

**Effects of plant and soil characteristics on phyllosphere and rhizosphere fungal communities  
during plant development in a copper tailings dam**

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## Supplemental Material

**Table S1**

Mean values ( $\pm$  SE) of *Bothriochloa ischaemum* properties in copper tailings dam. Significant differences between sites (Duncan test,  $P < 0.05$ ) are denoted with letters (a > b > c).

	Seedling	Tiller	Mature
TN_Leaf	3.213 $\pm$ 0.758b	93.748 $\pm$ 4.955a	5.199 $\pm$ 1.844b
TC_Leaf	47.158 $\pm$ 2.832b	45.319 $\pm$ 0.313b	78.431 $\pm$ 1.821a
C/N_Leaf	15.819 $\pm$ 2.462a	0.486 $\pm$ 0.028b	18.478 $\pm$ 4.912a
TS_Leaf	1.009 $\pm$ 0.702	0.157 $\pm$ 0.009	0.519 $\pm$ 0.184
TN_Sheath	0.817 $\pm$ 0.031b	41.381 $\pm$ 7.046a	1.329 $\pm$ 0.085b
TC_Sheath	42.720 $\pm$ 0.462a	33.346 $\pm$ 0.656b	6.631 $\pm$ 0.260c
C/N_Sheath	52.458 $\pm$ 2.341a	0.854 $\pm$ 0.148c	5.056 $\pm$ 0.537b
TS_Sheath	0.180 $\pm$ 0.022b	0.130 $\pm$ 0.008b	0.802 $\pm$ 0.093a
TN_Root	0.985 $\pm$ 0.016b	9.392 $\pm$ 3.120a	0.851 $\pm$ 0.035b
TC_Root	44.337 $\pm$ 0.032b	44.832 $\pm$ 0.096a	15.330 $\pm$ 0.277c
C/N_Root	45.038 $\pm$ 0.693a	6.949 $\pm$ 3.319c	18.089 $\pm$ 0.871b
TS_Root	0.627 $\pm$ 0.154a	0.244 $\pm$ 0.009b	0.032 $\pm$ 0.005c

Abbreviations mean total nitrogen (TN), total carbon (TC), total sulfur (TS), and the ratio of carbon and nitrogen (C/N); the unit of TN, TC and TS,  $\text{g}\cdot\text{kg}^{-1}$ .

**Table S2**

Soil chemical properties of copper tailings dam. Values represent mean with standard error in parenthesis. Significant differences between sites (Duncan test,  $P < 0.05$ ) are denoted with letters (a > b > c).

	Seedling	Tiller	Mature
SWC (%)	0.841±0.036c	15.499±1.260b	86.162±0.213a
pH	8.203±0.020b	8.913±0.019a	8.113±0.029c
NH <sub>4</sub> <sup>+</sup> -N (mg·kg <sup>-1</sup> )	0.156±0.029bc	0.273±0.116ab	0.427±0.075a
NO <sub>3</sub> <sup>-</sup> -N (mg·kg <sup>-1</sup> )	0.064±0.006c	0.220±0.019a	0.134±0.007b
NO <sub>2</sub> <sup>-</sup> -N (mg·kg <sup>-1</sup> )	0.006±0.001b	0.008±0.001b	0.011±0.002a
TN (g·kg <sup>-1</sup> )	0.082±0.001a	0.029±0.003c	0.047±0.005b
TC (g·kg <sup>-1</sup> )	6.017±0.919a	0.627±0.018b	1.033±0.041b
C/N	73.516±11.817a	21.681±1.164b	22.058±1.474b
TS (g·kg <sup>-1</sup> )	0.459±0.294a	0.065±0.002b	0.144±0.017ab
ST (°C)	23.900±0.473c	28.833±0.698a	26.867±0.484b
Salinity (mg·L <sup>-1</sup> )	0.000±0.000c	14.333±3.844b	31.667±1.202a
EC (μs·cm <sup>-1</sup> )	0.000±0.000c	26.667±7.219b	57.667±1.667a

Abbreviations mean soil water content (SWC), ammonium nitrogen (NH<sub>4</sub><sup>+</sup>-N), nitrate nitrogen (NO<sub>3</sub><sup>-</sup>-N), nitrite nitrogen (NO<sub>2</sub><sup>-</sup>-N), total nitrogen (TN), total carbon (TC), total sulfur (TS), the ratio of carbon and nitrogen (C/N), soil temperature (ST), and electrical conductivity (EC).

