Supplemental Material

Table S1 Rhizosphere soil physicochemical properties and root nutritional status in different fertilizer treatments.

Variables	Control	NPK	NPKS	NPKM
RS_Moisture	13.2 (1.6)b	10.2 (1.2)b	15.0 (1.1)ab	20.9 (2.1)a
RS_pH	7.15 (0.03)a	5.41 (0.07)b	5.52 (0.16)b	7.06 (0.07)a
RS_DOC (mg kg^{-1})	47.3 (3.3)c	86.6 (7.5)b	114 (5)a	134 (8)a
RS_DON (mg kg^{-1})	0.820 (0.243)c	5.63 (0.96)b	10.7 (1.5)a	6.86 (1.23)ab
RS_NO_3^--N (mg kg^{-1})	8.96 (0.87)b	18.8 (3.3)ab	8.18 (1.53)b	35.4 (11.8)a
RS_NH_4^+-N (mg kg^{-1})	4.79 (0.13)a	6.01 (0.45)a	5.88 (1.58)a	5.58 (0.29)a
RS_TC (g kg^{-1})	8.91 (0.14)b	11.5 (0.4)b	15.7 (0.6)b	32.5 (3.6)a
RS_TN (g kg^{-1})	0.848 (0.026)c	1.31 (0.06)b	1.59 (0.04)b	2.82 (0.12)a
RS_TP (g kg^{-1})	0.268 (0.009)c	0.510 (0.036)b	0.473 (0.020)b	0.915 (0.034)a
RS_TK (g kg^{-1})	13.9 (0.1)ab	12.6 (0.7)b	14.3 (0.2)ab	15.2 (0.6)a
RS_AP (mg kg^{-1})	2.37 (0.17)c	33.2 (3.2)b	27.4 (2.3)b	78.9 (3.9)a
RS_AK (mg kg^{-1})	129 (3)c	184 (32)bc	347 (27)b	825 (84)a
RS_C:N ratio	10.5 (0.2)ab	8.78 (0.22)b	9.90 (0.27)ab	11.4 (0.8)a
RS_C:P ratio	33.3 (0.5)a	22.9 (2.0)b	33.3 (0.4)a	35.2 (2.6)a
RS_N:P ratio	0.106 (0.003)c	0.163 (0.007)b	0.199 (0.005)b	0.353 (0.015)a
RS_Ca (g kg^{-1})	6.47 (0.54)a	5.57 (0.75)a	4.78 (0.26)a	6.79 (0.08)a
RS_Mg (g kg^{-1})	5.85 (0.15)a	5.29 (0.04)b	5.25 (0.08)b	5.64 (0.08)ab
RS_Na (g kg^{-1})	10.7 (0.23)a	10.1 (0.1)ab	10.4 (0.1)a	9.67 (0.20)b
RS_Fe (g kg^{-1})	23.0 (0.7)a	23.0 (0.2)a	22.9 (0.4)a	21.6 (0.4)a
RS_Mn (mg kg^{-1})	372 (25)a	370 (28)a	394 (12)a	361 (16)a
RS_Zn (mg kg^{-1})	44.1 (1.4)b	42.3 (0.8)b	42.0 (0.5)b	54.4 (0.7)a
Root_TC (g kg^{-1})	402 (4)a	380 (3)b	382 (4)b	386 (5)ab
Root_TN (g kg^{-1})	6.63 (0.38)a	5.13 (0.95)a	4.66 (0.31)a	6.98 (0.88)a
Root_TP (g kg^{-1})	0.366 (0.027)c	0.565 (0.019)b	0.579 (0.021)b	1.04 (0.04)a
Root_TK (g kg^{-1})	4.32 (0.52)b	4.45 (0.51)b	5.79 (0.36)ab	6.59 (0.14)a
Root_C:N ratio	61.2 (2.9)a	80.9 (12.5)a	83.1 (5.9)a	57.7 (6.7)a
Root_C:P ratio	1115 (82)a	674 (22)b	662 (23)b	372 (11)c
Root_N:P ratio	18.2 (0.98)a	9.18 (1.91)b	8.03 (0.37)b	6.67 (0.67)b
Root_Ca (g kg^{-1})	2.05 (0.06)b	1.99 (0.10)b	1.74 (0.08)b	2.58 (0.17)a
Root_Mg (g kg^{-1})	0.848 (0.068)a	1.02 (0.05)a	0.913 (0.045)a	0.998 (0.085)a
Root_Na (g kg^{-1})	0.951 (0.054)a	0.886 (0.048)a	0.783 (0.101)a	1.00 (0.06)a
Root_Fe (g kg^{-1})	2.56 (0.33)a	3.79 (0.24)a	3.18 (0.11)a	2.85 (0.44)a
Root_Mn (mg kg^{-1})	67.5 (5.2)b	150 (17)a	146 (6)a	67.5 (6.0)b
Root_Zn (mg kg^{-1})	25.0 (2.0)a	16.3 (1.3)b	15.0 (0.9)b	14.8 (1.0)b

