

Table S1. Effects of growth stage, intercropping functional group, and their interaction on soil physicochemical properties in 2023 and 2024.

		SBD		Porosity		CEC		pH		SWC		NO ₃ ⁻ -N		NH ₄ ⁺ -N		TN		TP		AP	
	Factors	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>
Year	Stage	0.70	0.40	0.86	0.35	0.48	0.49	0.42	0.52	0.38	0.54	2.26	0.13	0.06	0.81	2.56	0.11	3.81	0.05	0.67	0.41
2023	Treatment	4.80	0.03*	0.96	0.33	0.50	0.48	3.81	0.05	2.04	0.15	3.37	0.07	54.91	0.00***	0.09	0.76	51.92	0.00***	1.63	0.20
	Stage × Treatment	0.00	0.97	0.41	0.52	0.02	0.89	4.93	0.03*	0.18	0.67	0.12	0.73	1.84	0.18	0.43	0.51	6.49	0.01*	6.49	0.01*
	Factors	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>
Year	Stage	0.31	0.58	0.03	0.85	0.58	0.45	0.40	0.53	0.00	0.95	2.28	0.13	1.51	0.22	0.61	0.44	0.30	0.58	1.44	0.23
2024	Treatment	4.39	0.04*	2.88	0.09	0.05	0.82	5.55	0.02*	1.55	0.21	2.17	0.14	0.16	0.69	2.96	0.09	1.91	0.17	0.00	0.98
	Stage × Treatment	0.00	0.98	0.16	0.69	0.01	0.93	0.50	0.48	0.27	0.60	0.01	0.92	0.00	0.98	0.08	0.77	0.28	0.60	0.97	0.32

Note: F and *p* values were obtained from mixed-effects models testing the effects of growth stage, intercropping functional group, and their interaction on soil physicochemical properties. Physical properties include SBD: soil bulk density; porosity; and SWC: soil water content; while chemical properties include CEC: cation exchange capacity; pH; NO₃⁻-N: nitrate nitrogen; NH₄⁺-N: ammonium nitrogen; TN: total nitrogen; TP: total phosphorus; and AP: available phosphorus... Asterisks indicate significant effects: * *p* < 0.05, ** *p* < 0.01, and *** *p* < 0.001.

Table S2. Effects of growth stage, intercropping functional group, and their interaction on soil microbial in 2023 and 2024.

		MBC		MBN		MBP		AG		CBH		NAG		XYL		LAP		PPO		GCH		GH	
	Factors	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>
Year	Stage	2.34	0.13	1.99	0.16	17.70	0.00***	1.83	0.18	0.08	0.78	16.02	0.00***	1.55	0.21	9.02	0.00**	0.04	0.84	1.00	0.32	22.87	0.00***
2023	Treatment	0.38	0.54	0.00	0.96	22.88	0.00***	6.26	0.01*	4.48	0.03*	1.06	0.30	1.32	0.25	2.94	0.09	0.43	0.51	1.45	0.23	0.41	0.52
	Stage × Treatment	1.28	0.26	0.20	0.65	2.68	0.10	0.41	0.52	1.19	0.28	3.62	0.06	0.13	0.72	3.12	0.08	0.29	0.59	0.03	0.86	4.24	0.04*
	Factors	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>	F	<i>p</i>
Year	Stage	1.49	0.22	1.52	0.22	6.93	0.01**	0.40	0.53	0.21	0.65	2.16	0.14	1.06	0.30	3.00	0.08	0.59	0.44	2.44	0.12	3.64	0.06
2024	Treatment	0.25	0.61	13.36	0.00***	2.32	0.13	4.02	0.04*	7.75	0.01**	7.53	0.01**	0.98	0.32	6.18	0.01*	0.68	0.41	3.42	0.06	3.03	0.08
	Stage × Treatment	0.85	0.36	0.30	0.58	0.06	0.80	0.02	0.89	1.32	0.25	0.16	0.69	0.69	0.40	0.17	0.68	0.44	0.51	0.70	0.40	0.16	0.69

Note: F and *p* values were obtained from mixed-effects models testing the effects of growth stage, intercropping functional group, and their interaction on soil microbial. Microbal properties include MBC: microbial biomass carbon; MBN: microbial biomass nitrogen; MBP: microbial biomass phosphorus; AG: α -1,4-glucosidase; CBH: β -1,4-cellobiohydrolase; NAG: β -1,4-N-acetylglucosaminidase; XYL: β -1,4-xylosidase; LAP: L-leucine aminopeptidase; PPO: polyphenol oxidase; GCH: carbon-acquiring hydrolase activity; and GH: total hydrolase activity. Asterisks indicate significant effects: * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$.