**Table S3**

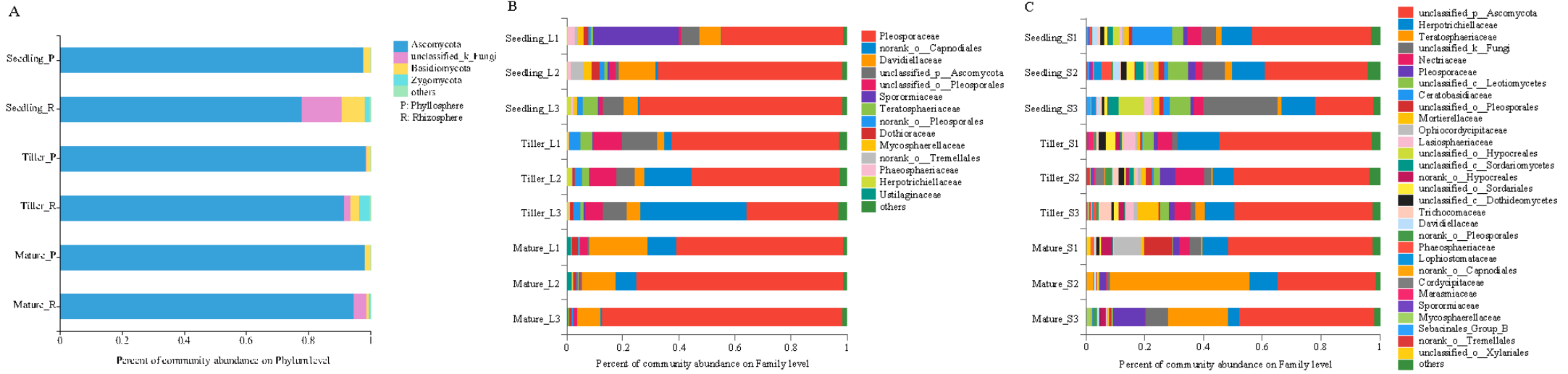
Network properties obtained through network analysis from phyllosphere and rhizosphere fungal communities.

	Nodes	Edges	Average Degree	Network Diameter	Clustering Coefficient	Average Path Length
Phyllosphere	82	416	10.146	9	0.685	3.218
Rhizosphere	122	626	10.262	8	0.637	3.574