Values are mean (SE) (n = 4). Different letters in each column denote a significant difference among treatments detected by Tukey's HSD at $P < 0.05$. RS, Rhizosphere soil. DOC, dissolved organic carbon; DON, dissolved organic nitrogen; NO_3^--N, nitrate nitrogen; NH_4^+-N, ammonium nitrogen; TC, total carbon; TN, total nitrogen; TP, total phosphorus; TK, total potassium; AP, available phosphorous; AK, available potassium. Control, no fertilizer addition; NPK, mineral fertilizer only; NPKS, mineral fertilizer plus wheat straw; NPKM, mineral fertilizer plus cow manure.

Table S2 Results of an ADONIS test between different fertilization treatments on arbuscular mycorrhizal fungal (AMF) communities in the rhizosphere soil (RS) and root endosphere (ES), respectively. Differences between AMF communities were quantified by Bray-Curtis distances. For abbreviations, see Table S1.

ADONIS test	RS		ES	
	R^2	*P*	R^2	*P*
Total	0.30	0.001	0.29	0.003
Control *vs*. NPK	0.73	0.043	0.95	0.028
Control *vs*. NPKS	0.59	0.022	0.97	0.026
Control *vs*. NPKM	0.70	0.033	0.99	0.028
NPK *vs*. NPKS	0.25	0.038	0.54	0.043
NPK *vs*. NPKM	0.68	0.026	0.95	0.025
NPKS *vs*. NPKM	0.54	0.022	0.98	0.034

Table S3 The relative abundance of arbuscular mycorrhizal fungal families in the rhizosphere soil (RS) and root endosphere (ES) under different fertilization treatments, respectively. For abbreviations, see Table S1.

Relative abundance (%)	RS			
	Control	NPK	NPKS	NPKM
Archaeosporaceae	0.028 (0.009)b	0.430 (0.203)ab	1.54 (0.67)a	0.029 (0.017)b
Claroideoglomeraceae	16.0 (3.8)c	77.2 (5.4)a	58.5 (10.2)ab	38.2 (5.5)b
Diversisporaceae	4.14 (1.48)ab	0.894 (0.893)bc	0c	5.12 (1.68)a
Gigasporaceae	2.17 (2.15)b	0b	5.35 (5.34)ab	25.6 (10.6)a
Glomeraceae	69.3 (2.7)a	20.3 (4.3)b	32.4 (13.1)b	21.4 (3.4)b
Paraglomeraceae	8.36 (2.70)a	0.995 (0.526)b	2.09 (0.78)ab	6.52 (1.27)ab
Other	0a	0.261 (0.153)a	0.088 (0.065)a	3.24 (2.29)a
Relative abundance (%)	**ES**			
	Control	**NPK**	**NPKS**	**NPKM**
Archaeosporaceae	26.6 (3.2)a	0b	0b	0b
Claroideoglomeraceae	0a	0.286 (0.140)a	0.095 (0.089)a	0.052 (0.036)a
Gigasporaceae	0a	0.008 (0.008)a	0a	0a
Glomeraceae	72.2 (2.7)a	0.581 (0.314)b	0.097 (0.058)b	0.113 (0.031)b
Paraglomeraceae	1.23 (1.14)b	80.5 (3.6)a	86.6 (1.7)a	99.6 (0.1)a
Other	0b	18.6 (3.8)a	13.2 (1.7)a	0.214 (0.072)b

Values are mean (SE) (n = 4). Different letters in each column denote a significant difference among treatments detected by Tukey's HSD at $P < 0.05$.

Table S4 Topological features of arbuscular mycorrhizal fungal co-occurrence networks of under different fertilization treatments in the rhizosphere soil (RS) and root endosphere (ES), respectively. For abbreviations, see Table S1.

