**Supplementary table 1.** Physico-chemical properties of the soils in different treatments

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Treatment | TOC (g kg-1) | | TN (g kg-1) | AN (mg kg-1) | TP (g kg-1) | AP (mg kg-1) | TK ( g kg-1) | AK (mg kg-1) | pH |
| CTS | 13.88±0.06a | 0.95±0.06a | | 76.14±1.55a | 0.68±0.01d | 17.65±1.14a | 21.54±0.34a | 147.05±8.14a | 7.89±0.18a |
| NTS | 14.61±0.42a | 0.97±0.01a | | 75.59±1.34a | 0.89±0.01b | 14.99±0.40a | 21.99±0.71a | 160.35±16.95a | 8.11±0.03a |
| CT | 12.81±0.63a | 0.85±0.08ab | | 60.80±2.32b | 0.79±0.01c | 15.36±1.84a | 21.65±0.75a | 77.22±0.00b | 8.01±0.12a |
| NT | 13.11±0.87a | 0.81±0.01b | | 65.18±2.05c | 0.93±0.01a | 13.93±1.29a | 21.75±0.42a | 77.22±0.00b | 8.07±0.04a |

**Note:** Total organic carbon, TOC; Total nitrogen, TN; Alkaline nitrogen, AN; Total phosphorus, TP; Available phosphorus, AP; Total potassium, TK; Available potassium, AK; Values in the same column followed by different letters differ significantly (P < 0.05).

**Supplementary table 2.** Topological properties of the fungal sub-community networks

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Tillage (CT and CTS) | | | No-tillage (NT and NTS) | | |
|  | Abundant | Intermediate | Rare | Abundant | Intermediate | Rare |
| Number of nodesa | 39 | 250 | 372 | 38 | 222 | 376 |
| Number of edgesb | 144 | 4523 | 5334 | 75 | 1751 | 5136 |
| Positive edgesc | 88 | 2431 | 4866 | 34 | 944 | 4879 |
| Negative edgesd | 56 | 2092 | 468 | 41 | 807 | 437 |
| Modularitye | 1.135 | 3.49 | 0.867 | -12.2 | 4.14 | 0.684 |
| Number of communityf | 11 | 12 | 14 | 13 | 10 | 14 |
| Network diameterg | 7 | 6 | 9 | 6 | 5 | 6 |
| Average path lengthh | 2.525 | 2.497 | 2.8 | 2.685 | 2.859 | 2.795 |
| Average degreei | 7.385 | 36.184 | 28.677 | 3.974 | 15.775 | 28.227 |
| Average clustering coefficientj | 0.659 | 0.617 | 0.861 | 0.503 | 0.518 | 0.82 |
| Densityk | 0.194 | 0.145 | 0.077 | 0.107 | 0.071 | 0.075 |
|  | No straw mulching (CT and NT) | | | Straw mulching (CTS and NTS) | | |
|  | Abundant | Intermediate | Rare | Abundant | Intermediate | Rare |
| Number of nodesa | 39 | 241 | 340 | 38 | 224 | 372 |
| Number of edgesb | 130 | 2794 | 4101 | 80 | 1814 | 4203 |
| Positive edgesc | 76 | 1529 | 3810 | 35 | 950 | 3783 |
| Negative edgesd | 54 | 1265 | 291 | 45 | 864 | 420 |
| Modularitye | 1.91 | 3.149 | 0.843 | -10.063 | 7.748 | 0.868 |
| Number of communityf | 11 | 9 | 14 | 16 | 9 | 14 |
| Network diameterg | 6 | 7 | 8 | 5 | 6 | 6 |
| Average path lengthh | 2.349 | 2.726 | 2.847 | 2.243 | 2.912 | 3.026 |
| Average degreei | 6.667 | 23.187 | 24.124 | 4.211 | 16.196 | 22.597 |
| Average clustering coefficientj | 0.582 | 0.592 | 0.855 | 0.749 | 0.541 | 0.795 |
| Densityk | 0.175 | 0.097 | 0.071 | 0.114 | 0.073 | 0.061 |

**Note**: CT, soil sampled from convention tillage field. CTS, soil sampled from tillage and straw mulching field. NT, soil sampled from the site of no-tillage field. NTS, soil sampled from the site of no-tillage and straw mulching field. Fungal OTUs with significant (p < 0.05) and strong (r >0.6) correlation. Correlation analysis was performed by R language (R 2021, version 4.1.1). The parameters of network were calculated by Gephi 0.9.2.

a,bNumber of connection obtained by Gephi.

cPositive correlation between two fungal OTUs.

dNegative correlation between two fungal OTUs.

eStructure with high-density connection between nodes.

fA community is defined as a group of nodes that are densely connected internally.

gThe longest distance between nodes in the network.

hAverage network distance between all pairs of nodes or the average length of all edges.

iThe average number of connections of every node in the network .

