**Microbial community shifts with soil properties and enzyme activities in inter-/mono-cropping systems in response to tillage**

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**Table S1 Taxonomic alpha diversity based on absolute abundance homogenization matrix at phylum levels in the different treatments.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Factors | Treatment | Archaea |  | Bacteria |  | Eukaryota |
| Shannon | Pielou eveness |  | Shannon | Pielou eveness |  | Shannon | Pielou eveness |
| Tillage (T) | CT | 0.287±0.005 | 0.107±0.001 |  | 1.926±0.005b | 0.397±0.001b |  | 1.21±0.035 | 0.677±0.021 |
|  | NT | 0.282±0.006 | 0.104±0.002 |  | 1.943±0.007a | 0.401±0.001a |  | 1.199±0.044 | 0.669±0.025 |
| Pattern (P) | M | 0.285±0.004b† | 0.106±0.002b |  | 1.929±0.005 | 0.398±0.001 |  | 1.18±0.048bc | 0.651±0.023bc |
|  | P | 0.269±0.008c | 0.1±0.003b |  | 1.94±0.008 | 0.401±0.002 |  | 1.119±0.027c | 0.625±0.015c |
|  | IM | 0.299±0.006a | 0.112±0.002a |  | 1.935±0.004 | 0.399±0.001 |  | 1.234±0.049ab | 0.699±0.034ab |
|  | IP | 0.285±0.004b | 0.106±0.001b |  | 1.934±0.007 | 0.399±0.001 |  | 1.285±0.034a | 0.717±0.019a |
| T:P | CTM | 0.284±0.005 | 0.105±0.002 |  | 1.927±0.006bc | 0.397±0.001cd |  | 1.21±0.045 | 0.661±0.017 |
|  | CTP | 0.269±0.006 | 0.101±0.001 |  | 1.924±0.006bc | 0.398±0.001cd |  | 1.125±0.018 | 0.628±0.01 |
|  | CTIM | 0.305±0.005 | 0.115±0.002 |  | 1.915±0.005c | 0.395±0.001d |  | 1.215±0.05 | 0.699±0.04 |
|  | CTIP | 0.292±0.005 | 0.109±0.002 |  | 1.938±0.004ab | 0.4±0.001abc |  | 1.289±0.028 | 0.719±0.016 |
|  | NTM | 0.286±0.004 | 0.106±0.002 |  | 1.932±0.004bc | 0.398±0.001cd |  | 1.15±0.051 | 0.642±0.029 |
|  | NTP | 0.269±0.01 | 0.1±0.004 |  | 1.955±0.01ab | 0.404±0.002abc |  | 1.113±0.036 | 0.621±0.02 |
|  | NTIM | 0.293±0.006 | 0.108±0.002 |  | 1.954±0.004ab | 0.403±0.001abc |  | 1.254±0.049 | 0.7±0.027 |
|  | NTIP | 0.277±0.003 | 0.102±0.001 |  | 1.931±0.01bc | 0.399±0.002bcd |  | 1.28±0.04 | 0.715±0.022 |
| PremANOVA: Pr(＞F) | Tillage | 0.218 | 0.113 |  | **0.004\*\*** | **0.005\*\*** |  | 0.756 | 0.711 |
| Pattern | **0.002\*\*** | **0.002\*\*** |  | 0.597 | 0.366 |  | **0.013\*** | **0.011\*** |
| T×P | 0.513 | 0.299 |  | **0.013\*** | **0.025\*** |  | 0.774 | 0.986 |

†Different letters in the same column indicated the significant difference between different treatments. CTM, CTP, CTIM, CTIP were the maize monoculture, pea monoculture, maize in intercropping (Maize/Pea), and pea in intercropping (Maize/Pea) in conventional tillage system and NTM, NTP, NTIM, NTIP were the maize monoculture, pea monoculture, maize in intercropping (Maize/Pea), and pea in intercropping (Maize/Pea) in no-tillage system, respectively.\**P*<0.05, \*\**P*<0.01, and \*\**P*<0.001.