Table S3. Topological properties of bacterial and fungal co-occurrence networks under different intercropping systems.

Microbial group	Year	Intercropping functional group	Growth stage	No.node	No.edge	Average degree	Graph density	Modularity	Average clustering coefficient	Average path length
Bacteria	2023	Legmue	Growth	1285	3396	5.286	0.004	0.983	1	1
			Mature	431	1404	6.515	0.015	0.907	1	1
		Gramineae	Growth	1204	3223	5.354	0.004	0.986	1	1
			Mature	407	1246	6.123	0.015	0.952	1	1
	2024	Legmue	Growth	1166	2308	3.959	0.003	0.988	1	1
			Mature	100	173	3.460	0.035	0.922	1	1
		Gramineae	Growth	1193	2573	4.313	0.004	0.990	1	1
			Mature	90	150	3.030	0.031	0.914	1	1
Fungi	2023	Legmue	Growth	184	205	2.228	0.012	0.954	1	1
			Mature	157	190	2.420	0.016	0.944	1	1
		Gramineae	Growth	185	145	1.568	0.009	0.965	1	1
			Mature	182	242	2.659	0.015	0.954	1	1
	2024	Legmue	Growth	286	251	1.755	0.006	0.982	1	1
			Mature	155	232	2.994	0.019	0.946	1	1
		Gramineae	Growth	305	267	1.751	0.006	0.980	1	1
			Mature	154	236	3.065	0.020	0.942	1	1

Note: Bacterial and fungal co-occurrence networks were constructed for legume and gramineous intercropping systems during the growth and mature stages in 2023 and 2024. “No. of nodes” and “No. of edges” indicate the number of nodes and edges in each network, respectively. Average degree, graph density, modularity, average clustering coefficient, and average path length were calculated to describe network complexity and topological characteristics.

