

Manuscript title: Variations in soil organic carbon fractions and microbial community in rice fields under an integrated cropping system

Author's Name: Chao Wang^{1,2,3}, Qiannan Yang^{1,2}, Jing Chen^{1,2}, Chi Zhang³, Kexue Liu^{1,2*}

Affiliations:

¹ School of Resources and Planning, Guangzhou Xinhua University, Guangzhou, 510520, China.

² Institute of South China Urban-Rural Economic and Social Development, Guangzhou 510642, China

³ College of Natural Resources and Environment, South China Agricultural University, Guangzhou 510642, China

Corresponding Author: Kexue Liu Tel: +86 13688859099; Fax: 0202 87579896; Email: liukexue@xhsysu.edu.cn

Appendix. Supplementary data

Table S1 Soil nutrient, soil carbon indicators and C-related enzyme activities under different cropping systems.

Indicator	Unit	RFD	RPS	CRS	RFD	RPS	CRS
-----------	------	-----	-----	-----	-----	-----	-----

		Topsoil			Subsoil		
pH		5.82±0.03a	5.67±0.02b	5.00±0.08c	5.83±0.05a	5.87±0.07a	4.98±0.06b
TN	g kg ⁻¹	1.15±0.02a	0.85±0.02b	0.82±0.06b	1.08±0.06a	0.66±0.03b	0.76±0.07b
TP	g kg ⁻¹	2.31±0.06a	1.36±0.05b	1.23±0.02c	1.92±0.02a	1.24±0.02b	1.06±0.01c
TK	g kg ⁻¹	15.89±0.94a	7.76±0.27b	15.07±0.07a	13.38±0.38b	7.04±0.26c	14.51±0.39a
AN	mg kg ⁻¹	86.27±1.44a	56.06±0.83b	48.96±0.83c	82.99±1.44a	47.14±0.83b	47.87±0.32b
AP	mg kg ⁻¹	203.58±1.17a	54.45±1.12c	68.45±0.92b	196.40±3.48a	42.76±0.56c	68.45±1.28b
AK	mg kg ⁻¹	186.67±2.89a	131.67±2.89b	88.00±3.46c	88.33±5.77b	116.67±4.16a	76.67±2.89c
OC	g kg ⁻¹	10.99±0.16a	9.06±0.15b	7.94±0.06c	10.11±0.24a	7.64±0.38b	7.46±0.15b
EOC	g kg ⁻¹	1.45±0.08a	0.70±0.07c	1.18±0.01b	1.32±0.08a	0.24±0.03c	0.47±0.03b
DOC	mg kg ⁻¹	304.78±5.49a	271.57±7.45b	228.72±5.58c	278.77±4.31a	262.84±6.07b	179.60±1.57c
MBC	mg kg ⁻¹	154.84±10.98a	98.09±1.81b	48.90±1.31c	67.85±5.73a	37.99±1.97b	44.74±3.40b
HA	g kg ⁻¹	0.93±0.05a	0.41±0.03c	0.59±0.03b	0.83±0.09a	0.39±0.02b	0.45±0.02b
FA	g kg ⁻¹	2.75±0.05a	2.29±0.11b	1.65±0.07c	2.56±0.08a	2.08±0.11b	1.65±0.04c
HA/FA		0.34±0.02a	0.18±0.01b	0.36±0.01a	0.32±0.04a	0.19±0.02b	0.27±0.02a

RFD, rice–fish–duck integrated cropping system; RPS, rice–pepper rotation system; CRS, conventional rice cropping system. TN, total nitrogen; TP, total phosphorus; TK, total potassium; AN, available nitrogen; AP, available phosphorus; AK, available potassium; OC, organic carbon; EOC, easily oxidized organic carbon; DOC, dissolved organic carbon; MBC, microbial biomass carbon; HA, humic acid; FA, fulvic acid; HA/FA, ratio of HA to FA. Different letters indicate significant differences between cropping systems at $P < 0.05$ level.

Table S2 Nutrient content of duck manure

	Weight (kg d ⁻¹)	SOM (g kg ⁻¹)	TN (g kg ⁻¹)	TP (g kg ⁻¹)	TK (g kg ⁻¹)
Duck manure	0.14	262	11.0	14.0	6.2

SOM, soil organic matter; TN, total nitrogen; TP, total phosphorus; TK, total potassium

Table S3 Sensitivity index of soil chemical properties and soil carbon fractions to copping systems

	TN	TP	TK	AN	AP	AK	MBC	OC	EOC	DOC	HA	FA
0–10 cm	0.50	0.97	1.22	0.82	2.84	1.26	2.52	0.40	1.29	0.38	1.52	0.77
10–20 cm	0.81	0.86	1.18	0.82	2.70	0.60	1.06	0.42	5.15	0.58	1.45	0.63
Sum	1.31	1.83	2.40	1.64	5.54	1.86	3.58	0.83	6.44	0.96	2.97	1.40
	Soil nutrients						Soil carbon contents					

Average	2.43	2.70
---------	------	------

The soil sensitivity index (*SI*) is derived from the following equation (Bremer et al., 1994): $SI = (I_{\max} - I_{\min})/I_{\min}$, where I_{\max} is the maximum value of variables under different cropping systems, I_{\min} is the minimum value of variables under different cropping systems.

