

**Figure S1.** Venn of soil bacterial during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.



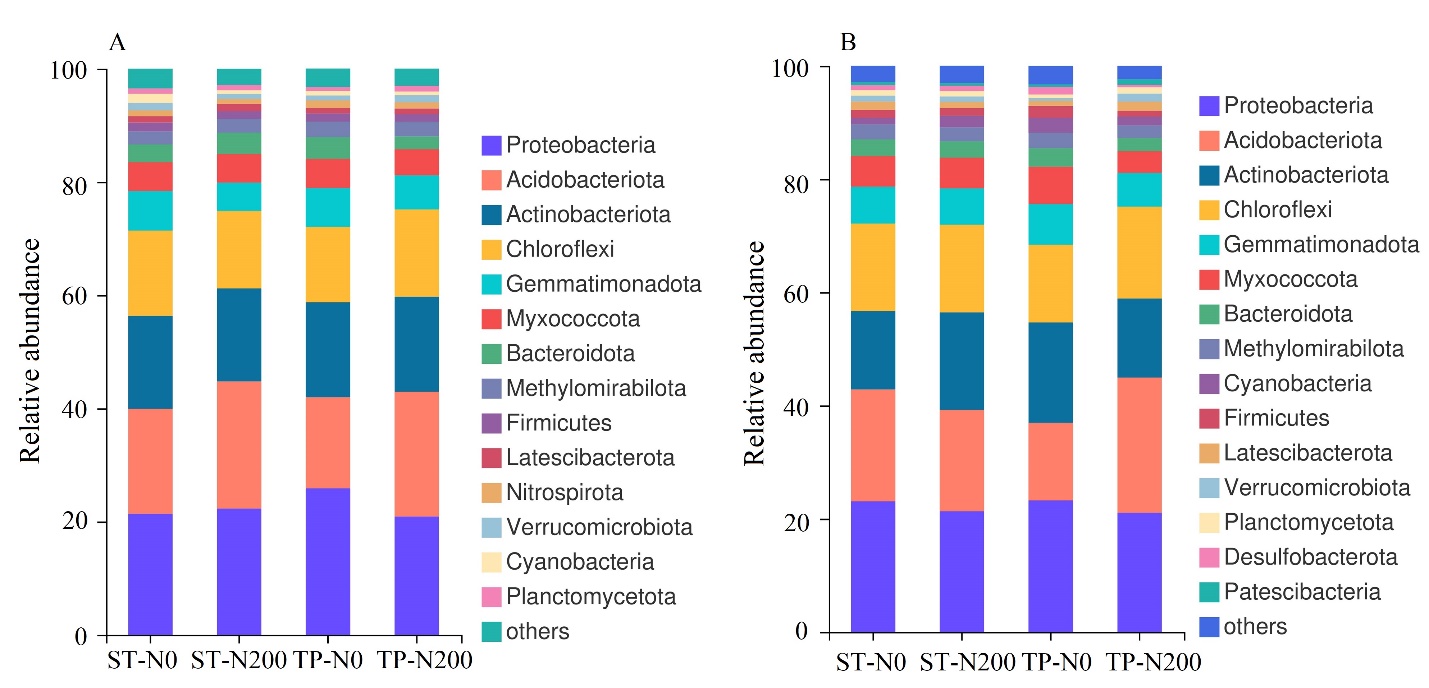
**Figure S2.** Venn of soil fungi during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.