**Table S2 The abundance of archaea communities at the phylum level.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Phylum | p\_Thaumarchaeota | p\_Euryarchaeota | p\_Crenarchaeota | p\_Candidatus Bathyarchaeota | p\_Candidatus Woesearchaeota | others |
| Tillage (T) |  |  |  |  |  |  |
| CT | 94.19±0.1b | 2.66±0.09 | 2.37±0.03a | 0.41±0.01 | 0.1±0 | 0.28±0.01 |
| NT | 94.56±0.06a † | 2.58±0.05 | 2.1±0.03b | 0.4±0.01 | 0.09±0 | 0.26±0 |
| Pattern (P) |  |  |  |  |  |  |
| M | 94.03±0.11b | 2.95±0.07a | 2.19±0.04 | 0.45±0.01a | 0.1±0a | 0.28±0.01 |
| P | 94.58±0.15a | 2.48±0.12b | 2.2±0.05 | 0.39±0.02bc | 0.08±0.01b | 0.27±0 |
| IM | 94.35±0.1a | 2.61±0.08b | 2.28±0.06 | 0.42±0.01b | 0.09±0ab | 0.26±0 |
| IP | 94.55±0.12a | 2.44±0.1b | 2.27±0.05 | 0.38±0.01c | 0.09±0.01ab | 0.26±0.01 |
| T:P |  |  |  |  |  |  |
| CTM | 93.86±0.14 | 2.89±0.1 | 2.42±0.04a | 0.44±0.02 | 0.1±0 | 0.28±0.01 |
| CTP | 94.4±0.27 | 2.58±0.2 | 2.25±0.08bc | 0.41±0.03 | 0.09±0.01 | 0.28±0.01 |
| CTIM | 94.15±0.09 | 2.67±0.13 | 2.4±0.07ab | 0.41±0.02 | 0.1±0.01 | 0.28±0 |
| CTIP | 94.34±0.17 | 2.5±0.13 | 2.4±0.02a | 0.4±0.02 | 0.1±0.01 | 0.27±0.01 |
| NTM | 94.19±0.09 | 3.01±0.02 | 1.96±0.07d | 0.46±0 | 0.1±0 | 0.29±0 |
| NTP | 94.76±0.11 | 2.38±0.1 | 2.16±0.02c | 0.37±0.01 | 0.07±0 | 0.26±0 |
| NTIM | 94.55±0.13 | 2.55±0.08 | 2.15±0.04c | 0.42±0.01 | 0.09±0 | 0.25±0 |
| NTIP | 94.76±0.12 | 2.39±0.12 | 2.13±0.09c | 0.37±0.02 | 0.09±0.01 | 0.26±0 |
| Tillage (T) | **0.004 \*\*** | 0.319 | **≤0.001\*\*\*** | 0.297 | 0.079 | 0.176 |
| Pattern (P) | **0.011\*** | **≤0.001\*\*\*** | 0.237 | **≤0.001 \*\*\*** | **0.016 \*** | 0.208 |
| T:P | 0.993 | 0.543 | **0.012 \*** | 0.186 | 0.652 | 0.556 |

†Different letters in the same column indicated the significant difference between different treatments. CTM, CTP, CTIM, CTIP were the maize monoculture, pea monoculture, maize in intercropping (Maize/Pea), and pea in intercropping (Maize/Pea) in conventional tillage system and NTM, NTP, NTIM, NTIP were the maize monoculture, pea monoculture, maize in intercropping (Maize/Pea), and pea in intercropping (Maize/Pea) in no-tillage system, respectively.\**P*<0.05, \*\**P*<0.01, and \*\*\**P*<0.001.