Compartment	Topological features	Control	NPK	NPKS	NPKM
RS	Nodes	114	66	66	56
	Edges	1468	335	344	326
	Average degree	25.75	10.15	10.42	11.64
	Transitivity	0.70	0.66	0.63	0.65
	Modularity	0.29	0.42	0.36	0.29
	Positive correlations %	91.14	89.85	87.21	93.56
	Negative correlations %	5.86	10.15	12.79	6.44
ES	Nodes	6	71	49	40
	Edges	12	300	120	73
	Average degree	4.00	8.45	4.90	3.65
	Transitivity	0.85	0.54	0.39	0.71
	Modularity	0	0.54	0.47	0.69
	Positive correlations %	75.00	100	100	100
	Negative correlations %	25.00	0	0	0

Table S5 Spearman correlations (r) between the relative abundances of the two arbuscular mycorrhizal fungal (AMF) families and rhizosphere soil physicochemical properties and root nutritional status. Significant effects are shown in bold (* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$). For abbreviations, see Table S1.

Variables	Glomeraceae in RS (r)	Paraglomeraceae in RS (r)	Glomeraceae in ES (r)	Paraglomeraceae in ES (r)
RS_Moisture	0.13	0.35	-0.42	**-0.55***
RS_pH	0.38	**0.81*****	0.26	0.01
RS_DOC	-0.47	-0.17	**-0.78*****	**0.82*****
RS_DON	-0.35	-0.42	**-0.79*****	**0.58***
RS_NO_3^--N	**-0.62****	-0.12	0.05	0.54*
RS_NH_4^+-N	-0.47	-0.45	-0.39	0.35
RS_TC	-0.44	-0.11	**-0.80*****	**0.92*****
RS_TN	-0.44	-0.21	**-0.79*****	**0.89*****
RS_TP	**-0.66****	0.32	**-0.52***	**0.84*****
RS_TK	0.01	0.32	-0.41	**0.64****
RS_AP	**-0.69****	-0.22	-0.45	**0.85*****
RS_AK	-0.35	0.01	**-0.73****	**0.88*****
RS_C:N ratio	0.49	**0.72****	0.04	0.05
RS_C:P ratio	0.53	**0.52***	-0.21	0.09
RS_N:P ratio	-0.44	-0.12	**-0.79*****	**0.89*****
RS_Ca	0.24	**0.57***	0.48	0.04
RS_Mg	0.42	**0.80*****	0.49	-0.08
RS_Na	**0.63****	0.27	0.22	**-0.56***
RS_Fe	0.07	-0.28	0.16	-0.29
RS_Mn	0.21	0.05	-0.07	-0.02
RS_Zn	-0.11	0.39	0.03	0.37
Root_TC	**0.75****	**0.72****	**0.57***	**-0.55***
Root_TN	0.19	**0.67****	0.42	0.03
Root_TP	-0.45	-0.14	**-0.59***	**0.84*****
Root_TK	-0.13	0.19	**-0.57***	**0.76****
Root_C:N ratio	-0.19	**-0.65****	-0.37	-0.02
Root_C:P ratio	**0.52***	0.16	**0.58***	**-0.85*****
Root_N:P ratio	**0.68****	0.42	**0.55***	**-0.69****
Root_Ca	-0.22	0.36	0.27	0.29
Root_Mg	**-0.65****	-0.43	-0.14	0.35
Root_Na	-0.10	0.36	0.19	0.26

Root_Fe	**-0.59***	**-0.72****	-0.19	0.10
Root_Mn	-0.37	**-0.80*****	-0.35	-0.07
Root_Zn	0.39	0.33	**0.60***	**-0.67****

Table S6 Spearman correlations (r) between arbuscular mycorrhizal fungal (AMF) operational taxonomic unit (OTU) richness and rhizosphere soil physicochemical properties and root nutritional status. Significant effects are shown in bold (* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$). For abbreviations, see Table S1.