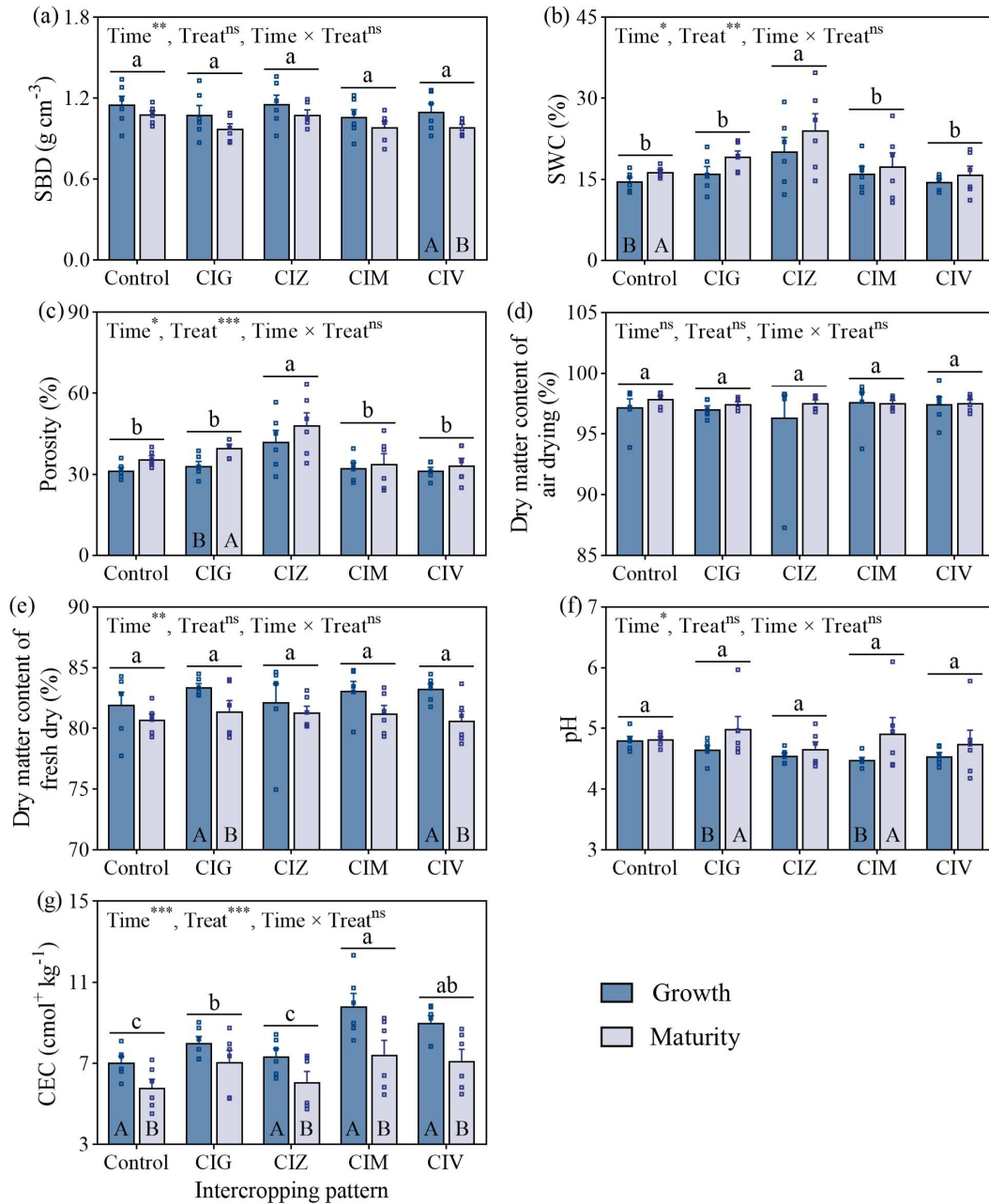


Fig. S1. Effects of intercropping on soil physicochemical properties. SBD (a), SWC (b), porosity (c), dry matter content of air-dried soil (d), dry matter content of fresh soil (e), pH (f), and CEC (g) under different intercropping patterns at the growth and maturity stages. Bars represent means, error bars represent standard errors, and points represent individual replicates. Different lowercase letters indicate significant differences among intercropping patterns within the same stage, whereas different uppercase letters indicate significant differences between the growth and maturity stages within the same intercropping pattern ($p < 0.05$). The effects of sampling time (Time), intercropping treatment (Treat), and their interaction (Time $\times$ Treat) were evaluated using two-way ANOVA. ns, not significant; *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$. Control, oil-tea monoculture; CIG, oil-tea with soybean; CIZ, oil-tea intercropped with maize; CIM, oil-tea intercropped with alfalfa; CIV, oil-tea intercropped with mouse-tail fescue.