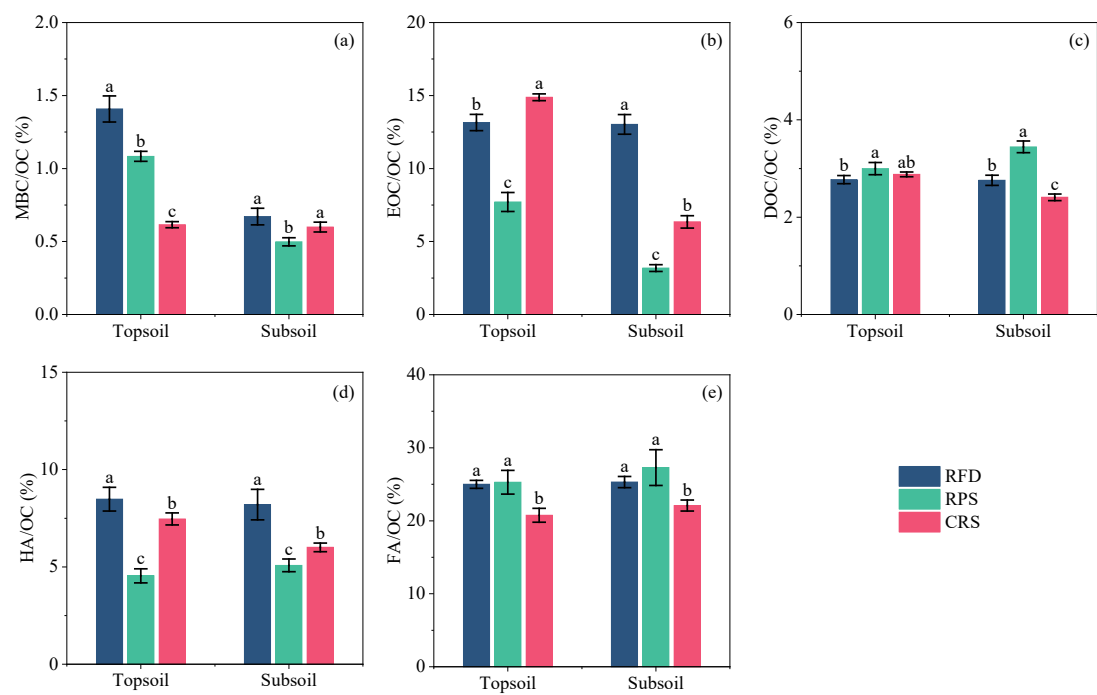


Figure S1. Proportion of soil microbial biomass carbon (MBC, a), easily-oxidation organic carbon (EOC, b), dissolved organic carbon (DOC, c), humic acid (HA, d), and fluvic acid (FA, e) under cropping systems. RFD, rice–fish–duck integrated cropping system; RPS, rice–pepper rotation system; CRS, conventional rice cropping system. Different letters indicate significant differences between cropping systems at $P < 0.05$ level.