**Table S3** **The abundance of Eukaryote communities at the phylum level.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Phylum | p\_Ascomycota | p\_Basidiomycota | p\_Blastocladiomycota | p\_Chytridiomycota | p\_Microsporidia | p\_Mucoromycota | p\_Zoopagomycota |
| Tillage (T) |  |  |  |  |  |  |  |
| CT | 55.8±1.24 | 20.6±0.56 | 1.39±0.15 | 13.77±0.65a† | 0.08±0 | 7.07±1.13 | 1.29±0.16 |
| NT | 55.39±0.62 | 22.63±0.44 | 1.32±0.05 | 10.8±0.37b | 0±0.02 | 8.58±0.76 | 1.28±0.07 |
| Pattern (P) |  |  |  |  |  |  |  |
| M | 53.21±0.9 | 20.21±0.71 | 1.4±0.15 | 13.01±1.04 | 0±0.01 | 11.06±0.71a | 1.1±0.2 |
| P | 56.24±1.99 | 23.88±0.48 | 1.44±0.17 | 12.75±0.77 | 0.16±0.02 | 4.58±1.72b | 0.95±0.1 |
| IM | 53.29±1.41 | 21.17±1.04 | 1.47±0.22 | 12.09±0.95 | 0±0.04 | 10.26±1.56a | 1.72±0.15 |
| IP | 59.64±0.99 | 21.2±0.55 | 1.12±0.09 | 11.29±0.39 | 0±0.01 | 5.39±1.17b | 1.36±0.11 |
| T:P |  |  |  |  |  |  |  |
| CTM | 55.59±1.49 | 18.72±1.17 | 1.5±0.25 | 15.68±1.71 | 0±0 | 7.29±1.13bc | 1.23±0.31 |
| CTP | 53.97±3.74 | 24.39±0.69 | 1.66±0.32 | 14.04±1.09 | 0.33±0 | 4.3±3.06c | 1.31±0.11 |
| CTIM | 54.57±2.41 | 19.14±1.37 | 1.54±0.38 | 13.56±0.55 | 0±0 | 9.86±2.47b | 1.33±0.14 |
| CTIP | 59.05±0.82 | 20.15±0.69 | 0.87±0.12 | 11.81±0.28 | 0±0.01 | 6.83±0.67bc | 1.28±0.16 |
| NTM | 50.82±0.1 | 21.71±0.51 | 1.31±0.02 | 10.34±0.74 | 0±0.02 | 14.84±0.38a | 0.98±0 |
| NTP | 58.51±1.32 | 23.36±0.68 | 1.22±0.07 | 11.46±0.33 | 0±0.04 | 4.85±1.43c | 0.59±0.15 |
| NTIM | 52±0.41 | 23.2±1.42 | 1.4±0.04 | 10.62±0.41 | 0±0.08 | 10.66±0.75b | 2.12±0.02 |
| NTIP | 60.23±1.66 | 22.26±0.8 | 1.36±0.12 | 10.77±0.58 | 0±0 | 3.95±1.88c | 1.43±0.15 |
| Tillage (T) | 0.830  | 0.070  | 0.830  | **0.017 \*** | 0.156  | 0.120  | 0.981  |
| Pattern (P) | 0.073  | 0.119  | 0.861  | 0.722  | 0.122  | **≤0.001\*\*\*** | 0.119  |
| T:P | 0.326  | 0.389  | 0.774  | 0.623  | 0.122  | **≤0.001\*\*\*** | 0.151  |

†Different letters in the same column indicated the significant difference between different treatments. CTM, CTP, CTIM, CTIP were the maize monoculture, pea monoculture, maize in intercropping (Maize/Pea), and pea in intercropping (Maize/Pea) in conventional tillage system and NTM, NTP, NTIM, NTIP were the maize monoculture, pea monoculture, maize in intercropping (Maize/Pea), and pea in intercropping (Maize/Pea) in no-tillage system, respectively.\**P*<0.05, \*\**P*<0.01, and \*\*\**P*<0.001.