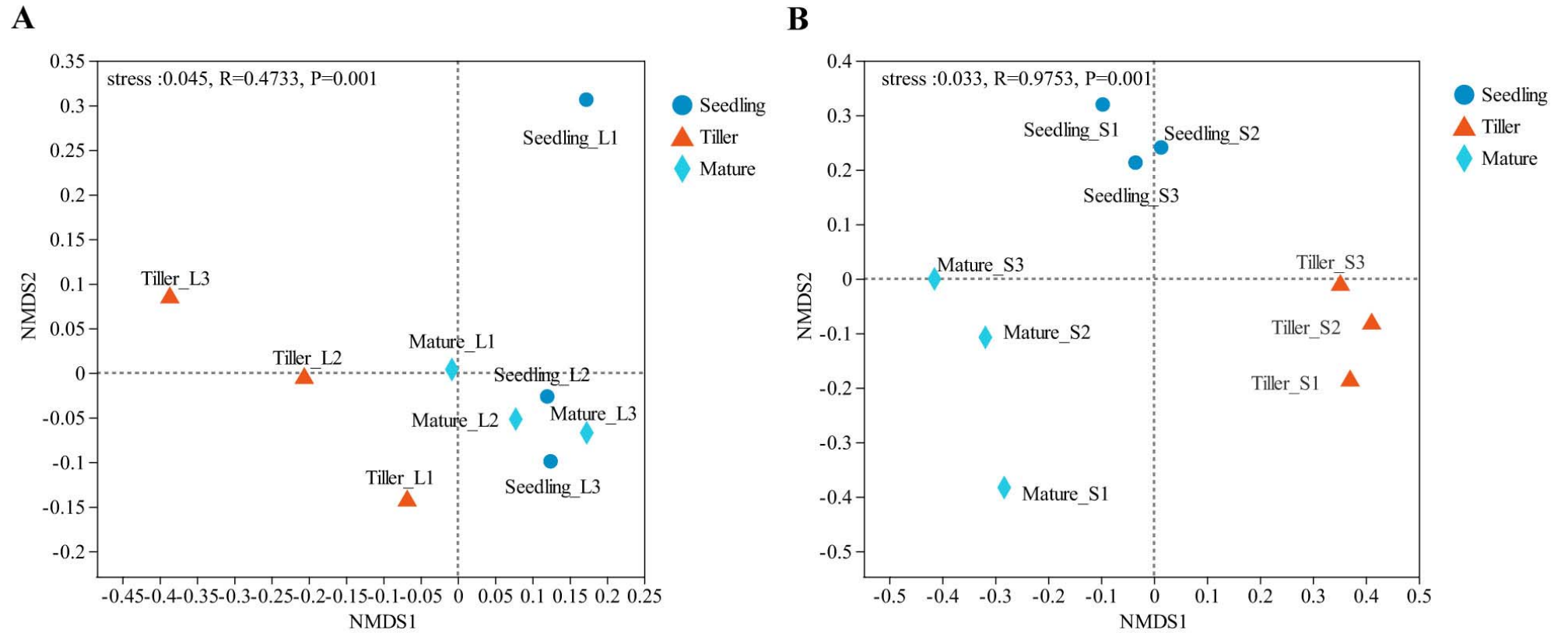
**Table S4**

Dominant keystone species from phyllosphere and rhizosphere fungal community structures.