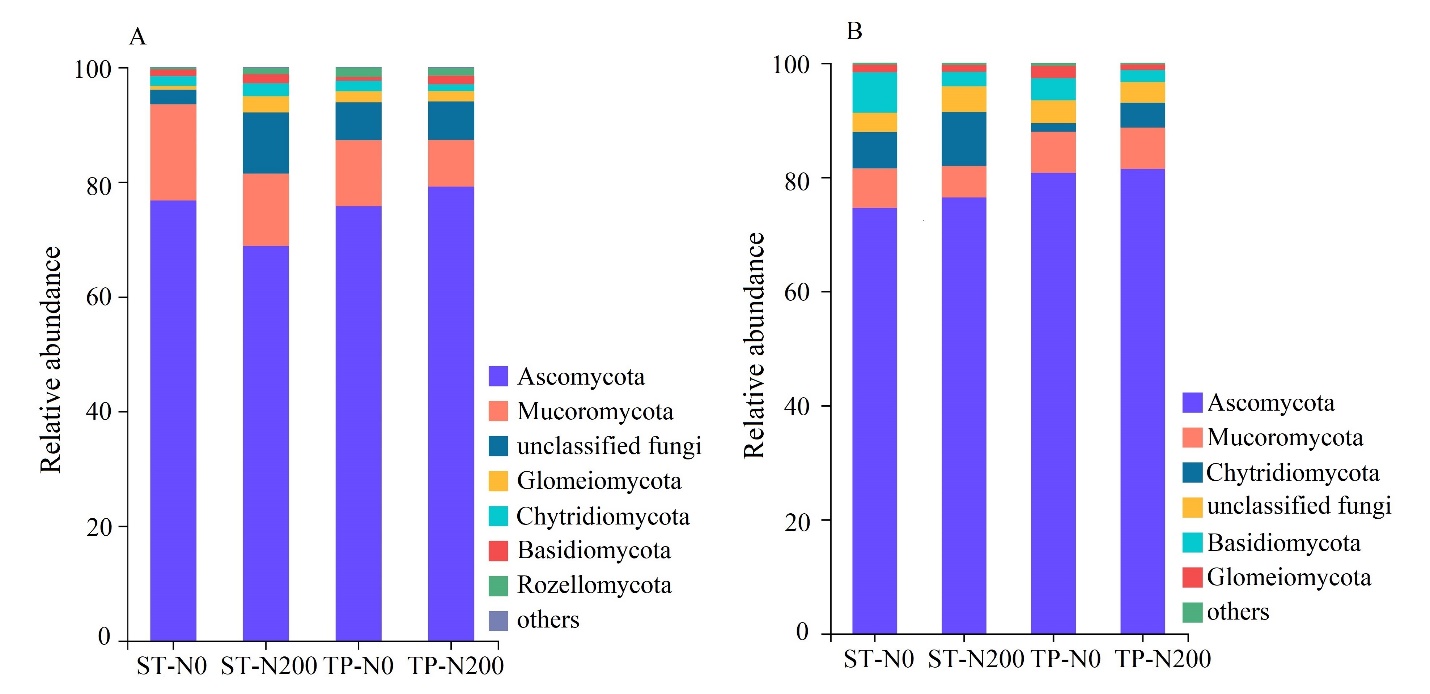
**Figure S3.** Venn of soil nematode during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.



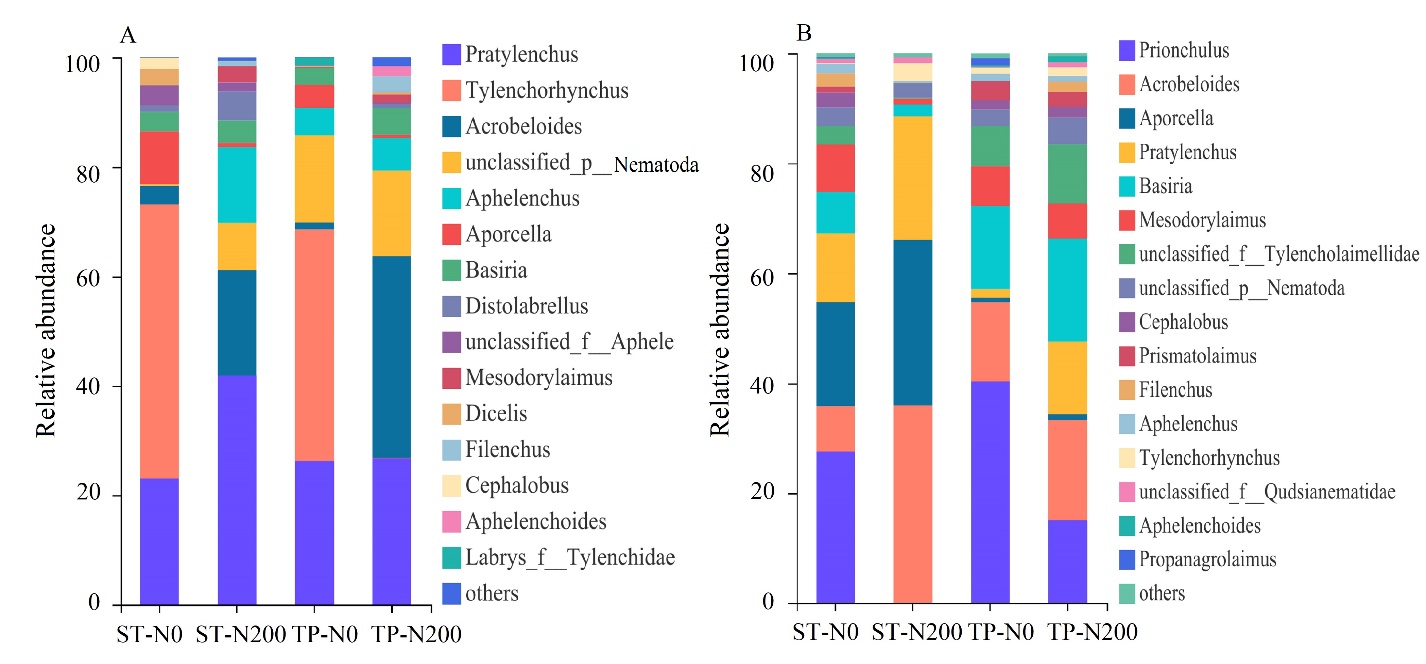
**Figure S4.** Relative abundance of soil bacterial during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.



