Effects of Chinese Milk Vetch Returning on Soil Properties, Microbial Community, and Rice Yield in Paddy Soil

Jishi Zhang [1], Chunfeng Zheng [1], Lin Zhang [2], Chenglan Zhang [1], Yuhu Lv [2], Liangpeng Nie [2], Xiangning Zhang [1], Benyin Li [1], Weidong Cao [3], Min Li [4], Chunzeng Liu [1,*] and Yuting Zhang [1,*]

[1] Institute of Plant Nutrition, Resources and Environment, Henan Academy of Agricultural Sciences, Zhengzhou 450002, China
[2] Institute of Plant Nutrition, Resources and Environment, Xinyang Academy of Agricultural Sciences, Xinyang 464000, China
[3] Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China
[4] Institute of Soil and Fertilizer, Anhui Academy of Agricultural Sciences, Hefei 230031, China
* Correspondence: liuczhnnky@126.com (C.L.); zhangythnnky1@126.com (Y.Z.); Tel.: +86-371-55373611 (C.L.); Fax: +86-371-55373611 (C.L.)

Supplemental Material

Figure S1

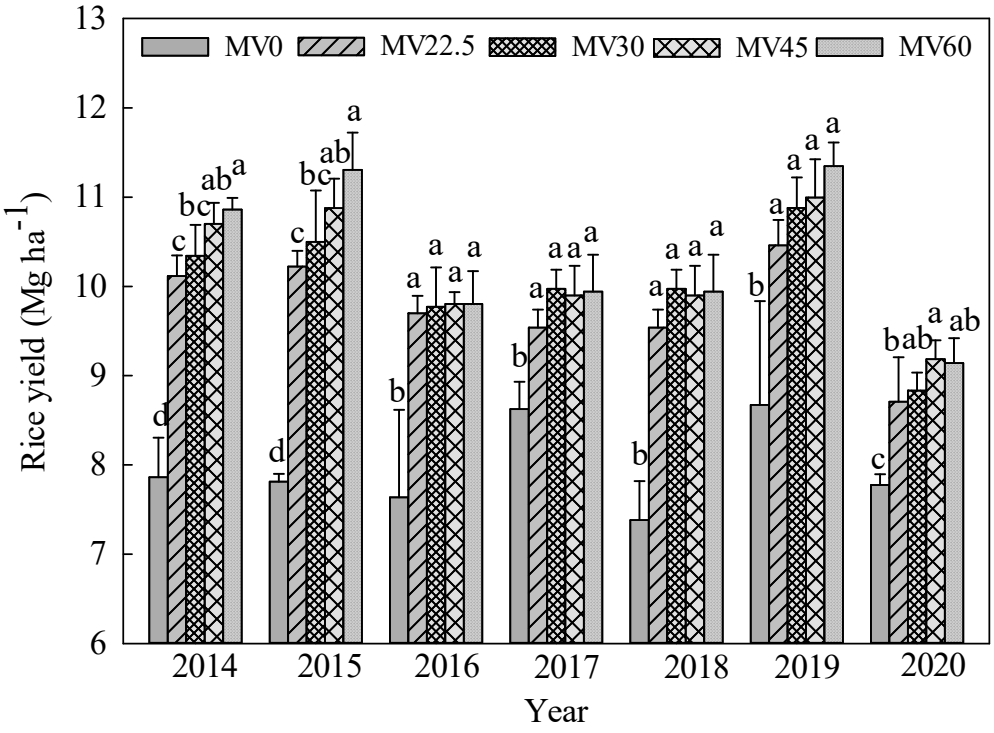

Figure S1 Rice yield under application of varied Chinese milk vetch (MV) rates from 2014 to 2020. Different letters indicate significant differences between application of varied MV rates at $P<0.05$.

Table S1 Rice yield as affected by the treatments, year and interaction between treatments and year. ANOVA for all data comes from Figure S1 in the supplemental material.

ANOVA	Sum of squares	Degrees of freedom	Mean of the squares	*F* value	*P* value
Yield (Mg ha^{-1})					
Treatment	105.34	4	26.335	161.98	<0.0001
Year	41.243	6	6.874	42.28	<0.0001
Treatment * Year	10.801	24	0.450	2.77	0.0002

Table S2 Relative abundance of the dominant phyla of bacteria after seven years of application of varied Chinese milk vetch (MV) rates. Phyla of bacteria with relative abundance < 5% are collectively called as "others".