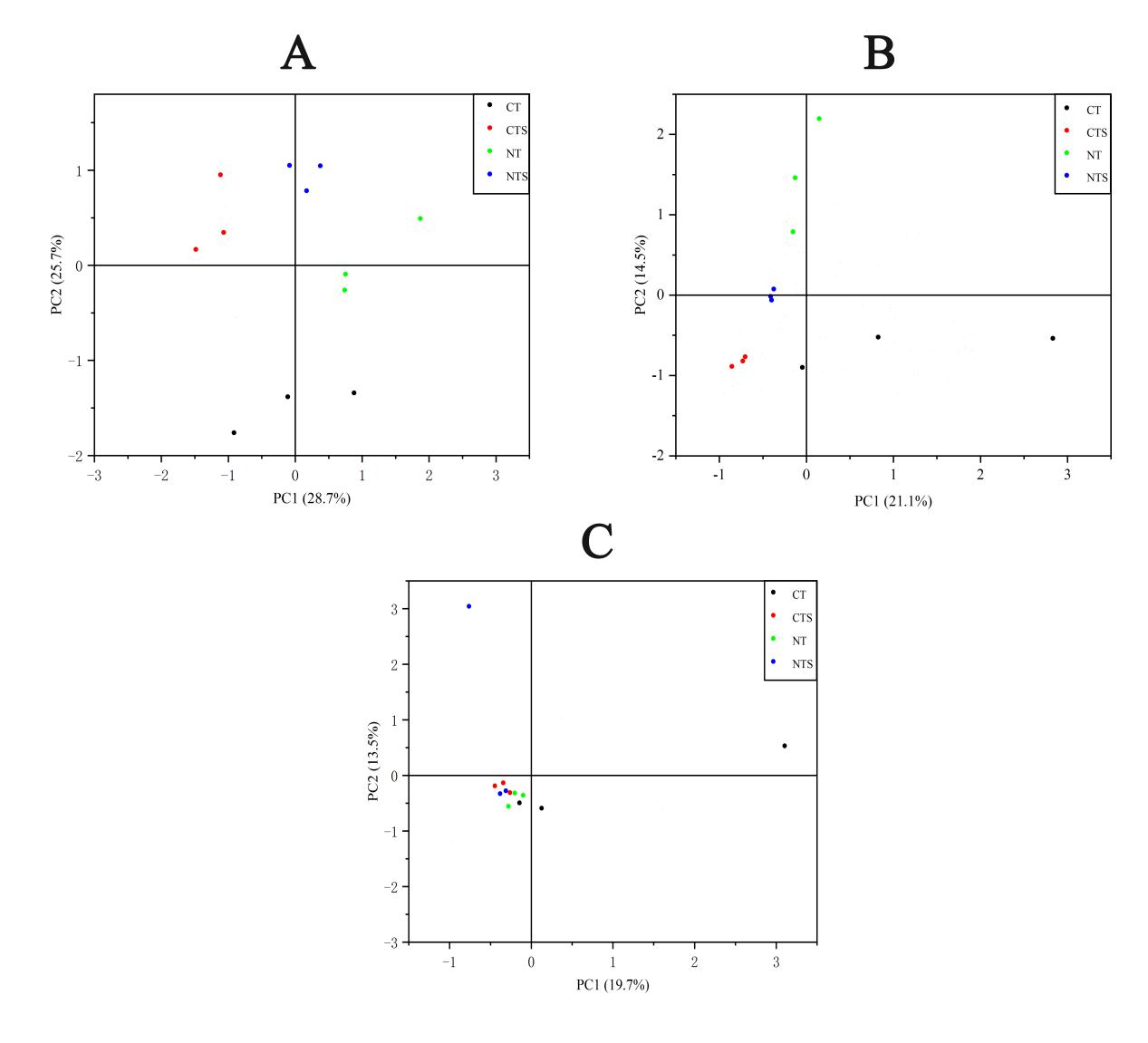
jThe average clustering coefficient is defined as the mean value of individual coefficients.

kThe density used to measure how close the network is to complete. A complete graph has all possible edges and density equal to 1.

**Supplementary table 4.** α-diversity of fungal sub-communities

|  |  |  |  |
| --- | --- | --- | --- |
| Fungal  Sub-communities | Treatment | Shannon | Chao1 |
| Abundant | CTS | 3.94±0.33a | 36.67±0.58a |
| NTS | 4.38±0.10a | 36.67±0.58a |
| CT | 4.21±0.62a | 37.00±1.00a |
| NT | 4.17±0.09a | 36.33±0.58a |
| Intermediate | CTS | 4.06±0.10a | 196.92±13.25a |
| NTS | 4.21±0.16a | 213.89±34.20a |
| CT | 3.89±0.39a | 137.00±7.55b |
| NT | 3.95±0.05a | 173.57±4.74a |
| Rare | CTS | 6.05±0.43a | 218.55±84.27a |
| NTS | 6.32±0.66a | 217.30±16.29a |
| CT | 6.20±0.53a | 145.86±19.23a |
| NT | 5.93±0.20a | 182.88±12.44a |

**Note**: Values in the same column followed by different letters differ significantly (P < 0.05)



**Figure. S1**. Principal component analysis of the abundant (A), intermediate (B) and rare (C) sub-communities in four treatments.