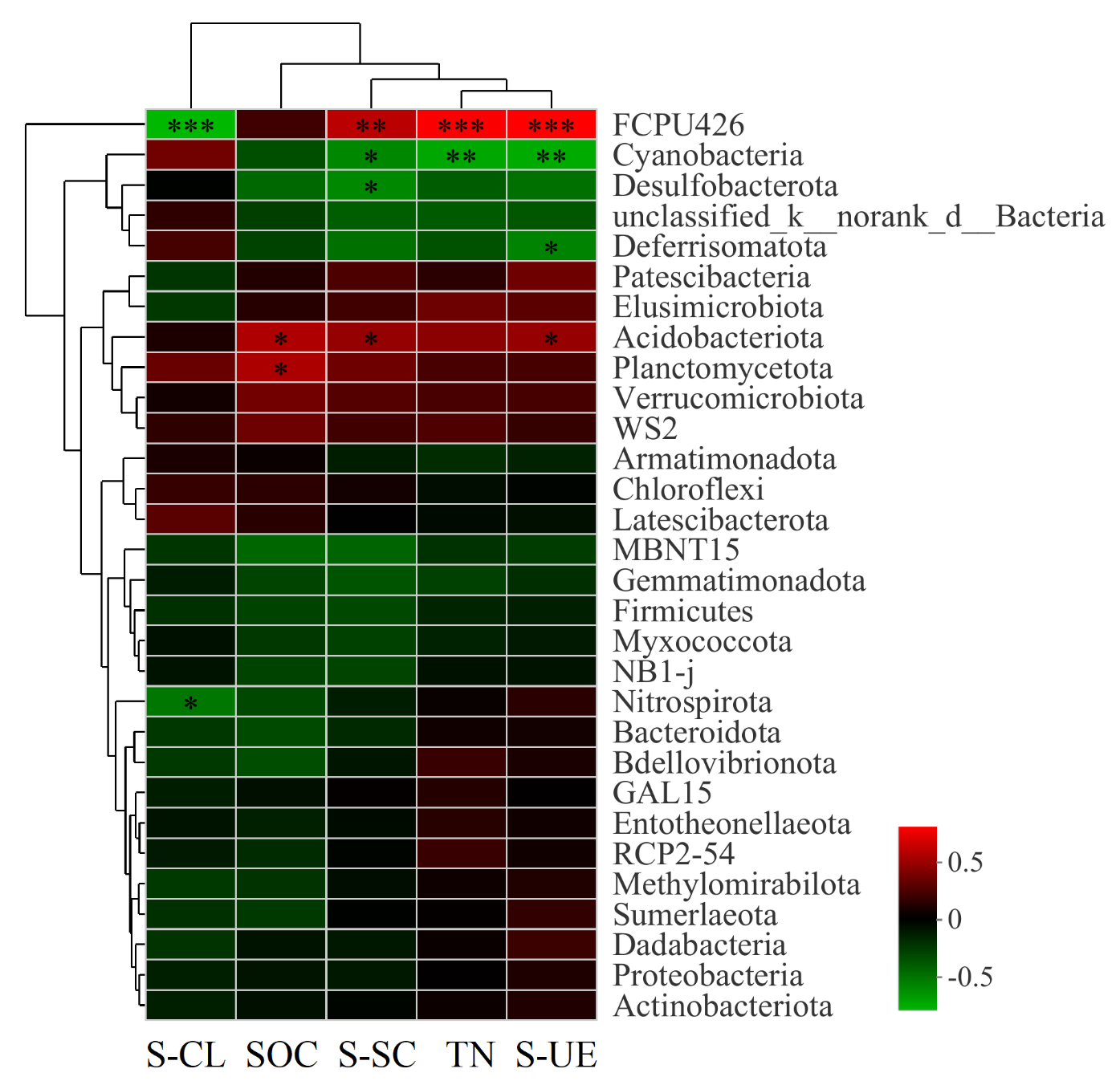
**Figure S5.** Relative abundance of soil fungi during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.