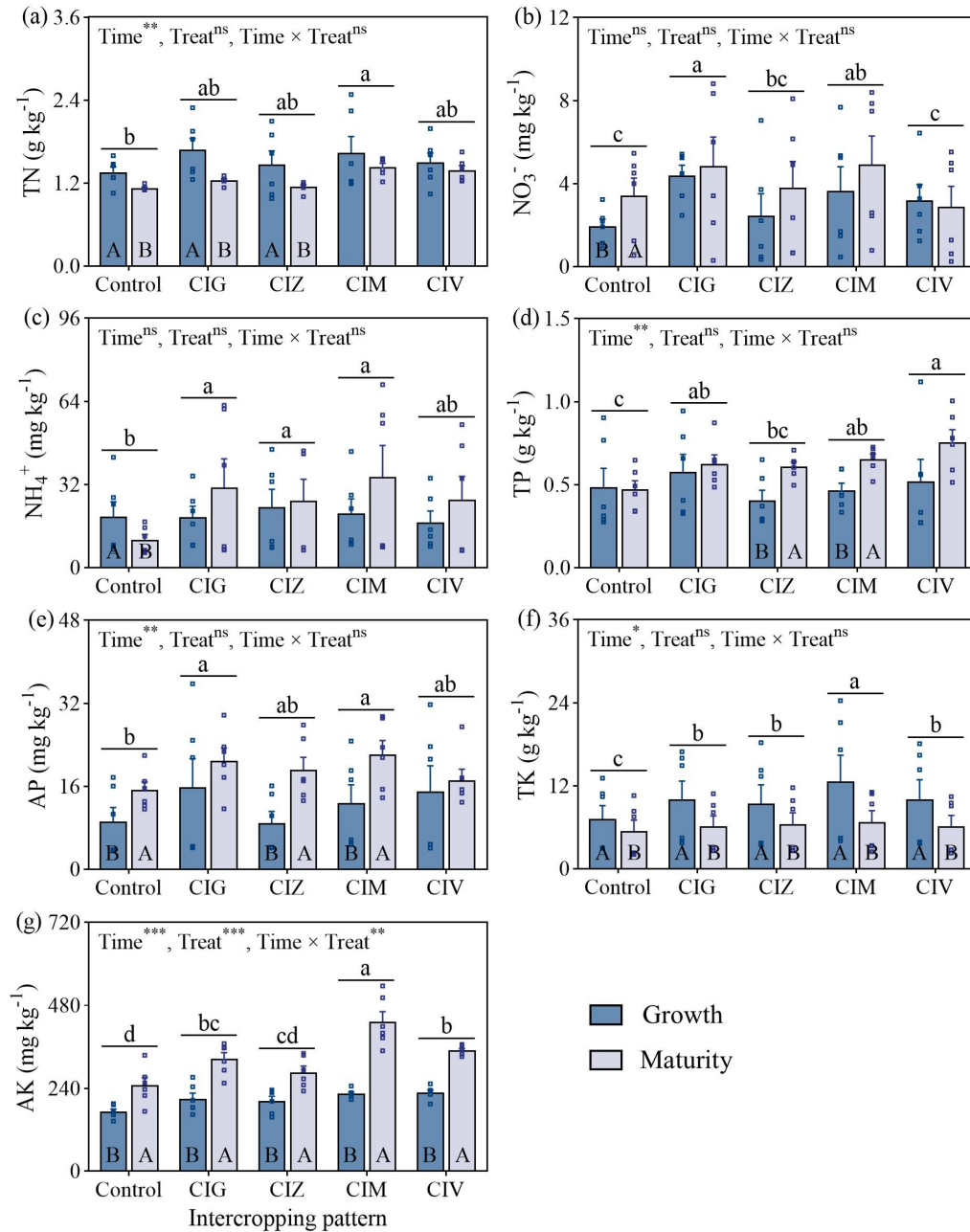


Fig. S2. Effects of intercropping on soil nutrient properties. TN (a), NO₃⁻-N (b), NH₄⁺-N (c), TP (d), AP (e), TK (f), and AK (g) under different intercropping patterns at the growth and maturity stages. Bars represent means, error bars represent standard errors, and points represent individual replicates. Different lowercase letters indicate significant differences among intercropping patterns within the same stage, whereas different uppercase letters indicate significant differences between the growth and maturity stages within the same intercropping pattern ($p < 0.05$). The effects of sampling time (Time), intercropping treatment (Treat), and their interaction (Time × Treat) were evaluated using two-way ANOVA. ns, not significant; *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$. Control, oil-tea monoculture; CIG, oil-tea with soybean; CIZ, oil-tea intercropped with maize; CIM, oil-tea intercropped with alfalfa; CIV, oil-tea intercropped with mouse-tail fescue.