Variables	Correlations (r) in RS	Correlations (r) in ES
RS_Moisture	-0.17	-0.25
RS_pH	0.17	**-0.59***
RS_DOC	**-0.78*****	0.32
RS_DON	**-0.54***	0.36
RS_NO_3^--N	-0.49	0.45
RS_NH_4^+-N	-0.32	**0.68****
RS_TC	**-0.73****	0.29
RS_TN	**-0.76****	0.27
RS_TP	**-0.75****	0.44
RS_TK	-0.23	-0.13
RS_AP	**-0.77*****	**0.51***
RS_AK	**-0.70****	0.16
RS_C:N ratio	0.05	**-0.61***
RS_C:P ratio	-0.02	**-0.55****
RS_N:P ratio	**-0.76****	0.27
RS_Ca	0.23	-0.37
RS_Mg	0.21	**-0.61***
RS_Na	**0.66****	**-0.51***
RS_Fe	0.33	0.18
RS_Mn	0.35	-0.07
RS_Zn	-0.31	-0.22
Root_TC	**0.68****	**-0.63****
Root_TN	-0.05	-0.36
Root_TP	**-0.71****	0.29
Root_TK	-0.47	0.09
Root_C:N ratio	0.09	0.39
Root_C:P ratio	**0.77****	-0.29
Root_N:P ratio	**0.67****	**-0.50***
Root_Ca	-0.23	-0.30
Root_Mg	**-0.52***	0.31
Root_Na	-0.37	-0.21
Root_Fe	-0.34	0.47

Root_Mn	-0.13	**0.53***
Root_Zn	0.41	**-0.63****

Table S7 Applied amounts of nutrients in the four treatments in an ongoing long-term experiment (35 years). For abbreviations, see Table S1.

Treatment	Mineral fertilizer ($kg/hm^2\ y^{-1}$)			Wheat straw (Fresh Base) (7,500 $kg/hm^2\ y^{-1}$)			Cow manure (Fresh Base) (30,000 $kg/hm^2\ y^{-1}$)		
	N	P	K	N	P	K	N	P	K
Control	0	0	0	0	0	0	0	0	0
NPK	180	90	86	0	0	0	0	0	0
NPKS	180	90	86	5.5 g/kg	3.2 g/kg	9.7 g/kg	0	0	0
NPKM	180	90	86	0	0	0	7.9 g/kg	4.3 g/kg	9.1 g/kg