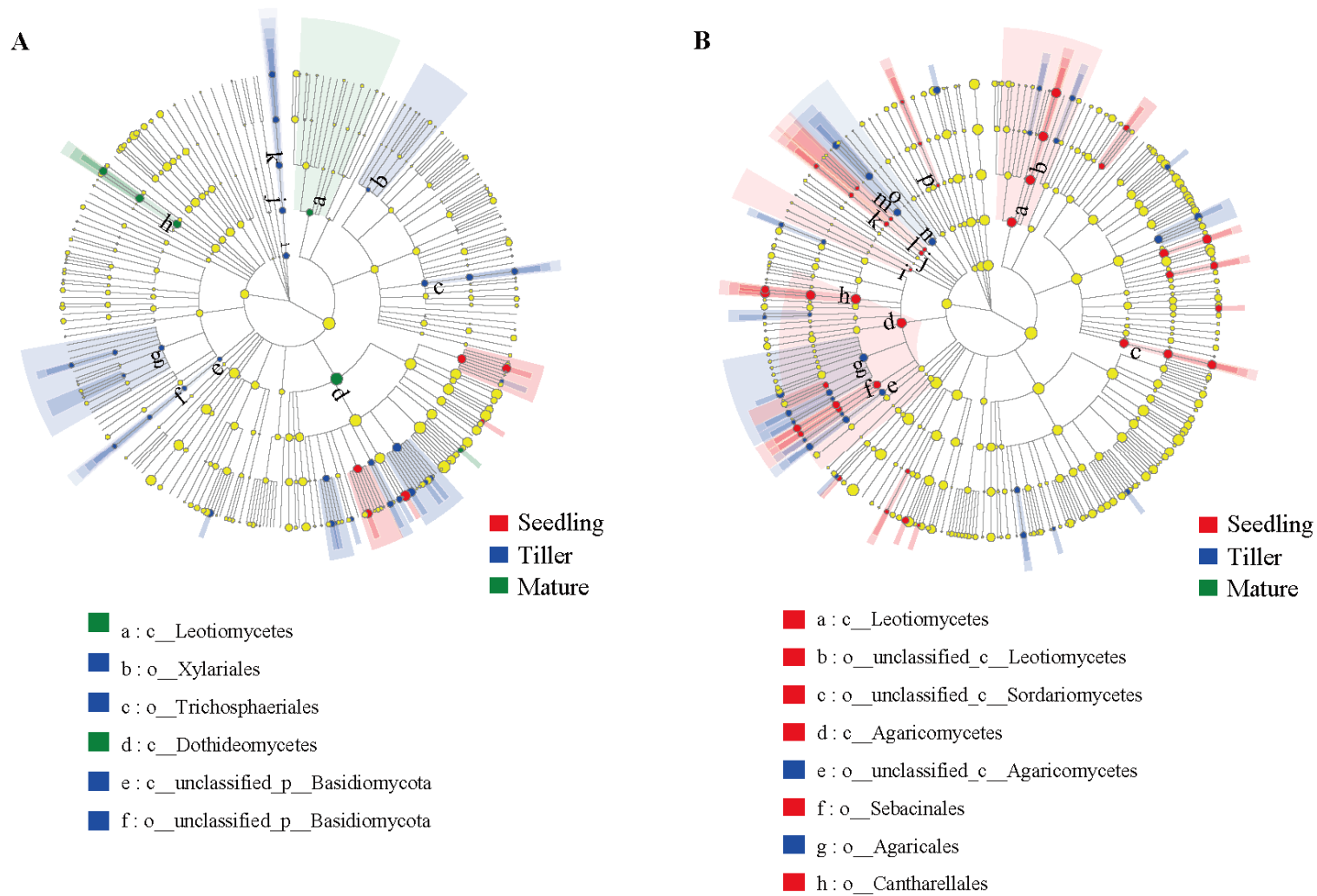
	Phylum	Family	Betweenness centrality
Phyllosphere	Ascomycota	Davidiellaceae	529.80
	Ascomycota	norank_o_Trichosphaeriales	404.33
	Ascomycota	norank_o_Pleosporales	388.47
	Ascomycota	Trichocomaceae	325.55
	Ascomycota	Montagnulaceae	280.90
	Ascomycota	Myxotrichaceae	268.00
	Ascomycota	Stictidaceae	263.18
	Ascomycota	Dothioraceae	262.64
	Ascomycota	Mycosphaerellaceae	216.06
	Basidiomycota	Marasmiaceae	196.84
Rhizosphere	Ascomycota	unclassified_o_Sordariales	775.03
	Ascomycota	unclassified_c_Dothideomycetes	749.90
	Ascomycota	Herpotrichiellaceae	622.33
	Ascomycota	unclassified_p_Ascomycota	566.71
	Ascomycota	Lasiosphaeriaceae	552.13
	Ascomycota	norank_p_Ascomycota	519.77
	Basidiomycota	unclassified_c_Agaricostilbomycetes	532.27
	Basidiomycota	unclassified_o_Sebacinales	530.93
	Basidiomycota	Ustilaginaceae	502.57
	Basidiomycota	Typhulaceae	452.00