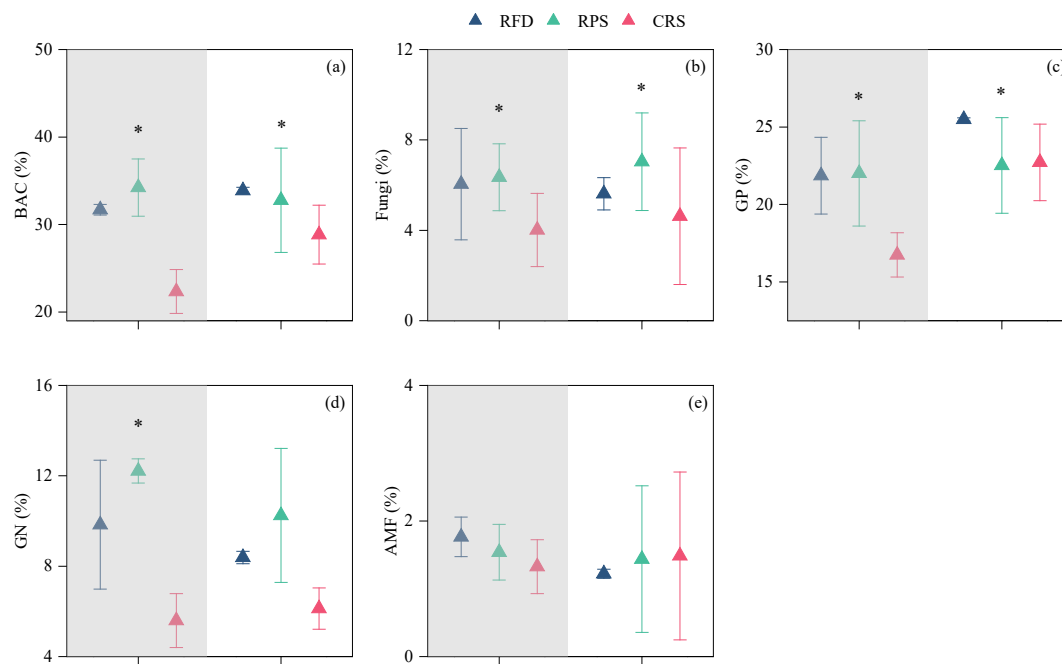


Figure S2. Relative abundances of bacteria (a), fungi (b), gram-positive bacteria (c), gram-negative bacteria (d), and arbuscular mycorrhizal fungi (e), and fungi: bacteria (i) under different cropping systems.

BAC, bacteria; GP, gram-positive bacteria; GN, gram-negative bacteria; arbuscular mycorrhizal fungi. RFD, rice–fish–duck integrated cropping system; RPS, rice–pepper rotation system; CRS, conventional rice cropping system. “*” means significant difference at $P < 0.05$ among different cropping systems.

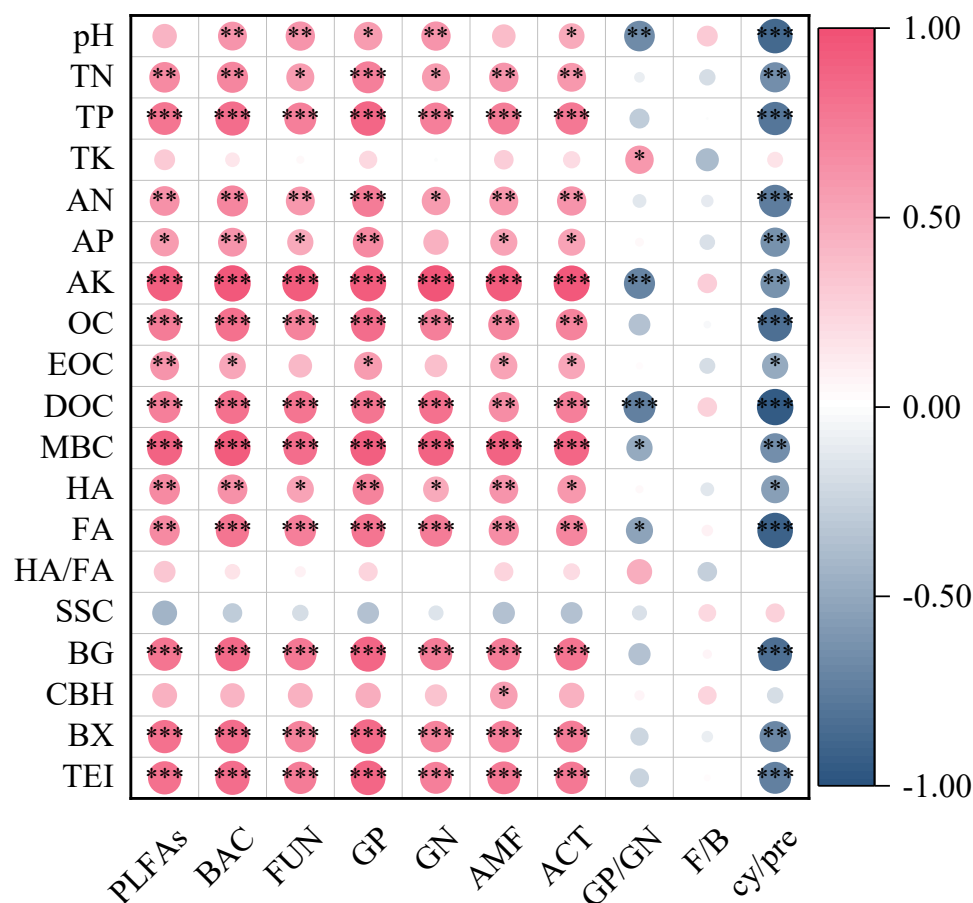


Figure S3. Relationship between soil nutrient, organic carbon fractions, C-hydrolyzing enzyme activities, and each individual PLFAs. TN, total nitrogen; TP, total phosphorus; TK, total potassium; AN, available nitrogen; AP, available phosphorus; AK, available potassium; OC, organic carbon; EOC, easily oxidized organic carbon; DOC, dissolved organic carbon; MBC, microbial biomass carbon; HA, humic acid; FA, fulvic acid; HA/FA, ratio of HA to FA; BG, β -1,4-glucosidase; CBH, β -Dcellobiohydrolase; BX, Xylosidase; TEI, total enzyme activity index. BAC, bacteria; FUN, fungi; GP, gram-positive bacteria; GN, gram-negative bacteria; AMF, arbuscular mycorrhizal fungi; GP/GN, gram-positive bacteria to gram-negative bacteria; F/B, the ratio of fungi to bacteria; cy/pre: the ratio of cyclopropyl to precursors PLFAs. *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.