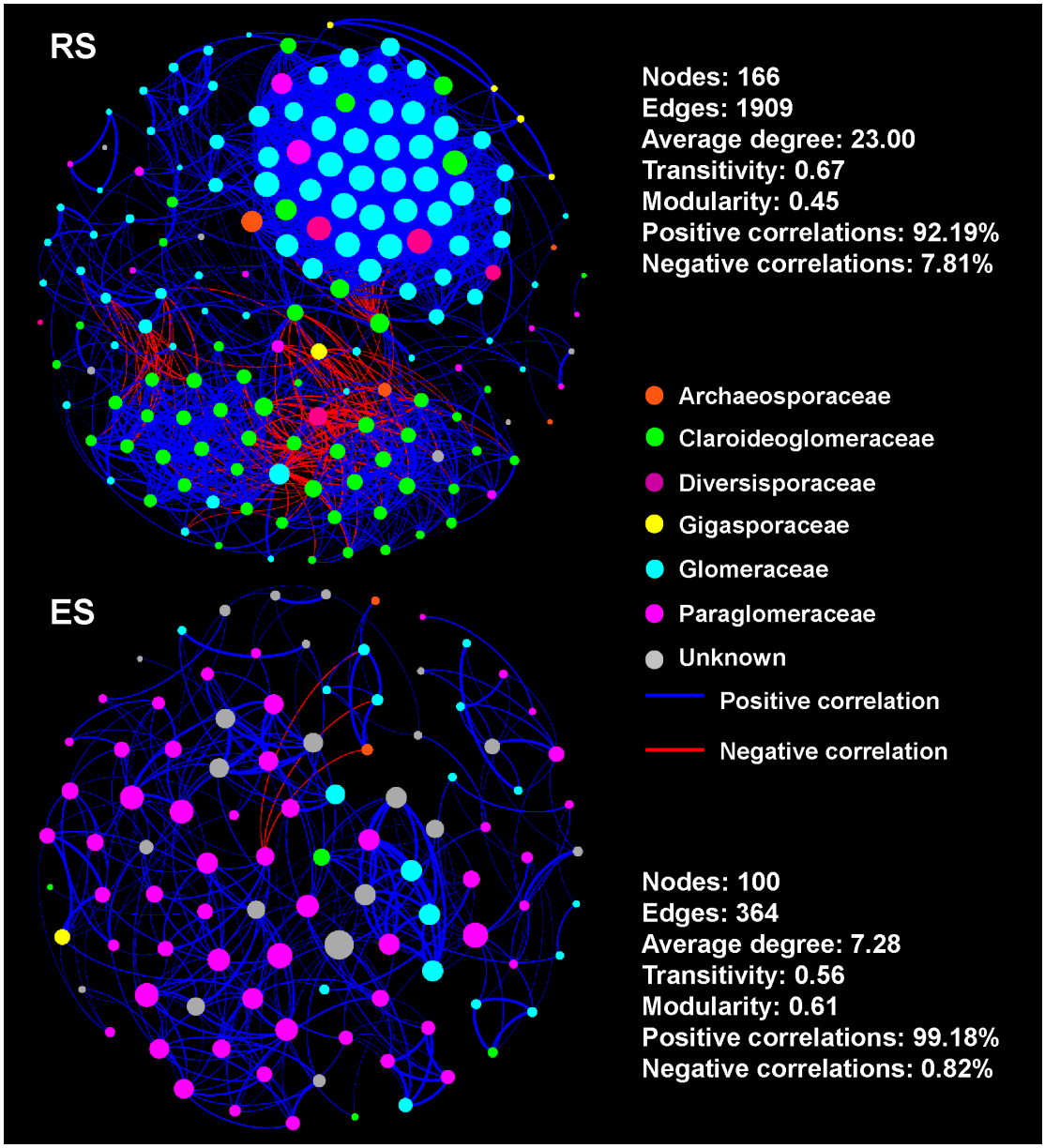

Fig. S1 Co-occurrence networks for visualizing significant associations ($r > 0.60$, $P < 0.05$) between arbuscular mycorrhizal fungal (AMF) operational taxonomic units (OTUs) in the rhizosphere soil (RS) and root endosphere (ES). Each dot represents an AMF OTU, different colors represent different families, node size represents the degree of the node, and edges denote significant relationships between OTUs.

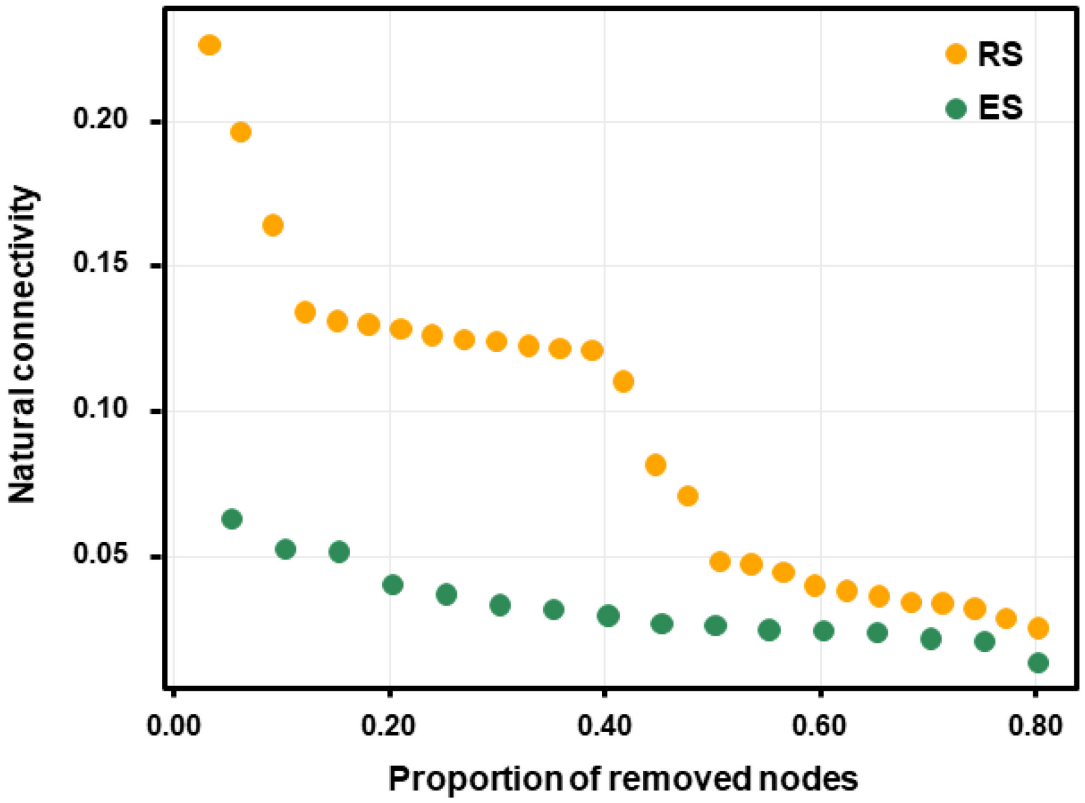

Fig. S2 Network stability. The decrease of natural connectivity when attack nodes in the static network.