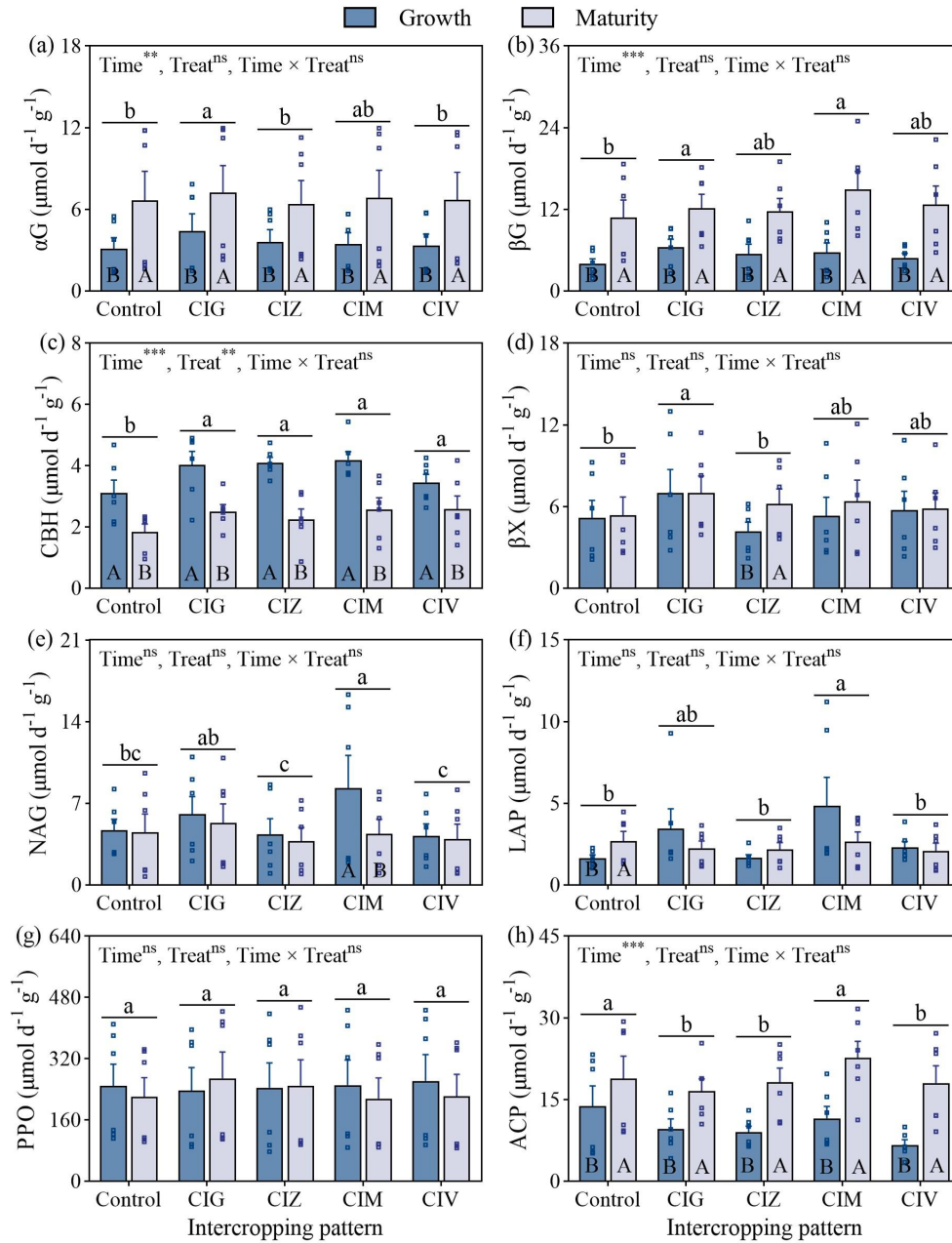


Fig. S3. Effects of intercropping on soil enzyme activities. αG (a), βG (b), CBH (c), βX (d), NAG (e), LAP (f), PPO (g), and ACP (h) under different intercropping patterns at the growth and maturity stages. Bars represent means, error bars represent standard errors, and points represent individual replicates. Different lowercase letters indicate significant differences among intercropping patterns within the same stage, whereas different uppercase letters indicate significant differences between the growth and maturity stages within the same intercropping pattern ($p < 0.05$). The effects of sampling time (Time), intercropping treatment (Treat), and their interaction (Time $\times$ Treat) were evaluated using two-way ANOVA. ns, not significant; *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$. Control, oil-tea monoculture; CIG, oil-tea with soybean; CIZ, oil-tea intercropped with maize; CIM, oil-tea intercropped with alfalfa; CIV, oil-tea intercropped with mouse-tail fescue.