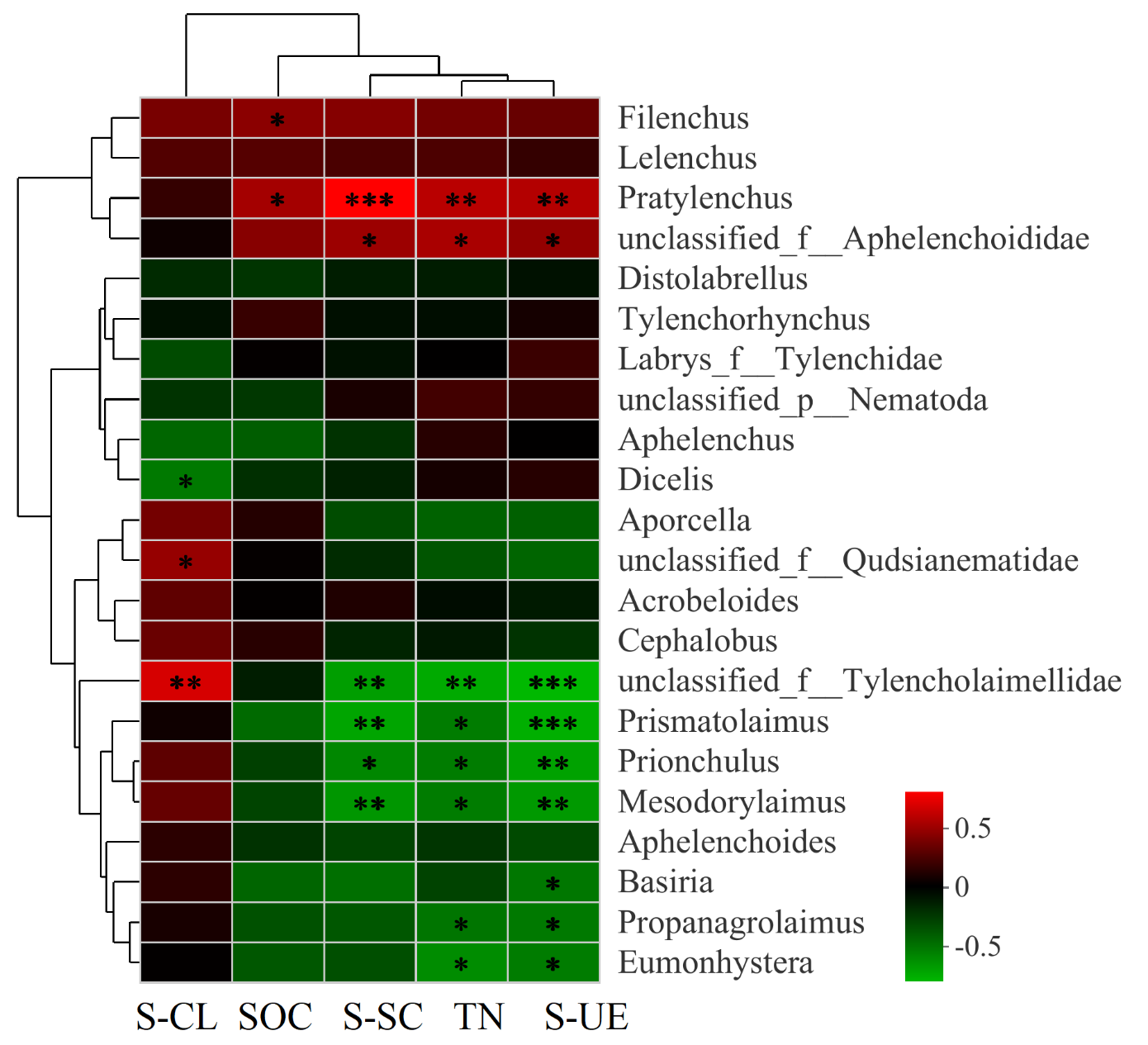
**Figure S6.** Relative abundance of soil nematode during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.



