidues and the metabolism by soil microorganisms due to the increase in microbial growth with the addition of carbon substrate. Similar results were confirmed by
(2012),Parihar *et al.* (2018), Rakshitha *et al.* (2023) and Ankit *et al.* (20

3.4 Effectoforganicallygrownintercroppingsystemsoncarbo

**Table5: Effectoforganicallygrownintercroppingsystemson soil c
total organic carbon**

Treatments		Verylabile (gkg^{-1})		Labile (gkg^{-1})		Lesslabile (gkg^{-1})		No (			
		0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm			
T1	Cotton	2.90	2.84	0.83	0.88	0.59	0.64	5.32			
T2	Cotton + Sunhemp	4.04	4.02	1.29	1.28	0.90	0.93	4.04			
T3	Cotton + Blackgram	3.50	3.46	1.00	0.94	0.77	0.84	4.69			
T4	Soybean + Pigeonpea	3.54	3.53	1.05	1.02	0.80	0.85	4.65	4.42	10.04	9.82
T5	Blackgram-Chickpea (Rabi)	3.15	3.13	0.84	0.85	0.62	0.65	5.20	4.85	9.81	9.48
T6	Greengram +Sorghum	3.36	3.34	0.93	0.94	0.68	0.69	4.92	4.61	9.90	9.57
T7	Sole Sunhemp	3.88	3.85	1.11	1.04	0.81	0.91	4.36	4.20	10.16	10.00
	SE(m)±	0.018	0.016	0.016	0.016	0.015	0.017	0.020			
	CDat5%	0.055	0.050	0.048	0.049	0.047	0.052	0.062			

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Meaning?

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Does this statement emanate from your findings? If not , kindly cite the author.

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Howcomeyouarepresentingresultson twodepthswhichisnotcapturedinyour materials and methods?

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Foot note

3.4.1 VeryLabileCarbon(CVL)

The soil carbon pools and the total soil organic carbon as influenced by organicallygrown intercropping systems at two different depths are as presented in Table 5. Very labile carbonpool of soils was foundto be significant (Table 5). Theverylabilecarbon in the different treatmentsvariedfrom 2.90 to4.04 gkg^{-1} in surface soil (0-20 cm) and 2.84 to 4.02 g kg^{-1} in subsurface soil (20-40 cm). The highest very labile carbon (4.04 g kg^{-1}) wasrecorded under Cotton + Sunhemp at 0-20 cm. Thismight be due to the provision of more organic matter by Sunhemp which has resulted in a significant increase in thevery labile carbon pool.In general,the surfacetop soil layerhashigher SOC concentration as compared to lower depths. Very labile form of carbon (VLC) which
oxidizable fraction of carbon is more easily decomposable and for this
to the supply of organic residues in the soil. The findings are in close
findings reported by (Chan *et al.* 2001). The lower values of
notedunderCotton(T1)maybeduetothecomparativelyloweradditionofbio
Similarresultswaspresentedby Babu*etal.*(2020).

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Please be consistent in using acronyms
so as not to confuse your reader. You

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After working on …

3.4.2 LabileCarbon(CL)

Thelabilecarbonvariedfrom0.83to1.29gkg^{-1}insurfacesoil(0-20cm)and0.
1.28 g kg^{-1} in sub-surface soil (20-40 cm). The effect of organica
system on the labile carbon pool of soils was found to be signific
highest labilecarbon (1.29g kg^{-1}) wasrecorded under the Cotton+ S
The increase in labile C content with the application of FYM, vermic
incorporation of legumes could be because of the fresh organic ma
These stimulated the microbial activity helping SOC decomposition d
of the labile C. Labile soil organic carbon pool is considered as the
source for microorganisms which turns them over rapidly and has
nutrient supply. Labile soil organic carbon pool generally include
organicmatter,microbial biomassandmineralizableorganicmatter.Thela
organic carbon (TOC) has been the main source of nutrition which in
and productivity of the soil (Chan *et al*., 2001 and Babu *et al.,* 2020).

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From where?

Adoption of Cotton + Sunhemp*intercropping* system can preferentially enhance more labile soil organic carbon and would be a useful approach for charact
carbon hence, building soil fertility and nutrient availability to pla
quantity of labile carbon pool isvery low as compared to TOC, it is ea
thus more important from the point of nutrient availability during the cr
compared to total soil organic carbon. Therefore, labile carbon pool h
the availabilityof nutrientsinthe soilfor uptake by plants. Thefi
agreement with the results reported by Ghosh *et al.* (2017), Kumar e
Balpande*et al.* (2020) and Babu *et al.* (2020).