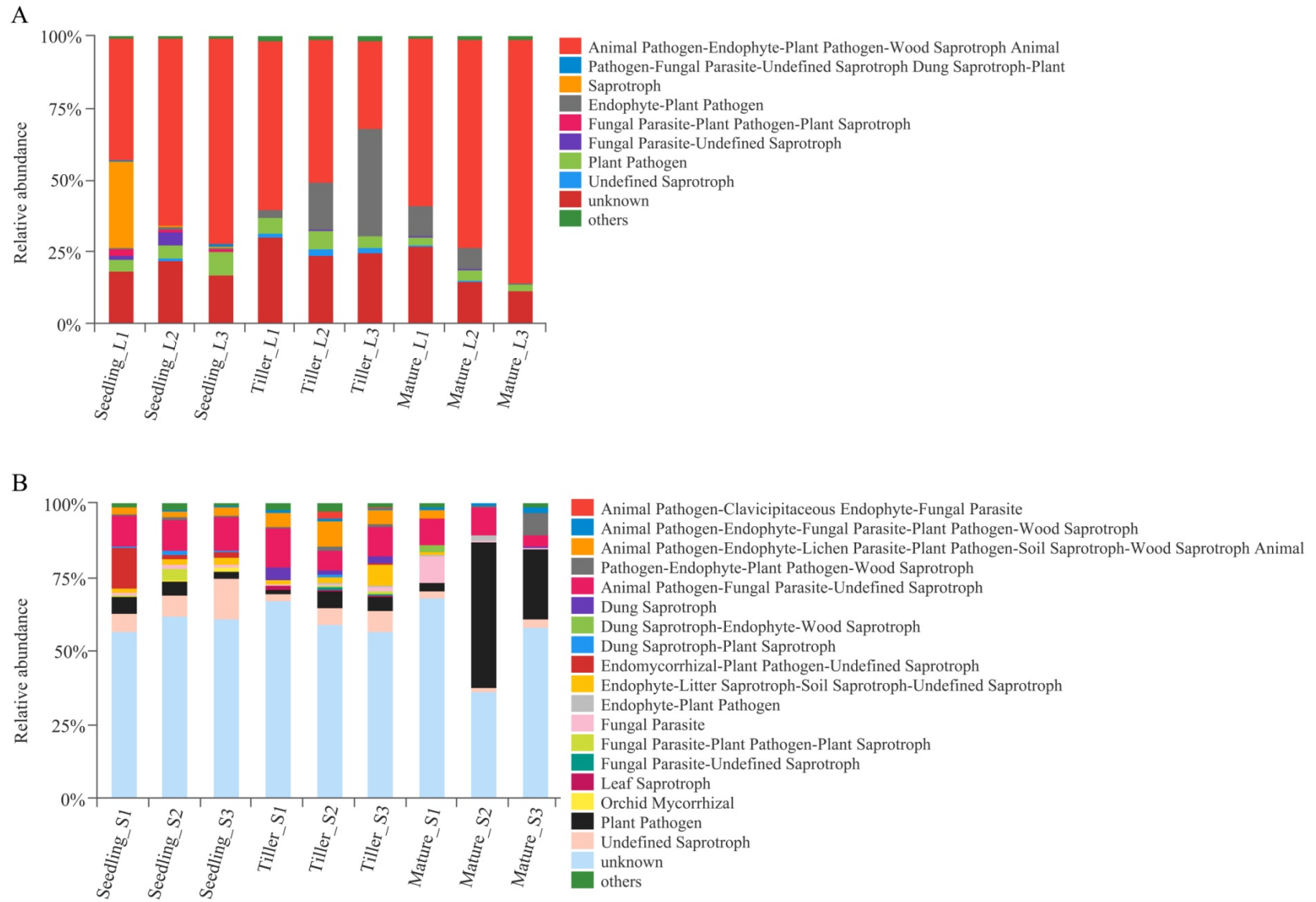
**FIGURE S1** Relative abundance of fungal phyla (A), dominant phyllosphere (B) and rhizosphere (C) fungal community families (with average relative abundance > 1%) among different plant growth stages.



**FIGURE S2** Non-metric multidimensional scaling (NMDS) of phyllosphere (A) and rhizosphere (B) samples among plant development processes based on the relative abundance of fungal OTUs.



**FIGURE S3** Cladogram showing the phylogenetic distribution of phyllosphere (A) and rhizosphere (B) fungal communities from different development stages. Different-colored regions represent different constituents (red, seedling; green, mature; blue, tiller). Circles indicate phylogenetic levels from phylum to genus. The diameter of each circle is proportional to the abundance of the group.



**FIGURE S4** Variations in composition of phyllosphere (A) and rhizosphere (B) fungal functional groups inferred by FunGuild during plant growth processes.