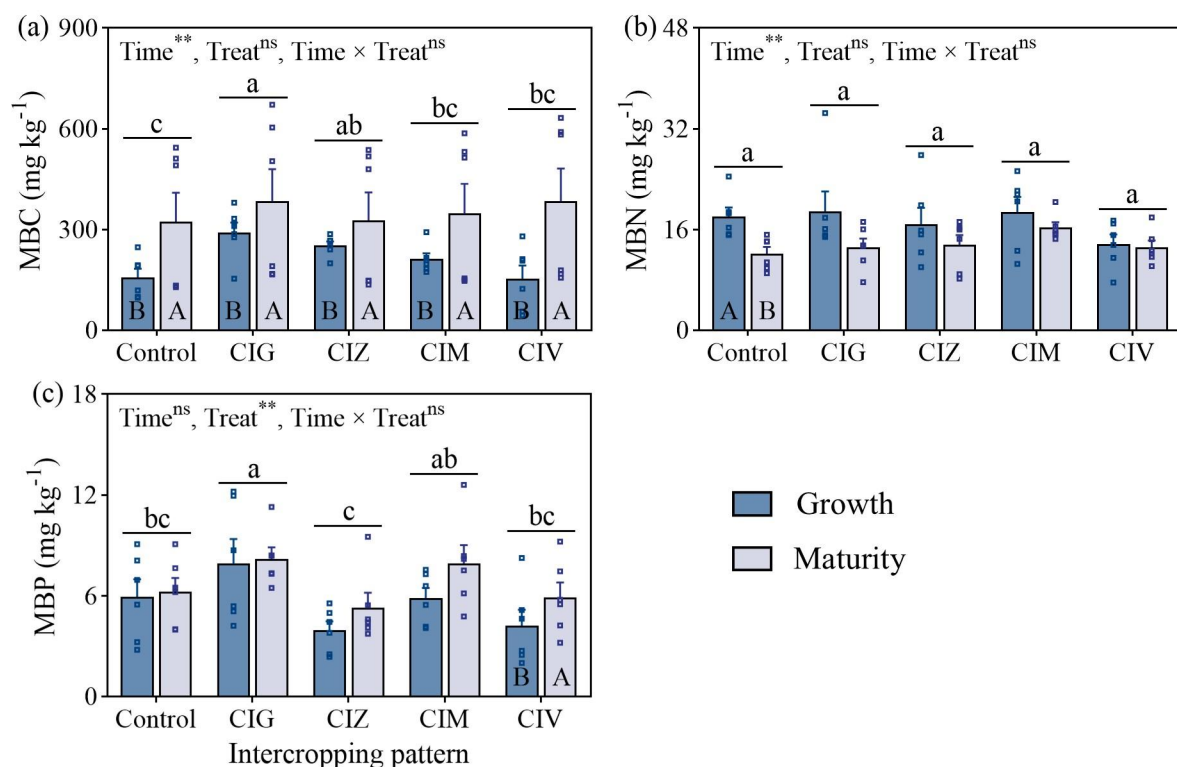
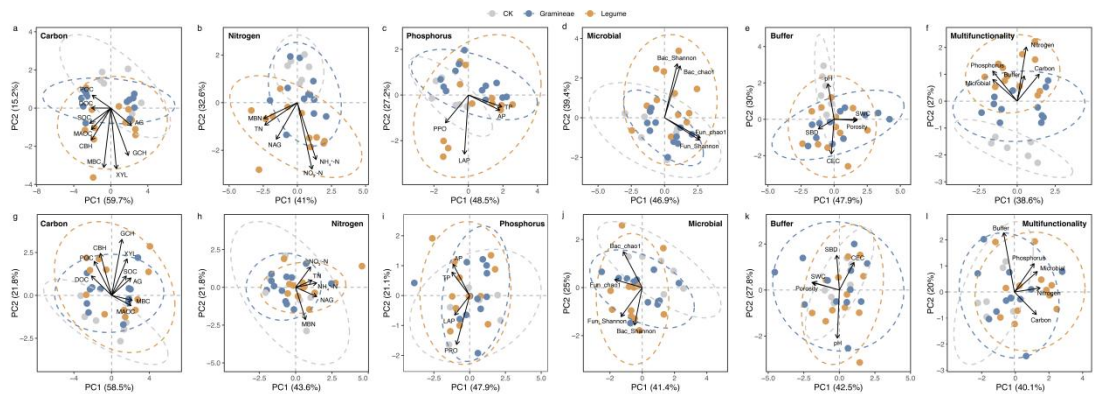