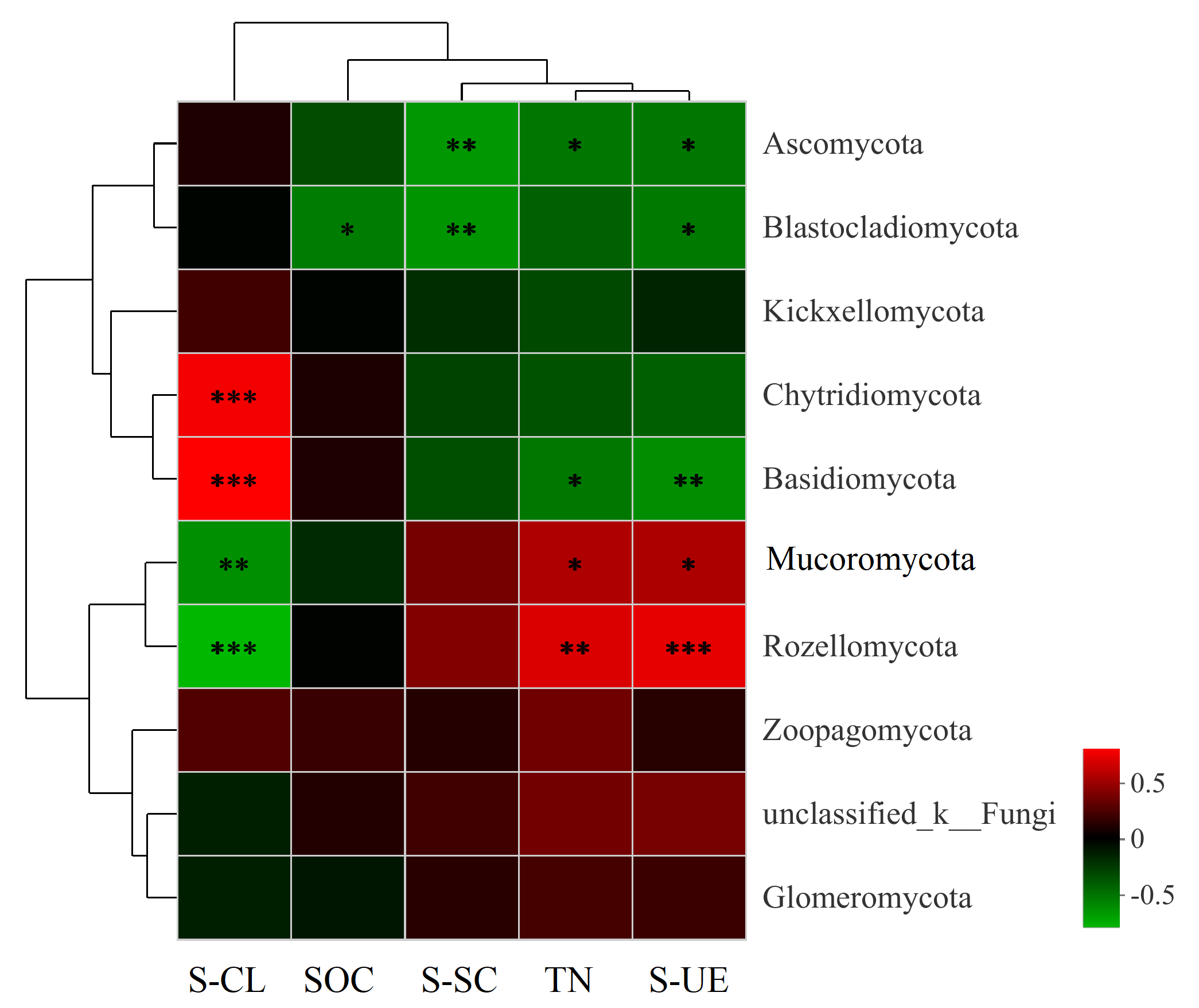
**Figure S7.** Spearman correlation of soil bacterial during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.



**Figure S8.** Spearman correlation of soil fungi during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.



**Figure S9.** Spearman correlation of soil nematode during spring (A) and in autumn (B) seasons.

Abbreviations: SR-N0 = straw returning without N fertilizer application; SR-N200 = straw returning with 200 kg ha-1 N fertilizer application; TP-N0 = traditional planting without N fertilizer application; TP-N200 = traditional planting with 200 kg/ha nitrogen fertilizer application.