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Add flesh to this

3.4.3 LesslabileCarbon(CLL)

Thelesslabilecarbonpoolrangedfrom0.59to0.90gkg^{-1}insurfacesoiland0.
0.93 g kg^{-1} (Table 5). It is evident from the results that the less labile
was significantly highest in Cotton + Sunhemp (20-40 cm). results rep
et al. (2020).

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Meaning?

3.4.4 Non-LabileCarbon(CNL)

It isobserved that the non-labile carbonvariedfrom 4.22 to 5.13 gkg^{-1}in
cm) and 4.05 to 4.94 g kg^{-1} in subsurface soil (20-40 cm) (Table 5). Th
organicallygrowncroppingsystem onthenon-labilecarbonpool insoilswa
significant. Non-labilecarbon pool was noted to be higher in Cotton (T1
the treatments. Among all treatments, thelowervalue of non-labilecarbon wasrecordedin Cotton + Sunhemp (4.05 gkg^{-1}) intercropping system at 20-40 cm depth. Thefindings

areinlinewiththeresultsreportedbyMandal*etal.*(2013),Das*etal.* (2017)and Babu *et al.* (2020).

3.4.5 TotalSoilOrganicCarbon(SOC)

SOC contentforallthetreatmentswashighinsurfacesoil(0-20cm)thaninsubsurface soil(20-40cm). SOCinsurfaceandsub-surfacesoilwasintheorder > T6 > T5>T1 respectively (Table 5). A build-up of thehigher amou soil over sub-surface soil is attributed to the accumulation of o rootbiomass and leftover crop residues in the former that decreased addition of root biomass and root exudates results in such variation in *al.*, 2008) and Babu *et al.* (2020).

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Why note say from the plant biomass instead.

3.4.6Percentcontributionofsoilcarbonpoolstototal Soilorganiccarb

Table6:Percentcontributionofsoilorganiccarbonpoolstototalso carboninsurfacesoil(0-20cm)

Treatments		Activepool (%)		Passivepool(%)	
		Verylabile	Labile	Lesslabile	Nonlabile
T1	Cotton	30.11	8.58	6.14	55.16
T2	Cotton+Sunhemp	39.35	12.53	8.81	39.32
T3	Cotton+Blackgram	35.12	10.02	7.76	47.09
T4	Soybean+Pigeonpea	35.28	10.47	7.92	46.33
T5	Blackgram-Chickpea(Rabi)	32.15	8.60	6.30	52.95
T6	Greengram+Sorghum	33.98	9.39	6.90	49.74
T7	Sole Sunhemp	38.20	10.97	7.95	42.88
	Average	34.88	10.08	7.40	47.64
	%contributiontoSOC	44.96		55.04	

Table7:Percentcontributionofsoilcarbonpoolstototalsoilorganiccarbonin subsurfacesoil(20-40 cm)

Treatments		Activepool (%)		Passivepool(%)	
		Verylabile	Labile	Lesslabile	Nonlabile
T1	Cotton	29.91	9.25	6.73	54.11
T2	Cotton+Sunhemp	39.88	12.73	9.20	38.19
T3	Cotton+Blackgram	35.53	9.61	8.60	46.26
T4	Soybean+Pigeon pea	35.93	10.34	8.69	45.04
T5	Blackgram-Chickpea(Rabi)	33.05	8.95	6.85	51.15
T6	Greengram+Sorghum	34.91	9.79	7.17	48.13
T7	Sole Sunhemp	38.48	10.40	9.10	42.02
	Average	35.38	10.15	8.05	46.41
	%contributiontoSOC	45.54		54.46	

Thedifferent soil carbonpoolswereanalysedandper cent contributionof eachpool was calculated against total soil organic carbon. The data pertaining to per cent contributionis reported in Table 6 for surface soil (0-20 cm) and Table 7 for subsurface soil (20-40 cm). The result indicated that there was a higher contribution of non-labile carbon to the total soil organic carbon and it varied from (40.36 to 54.26%) in surface soil (0-20 cm) and(39.39to53.12%)insubsurfacesoil(20-40cm)undervariousorganicallygrown intercropping systems. The lowest per cent contribution of the non-labile pool (39.39%) was noticed in Cotton + Sunhemp treatment whereas the highest per cent contribution was found in Cotton (54.26%). Among all the pools, the less labile carbon pool contributed6.27to8.66% (0-20cm) and6.87to9.02% (20-40 percentcontribution was recorded in the treatment of Cotton + Sun system. Thepercentcontributionofverylabile poolvariedfrom30.72to38. 30.55 to 39.11 % was for 20-40 cm. The highest per cent contributio pool was noticed in Cotton + Sunhemptreatment. The contribution carbonismoreor lesssimilar at bothdepths. Thescrutiny of theda centcontributionoflabilepoolrecorded8.75to12.31%insurfacesoil(0-20c 9.45 to 12.48% in subsurface soil (20-40 cm). It is noticed that t contribution of the labile pool was recorded in Cotton + Sunhem depths.