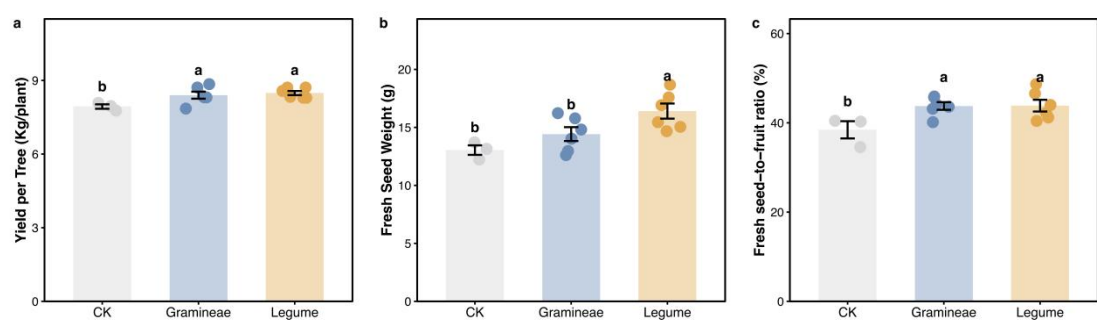
Fig. S4. Effects of intercropping on soil microbial biomass. MBC (a), MBN (b), and MBP (c) under different intercropping patterns at the growth and maturity stages. Bars represent means, error bars represent standard errors, and points represent individual replicates. Different lowercase letters indicate significant differences among intercropping patterns within the same stage, whereas different uppercase letters indicate significant differences between the growth and maturity stages within the same intercropping pattern ($p < 0.05$). The effects of sampling time (Time), intercropping treatment (Treat), and their interaction (Time $\times$ Treat) were evaluated using two-way ANOVA. ns, not significant; *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$. Control, oil-tea monoculture; CIG, oil-tea with soybean; CIZ, oil-tea intercropped with maize; CIM, oil-tea intercropped with alfalfa; CIV, oil-tea intercropped with mouse-tail fescue.



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52 **Fig. S5. Effects of intercropping on soil functional indicators based on principal component**
53 **analysis.** Principal component analysis (PCA) of soil indicators related to carbon cycling, nitrogen
54 cycling, phosphorus cycling, microbial function, soil buffering capacity, and overall soil
55 multifunctionality under monoculture, gramineous intercropping, and legume intercropping
56 systems in 2023 (a-f) and 2024 (g-l). Points represent individual soil samples, ellipses indicate
57 95% confidence intervals, and arrows indicate the loading direction of each functional indicator.

58



60 **Fig. S6. Effects of intercropping on oil-tea yield and fruit traits.** Yield per tree (a), fresh seed
61 weight (b), and fresh seed-to-fruit ratio (c) under monoculture, gramineous and legume
62 intercropping systems. Bars represent means, error bars represent standard errors, and points
63 represent individual replicates. Different lowercase letters indicate significant differences among
64 treatments ($p < 0.05$).