	Chloroflexi	Proteobacteria	Acidobacteriota	Actinobacteriota	Firmicutes	Desulfobacterota	Nitrospirotae
MV0	19.8±2.55a	18.1±2.29ab	13.5±2.30a	11.9±1.60a	7.36±2.07b	4.20±0.87a	3.99±0.62a
MV22.5	21.6±0.69a	15.8±1.01b	13.0±1.13a	10.9±1.42a	11.0±0.50a	4.82±1.00a	3.88±0.85a
MV30	19.5±2.71a	17.5±1.71ab	11.9±2.99a	10.5±2.15a	10.7±1.40ab	5.02±1.32a	4.10±1.01a
MV45	20.0±1.99a	17.2±1.65ab	11.7±1.20a	12.0±2.35a	11.9±3.36a	4.47±0.74a	4.02±1.11a
MV60	21.5±3.53a	18.7±2.33a	11.7±1.63a	10.4±1.60a	10.7±3.09ab	4.26±0.41a	3.43±0.43a

Values (mean ± standard deviation) were tested in Analysis of variance (ANOVA) with four replicates in each treatment. Means followed by different letters within a row are significant differences (P <0.05) from each other according to Duncan's multiple comparison test.

Table S3 Relative abundance of the dominant phyla of fungi after seven years of application of varied Chinese milk vetch (MV) rates. Phyla of bacteria with relative abundance < 1% are collectively called as “others”.

Treatment	Ascomycota	unclassified	Basidiomycota	Mortierellomycota	Chytridiomycota	Rozellomycota
MV0	57.7±11.7a	16.8±7.83a	10.9±2.72b	7.34±3.78a	4.74±1.66a	1.95±1.90a
MV22.5	50.6±16.4ab	16.8±6.81a	20.8±16.1ab	6.69±3.30a	2.79±0.89b	1.80±2.18a
MV30	49.8±2.59ab	21.6±5.65a	16.1±7.05ab	6.32±3.14a	2.93±0.65b	2.80±2.60a
MV45	34.0±14.2b	20.8±7.82a	33.3±18.6a	8.92±1.81a	2.04±0.40b	0.68±0.34a
MV60	51.4±13.8ab	22.7±7.65a	15.5±6.45b	6.21±1.69a	3.13±1.45ab	0.78±0.46a

Values (mean ± standard deviation) were tested in Analysis of variance (ANOVA) with four replicates in each treatment. Means followed by different letters within a row are significant differences (P <0.05) from each other according to Duncan’s multiple comparison test.

Table S4 Spearman correlation coefficients for relationships among bacteria phyla, soil properties and grain yield (n=20).

	Phyla	Yield	SOC	TN	TP	TK	AN	AP	AK	BD
Bacteria	Chloroflexi	-0.03	0.19	0.01	-0.14	-0.16	-0.12	0.42	0.32	-0.48*
	Proteobacteria	0.13	-0.09	0.25	-0.08	0.13	-0.11	-0.36	0.07	0.04
	Acidobacteria	-0.38	-0.19	-0.31	-0.16	-0.29	-0.21	0.23	-0.16	0.05
	Actinobacteria	-0.08	0.12	-0.01	-0.11	0.21	-0.09	-0.08	-0.36	-0.20
	Firmicutes	0.50*	0.37	0.21	0.34	0.27	0.47*	-0.03	0.19	-0.09
	Desulfobacteria	0.12	0.07	0.01	0.46*	-0.14	0.12	0.14	-0.01	0.12
	Nitrospirae	-0.13	-0.30	-0.05	0.26	0.01	0.06	-0.01	0.05	0.31
Fungi	Ascomycota	-0.22	-0.30	0.05	-0.12	-0.15	-0.42	0.12	-0.06	0.48*
	unclassified	0.11	0.16	0.18	-0.21	0.13	0.19	0.03	0.14	-0.53*
	Basidiomycota	0.40	0.34	0.05	0.40	0.31	0.42	-0.01	-0.10	-0.38
	Mortierellomycota	0.03	-0.12	0.11	-0.04	-0.09	0.23	0.07	-0.17	-0.10
	Chytridiomycota	-0.51*	-0.51*	-0.51*	-0.27	-0.56*	-0.50*	-0.41	0.22	0.32
	Rozellomycota	-0.26	-0.15	-0.27	0.08	-0.33	0.03	-0.05	0.10	0.15

* $P < 0.05$;

SOC, soil organic carbon; TN, total nitrogen; TP, total phosphorus; TK, total potassium; AN, alkali solution nitrogen; AP, available P; AK, available K; BD, bulk density.