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Of which particulate carbon?

The average contribution of C_{VL}, C_L, C_{LL}, and C_{NL}towards total organic carbon under different treatments in surface soil (0-20 cm) was 35.06%, 10.13%, 7.43% and 47.34% respectively. The passive pool (C_{LL}+C_{NL}) contributed a relatively higher proportion (55.04%) than the active pool (C_{VL}+C_L) (44.96%). Similarly, the average contribution of C_{VL}, C_L, C_{LL}, and C_{NL}towards total soil organic carbon under different treatments in subsurface soil was 35.26%, 10.12%, 8.02% and 46.61% respectively. In subsurfacesoil, the passive pool (C_{LL}+C_{NL}) contributed a relatively higher proportion (54.46%) than the active pool (C_{VL}+C_L) (45.54%). Similar results were reported by Das *et al.* (2017), Kumar *et al.* (2018) Balpande*et al.* (2020), Hadke*et al.* (2020) and Babu *et al.* (2020). also reported similar results in Vertisol.

Passive pool (C_{PP}) dominated active pool (C_{AP}) of C in all the treatments for various soil depths. As the C_{AP}generally included a light fraction of organic matter, microbialbiomass and mineralizable organic matter (Chan *et al.,* 2001, Chivhane and Bhattacharyya, 2010), organicintercroppingsystemscanplay apivotal roleinenhancing soil fertility, nutrient availability and crop productivity (Bhattacharyya *et al.*, 2007 and Babu *et al.*, 2020). The higher soil organic carbon pool as influenced by the organically grown intercropping system was more in the surface soil (0-20 cm) as compared to subsurface soil (20-40 cm) and was in the order of C_{NL}> C_{VL}> C_L >C_{LL}.

3.5 Correlationofcarbonpoolswithsoilpropertiesandcarbonpools

It was observed that the organic carbon was positively and significantly correlated with some of the soil properties shown in Table 8. It was noticed that organic carbon has a negative correlation with bulk density and calcium carbonate while it has positive and significant correlation with CO_2evolution and DHA. The results th thesignificance of organic carbon in concern to organically grown inte Also, the organic carbon was found to have significant and positive c labile carbon, labile carbon, less labile carbon and total carbon, where correlation with non-labile carbon. This result matches with Mir *et al.* states that ….

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Table8:Correlationoforganiccarbonwithsoilpropertiesandcarbonp

Sr.No.	A)Soilproperties	Or
1.	Bulkdensity	
2.	Hydraulicconductivity	
3.	Meanweightdiameter	0.747**
4.	Calciumcarbonate	-0.822**
	B)Biologicalparameters	
5.	CO_2evolution	0.804**
6.	Dehydrogenaseactivity	0.933**

	C)Carbonpools	
7.	Verylabilecarbon	0.985**
8.	Labile carbon	0.936**
9.	Lesslabilecarbon	0.928**
10.	Non-labilecarbon	-0.970**
11.	Total carbon	0.985**

*-=significantat5%,**significantat1%,NS:Non-Significant

4. CONCLUSION

The study revealed the significant impact of organically grown intercropping systems, particularly atthesecondtreatment(T2): Cotton+ Sunhemp combination, onvarioussoil carbon pools and other soil properties, contributing to improved soil quality, fertility, and overall soil health.