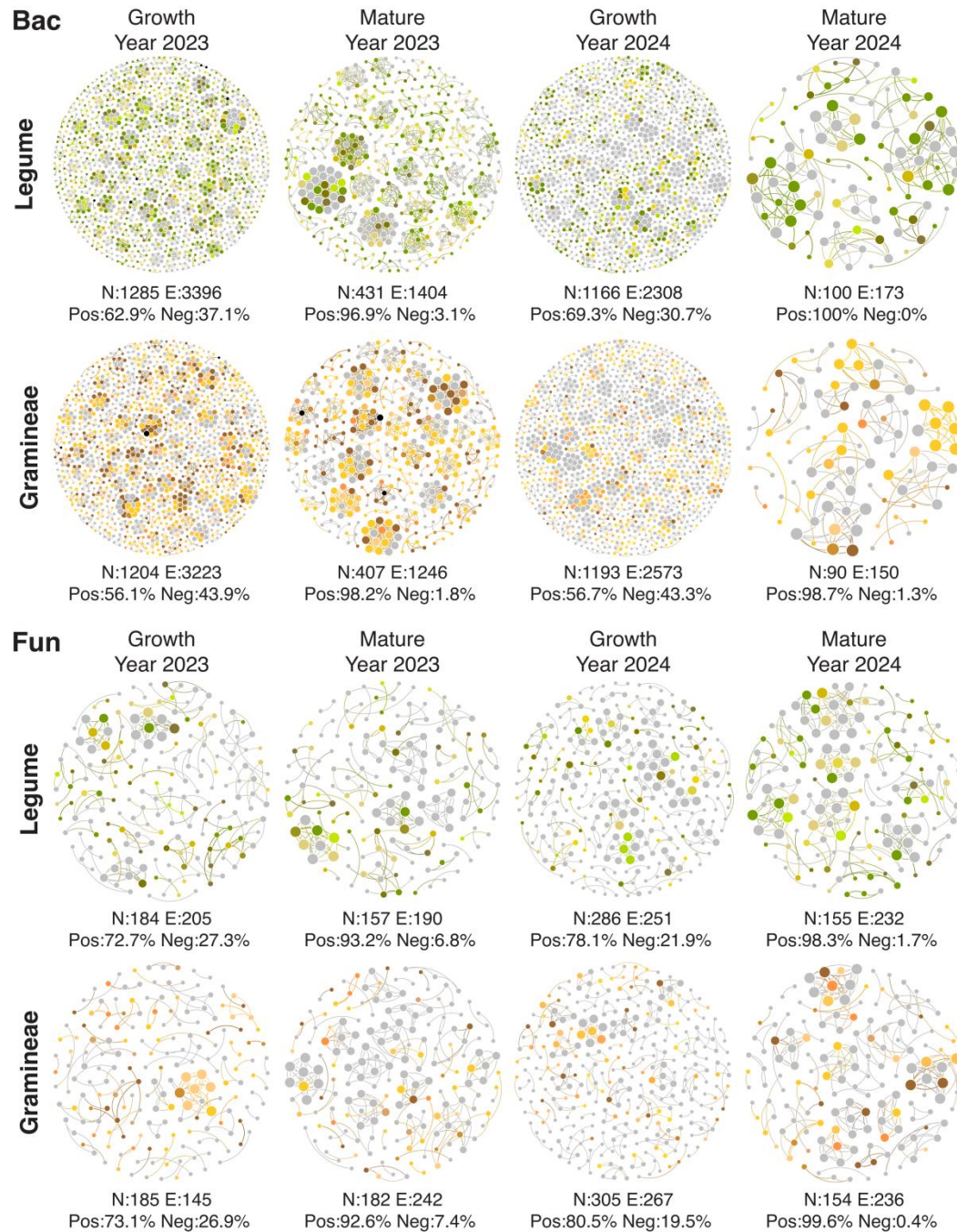


Fig. S7. Effects of intercropping on bacterial and fungal co-occurrence networks. Co-occurrence networks of bacterial and fungal communities under legume and gramineous intercropping systems during the growth and mature stages in 2023 and 2024. The upper panels show bacterial networks, and the lower panels show fungal networks. Nodes represent microbial taxa, and edges represent significant correlations between taxa. N and E indicate the number of nodes and edges, respectively. Pos and Neg indicate the proportions of positive and negative correlations, respectively.