**Table S4** **The abundance of bacterial communities at the phylum level.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Phylum | p\_Proteobacteria | p\_Acidobacteria | p\_Actinobacteria | p\_Gemmatimonadetes | p\_Candidatus Rokubacteria | p\_Chloroflexi | p\_Bacteroidetes | p\_Nitrospirae | p\_Planctomycetes | p\_Cyanobacteria | p\_Verrucomicrobia | p\_Firmicutes |
| Tillage (T) |  |  |  |  |  |  |  |  |  |  |  |  |
| CT | 42.68±0.28a† | 19.72±0.46 | 18.52±0.8 | 3.81±0.08a | 3.3±0.06b | 3.32±0.05b | 1.76±0.1 | 1.95±0.04b | 1.16±0.01b | 1±0.08b | 0.47±0.01 | 0.59±0.01a |
| NT | 41.33±0.23b | 19.53±0.26 | 19.54±0.43 | 3.57±0.03b | 3.47±0.03a | 3.49±0.03a | 1.84±0.05 | 2.08±0.03a | 1.22±0.01a | 1.2±0.04a | 0.46±0.01 | 0.52±0.01b |
| Pattern (P) |  |  |  |  |  |  |  |  |  |  |  |  |
| M | 42.94±0.24a | 21.16±0.28a | 16.51±0.51b | 3.63±0.07 | 3.55±0.08a | 3.33±0.05b | 2±0.08a | 1.87±0.03c | 1.19±0.01ab | 1.02±0.03b | 0.5±0.01a | 0.53±0.01 |
| P | 41.09±0.21c | 18.39±0.54c | 21.07±0.91a | 3.83±0.1 | 3.35±0.07ab | 3.55±0.03a | 1.45±0.12b | 2.03±0.06b | 1.22±0.01a | 1.3±0.03a | 0.44±0.01b | 0.57±0.01 |
| IM | 42.13±0.48ab | 19.6±0.63b | 18.99±0.99a | 3.63±0.08 | 3.35±0.06ab | 3.38±0.07ab | 1.88±0.13a | 2.01±0.05b | 1.18±0.01ab | 1.07±0.14ab | 0.47±0.01b | 0.56±0.01 |
| IP | 41.86±0.49bc | 19.36±0.56bc | 19.54±1.07a | 3.67±0.08 | 3.27±0.08b | 3.36±0.07b | 1.86±0.09a | 2.14±0.04a | 1.17±0.02b | 1.02±0.12b | 0.46±0.01b | 0.56±0.01 |
| T:P |  |  |  |  |  |  |  |  |  |  |  |  |
| CTM | 43.21±0.24a | 20.63±0.47 | 16.81±0.78 | 3.83±0.09 | 3.39±0.13bcd | 3.41±0.07b | 1.87±0.13 | 1.88±0.01cd | 1.17±0.01 | 1±0.02b | 0.49±0.01 | 0.55±0 |
| CTP | 42.07±0.27bc | 19.01±0.87 | 20.09±1.5 | 3.86±0.19 | 3.24±0.13cd | 3.39±0.05b | 1.49±0.19 | 1.9±0.1cd | 1.2±0.01 | 1.01±0.02b | 0.46±0.02 | 0.6±0.02 |
| CTIM | 43.37±0.72a | 19.61±1.06 | 18.33±1.6 | 3.72±0.12 | 3.18±0.08d | 3.16±0.12d | 1.78±0.21 | 1.94±0.08c | 1.15±0.02 | 0.99±0.23b | 0.47±0.02 | 0.59±0.01 |
| CTIP | 42.09±0.62bc | 19.64±0.8 | 18.83±1.83 | 3.85±0.15 | 3.37±0.12bcd | 3.33±0.06bc | 1.88±0.11 | 2.07±0.05b | 1.13±0.03 | 1.01±0.19b | 0.46±0.02 | 0.6±0.02 |
| NTM | 42.68±0.34ab | 21.69±0.05 | 16.21±0.26 | 3.43±0.06 | 3.7±0.04a | 3.26±0.04cd | 2.14±0.02 | 1.86±0.03d | 1.21±0.01 | 1.04±0.05b | 0.5±0 | 0.51±0.02 |
| NTP | 40.12±0.33e | 17.76±0.5 | 22.06±0.82 | 3.81±0.04 | 3.47±0.05bc | 3.7±0.04a | 1.41±0.11 | 2.17±0.05a | 1.23±0.01 | 1.59±0.06a | 0.42±0.01 | 0.54±0.01 |
| NTIM | 40.9±0.29d | 19.59±0.4 | 19.65±0.82 | 3.53±0.01 | 3.52±0.04ab | 3.6±0a | 1.99±0.1 | 2.08±0.01b | 1.22±0.01 | 1.15±0b | 0.46±0.01 | 0.53±0.01 |
| NTIP | 41.64±0.61c | 19.08±0.7 | 20.25±1.05 | 3.49±0.08 | 3.18±0.09d | 3.4±0.1b | 1.84±0.13 | 2.21±0.06a | 1.2±0.02 | 1.04±0.13b | 0.45±0.02 | 0.51±0.02 |
| Tillage (T) | **≤0.001\*\*\*** | 0.644 | 0.215 | **0.02 \*** | **0.006 \*\*** | **≤0.001\*\*\*** | 0.340 | **≤0.001\*\*\*** | **≤0.001\*\*\*** | **0.005 \*\*** | 0.249 | **0.002 \*\*** |
| Pattern (P) | **≤0.001\*\*\*** | **≤0.001\*\*\*** | **0.005 \*\*** | 0.404 | **0.014 \*** | **≤0.001\*\*\*** | **≤0.001\*\*\*** | **≤0.001\*\*\*** | **0.022 \*** | **0.016 \*** | **0.006 \*\*** | 0.454 |
| T:P | **≤0.001\*\*\*** | 0.270 | 0.695 | 0.569 | **0.010 \*\*** | **≤0.001\*\*\*** | 0.426 | **≤0.001\*\*\*** | 0.310 | **0.021 \*** | 0.296 | 0.838 |

†Different letters in the same column indicated the significant difference between different treatments. CTM, CTP, CTIM, CTIP were the maize monoculture, pea monoculture, maize in intercropping (Maize/Pea), and pea in intercropping (Maize/Pea) in conventional tillage system and NTM, NTP, NTIM, NTIP were the maize monoculture, pea monoculture, maize in intercropping (Maize/Pea), and pea in intercropping (Maize/Pea) in no-tillage system, respectively.\**P*<0.05, \*\**P*<0.01, and \*\*\**P*<0.001.