Soil Physical Properties: Bulkdensitywaslowes
Sunhemp(1.42Mgm³)andhighest in Soybean + Pigeon pea (1.43
conductivity was highest inCotton + Sunhemp (0.76 cm/hr). Mean w
highest in Cotton +Sunhemp (0.73 mm).
Soil Chemical Properties: SoilpHandelectricalconductivityremaine
Organic carbonincreasedfrom 5.29gkg^{-1}to6.09gkg^{-1},highest inCotton
carbonate reduced significantly, with Cotton+ Su
thehighestreduction(3.48%).Availablenitrogenincreased,withSoybean
having the highestvalue (209.27kg ha^{-1}). Availablephosphoruswashi
+Pigeonpea(22.28kg ha^{-1}),followedbyCotton+Sunhemp(20.62kg
Availablepotassiumincreased, withSoybean +Pigeonpea (35
thehighest value.
Soil Biological Properties: CO_2evolutionwashighest inCotton+ Sun
^{1}soil). Dehydrogenase activity washighest in Cotton+ Sunhemp (47.66

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These are already captured in the result

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Are these parameters significantly influenced by the treatments or not? Then what is their correlation relationship with carbon pool

Soil Carbon Pools: Passive carbon pool contributed more in both soil layers, with the highest in surface soil as compared with the Active carbon.
Organic carbon is positively and significantly correlated with key soil properties such as CO_2evolution and dehydrogenase activity, indicating its role in enhancing biological activity.It hasanegativecorrelationwithbulk density andcalcium carbonate, suggesting that higher organic carbon improved soil structure. Organic carbon also showed a positive correlation with very labile, labile and less labile carbon pools, but a negative correlation withnon-labilecarbon, emphasizingitsinfluence on activecarbonfractionsin organically grown intercropping systems.

Based on the data generated in the course of this study, it could be concluded that the different organically grown intercropping systems played a vital role in enhancing soil properties and carbon pools. However, organically grown T4 was found to be beneficialin improving nutrients availability. However, T2: and T7 recorded significant results in carbon pools and other soil properties. T2 and T4 were found to be suitable under organically grown intercropping systems to obtain higher productivity, improve soil properties and enhance carbon pools under semi-arid agro ecosystems.

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ANNEXURE

Correlationoforganiccarbonwithsoilpropertiesandcarbonpools

	BD	HC	MWD	pH	EC	OC	$CaCO_3$	Avail. N	Avail P	Avail K	CO_2 evolution	DHA	VLC	LC	LLC	NLC	TC
BD	1.000																
HC	-0.608 **	1.000															
MWD	-0.497 **	0.695 **	1.000														
pH	0.432*	-0.676 **	-0.522 **	1.000													
EC	-0.317	0.486*	0.538 **	-0.401	1.000												
OC	-0.703 **	0.871 **	0.747 **	-0.597 **	0.570 **	1.000											
$CaCO_3$	0.696 **	-0.729 **	-0.742 **	0.601 **	-0.630 **	-0.822 **	1.000										
Avail.N	-0.210	0.630 **	0.587 **	-0.223	0.485*	0.612 **	-0.584 **	1.000									
AvailP	-0.656 **	0.494 **	0.348	-0.174	0.250	0.581 **	-0.569 **	0.552 **	1.000								
AvailK	-0.530 **	0.515 **	0.536 **	-0.218	0.414	0.663 **	-0.711 **	0.546 **	0.744 **	1.000							
CO_2 evolution	-0.535 **	0.836 **	0.591 **	-0.732 **	0.578 **	0.804 **	-0.623 **	0.406	0.349	0.504 **	1.000						
DHA	-0.661 **	0.802 **	0.747 **	-0.475 *	0.721 **	0.933 **	-0.818 **	0.616 **	0.534 **	0.708 **	0.772 **	1.000					
VLC	-0.698 **	0.867 **	0.718 **	-0.617 **	0.613 **	0.985 **	-0.844 **	0.567 **	0.532 **	0.642 **	0.839 **	0.933 **	1.000				
LC	-0.667 **	0.808 **	0.730 **	-0.568 **	0.637 **	0.936 **	-0.829 **	0.554 **	0.523 **	0.672 **	0.803 **	0.899 **	0.950 **	1.000			
LLC	-0.669 **	0.872 **	0.759 **	-0.618 **	0.583 **	0.928 **	-0.837 **	0.684 **	0.591 **	0.660 **	0.806 **	0.864 **	0.937 **	0.947 **	1.000		
NLC	0.664 **	-0.839 **	-0.712 **	0.599 **	-0.608 **	-0.970 **	0.833 **	-0.585 **	-0.546 **	-0.648 **	-0.817 **	-0.908 **	-0.98 **	-0.976 **	-0.958 **	1.000	
TC	-0.635 **	0.861 **	0.721 **	-0.564 **	0.498 **	0.985 **	-0.781 **	0.631 **	0.559 **	0.644 **	0.806 **	0.890 **	0.970 **	0.916 **	0.916 **	-0.958 **	1.000

*5%singificant,**1%significant,NS:Non-Significant