Supplementary Table 1. PERMANOVA results of the effects of soil N availability and competition regime on the total biomass and root:shoot ratio of *Acacia melanoxylon*, *Podocarpus elatus*, *Pennisetum clandestinum* and *Cynodon dactylon*.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Total biomass** | | **Root:shoot ratio** | |
|  | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
| ***1) Acacia*** | | | | |
| Soil N availability | 0.429 | 0.515 | 1.709 | 0.199 |
| Competition regime | 0.264 | 0.770 | 0.525 | 0.619 |
| Soil N availability x Competition regime | 0.120 | 0.722 | 0.920 | 0.344 |
| ***2) Podocarpus*** | | | | |
| Soil N availability | 0.185 | 0.676 | 3.732 | 0.061 |
| Competition regime | 0.508 | 0.612 | 2.961 | 0.061 |
| Soil N availability x Competition regime | 0.289 | 0.594 | 0.009 | 0.913 |
| ***3) Pennisetum*** | | | | |
| Soil N availability | 57.563 | <0.001 | 0.195 | 0.662 |
| Competition regime | 8.013 | 0.001 | 7.835 | **0.001** |
| Soil N availability x Competition regime | 3.509 | **0.033** | 0.330 | 0.716 |
| ***4) Cynodon*\*** | | | | |
| Competition regime | 3.488 | **0.047** | 0.548 | 0.608 |

Significant values are indicated in bold.

\* at low soil N availability

Supplementary Table 2. Pairwise PERMANOVA comparisons of the effects of soil N availability and competition regime on the total biomass and root:shoot ratio of *Pennisetum clandestinum* and *Cynodon dactylon*, based on significant results from previous main tests.

|  |  |  |  |
| --- | --- | --- | --- |
|  | *Pairwise comparison* | *t* | *P(perm)* |
| ***1) Pennisetum*** | | | |
| **Total biomass** |  |  |  |
| *Competition regime* |  |  |  |
| Control | High N *vs* Low N | 7.771 | **<0.001** |
| Competition with *Acacia* | High N *vs* Low N | 3.036 | **0.006** |
| Competition with *Podocarpus* | High N *vs* Low N | 3.609 | **0.002** |
| *Soil N availability* |  |  |  |
| Low N | Control *vs* Competition with *Acacia* | 1.260 | 0.219 |
|  | Control *vs* Competition with *Podocarpus* | 1.375 | 0.197 |
|  | Competition with *Acacia* *vs* *Podocarpus* | 0.129 | 0.917 |
| High N | Control *vs* Competition with *Acacia* | 2.217 | **0.039** |
|  | Control *vs* Competition with *Podocarpus* | 5.067 | **<0.001** |
|  | Competition with *Acacia* *vs* *Podocarpus* | 1.122 | 0.281 |
| **Root:shoot ratio** |  |  |  |
|  | Control *vs* Competition with *Acacia* | 1.911 | 0.065 |
|  | Control *vs* Competition with *Podocarpus* | 4.849 | **<0.001** |
|  | Competition with *Acacia* *vs* *Podocarpus* | 1.748 | 0.088 |
| ***2) Cynodon*\*** | | | |
| **Total biomass** |  |  |  |
|  | Control *vs* Competition with *Acacia* | 2.957 | **0.014** |
|  | Control *vs* Competition with *Podocarpus* | 1.803 | 0.089 |
|  | Competition with *Acacia* *vs* *Podocarpus* | 0.593 | 0.573 |

Significant values are indicated in bold.

\* at low soil N availability

Supplementary Table 3. PERMANOVA results of the effects of soil N availability and competition regime on the ammonium (NH4+), nitrate (NO3-), glutamine-N (Gln-N) and arginine-N (Arg-N) net uptake capacity of fine roots of *Acacia melanoxylon*, *Podocarpus elatus*, *Pennisetum clandestinum* and *Cynodon dactylon.*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **NH4+** | | **NO3-** | | **Gln-N** | | **Arg-N** | |
|  | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
| 1. ***Acacia*** | | | | | | | | |
| Soil N availability | 37.985 | <0.001 | 6.185 | **0.017** | 5.570 | **0.026** | 62.242 | <0.001 |
| Competition regime | 3.749 | 0.037 | 0.508 | 0.616 | 0.405 | 0.675 | 3.058 | 0.066 |
| Soil N availability x Competition regime | 8.475 | **0.007** | 3.597 | 0.072 | 0.035 | 0.852 | 4.753 | **0.039** |
| 1. ***Podocarpus*** | | | | | | | | |
| Soil N availability | 15.837 | **<0.001** | 24.976 | **<0.001** | 4.055 | 0.053 | 56.456 | **<0.001** |
| Competition regime | 0.143 | 0.883 | 0.266 | 0.772 | 1.910 | 0.172 | 0.012 | 0.989 |
| Soil N availability x Competition regime | 0.217 | 0.654 | 0.135 | 0.725 | 4.706 | **0.036** | 0.042 | 0.842 |
| 1. ***Pennisetum*** | | | | | | | | |
| Soil N availability | 59.970 | **<0.001** | 1.386 | 0.252 | 53.854 | **<0.001** | 56.747 | **<0.001** |
| Competition regime | 0.200 | 0.830 | 0.933 | 0.405 | 2.248 | 0.131 | 2.709 | 0.066 |
| Soil N availability x Competition regime | 0.414 | 0.690 | 0.369 | 0.706 | 1.344 | 0.268 | 2.621 | 0.075 |
| 1. ***Cynodon\**** | | | | | | | | |
| Competition regime | 0.453 | 0.749 | 3.797 | **0.025** | 0.006 | 0.993 | 1.469 | 0.269 |

Significant values are indicated in bold.

\* at low soil N availability

Supplementary Table 4. Pairwise PERMANOVA comparisons of the effects of soil N availability and competition regime on the ammonium (NH4+), nitrate (NO3-), glutamine-N (Gln-N) and arginine-N (Arg-N) net uptake capacity of fine roots of *Acacia melanoxylon*, *Podocarpus elatus* and *Cynodon dactylon*, based on significant results from previous main tests.

|  |  |  |  |
| --- | --- | --- | --- |
|  | *Pairwise comparison* | *t* | *P(perm)* |
| 1. ***Acacia*** | | | |
| **NH4+** |  |  |  |
| *Competition regime* |  |  |  |
| Control | High *vs* low N | 2.160 | **0.005** |
| Competition with *Pennisetum* | High *vs* low N | 5.704 | **0.002** |
| *Soil N availability* |  |  |  |
| Low N | Control *vs* Competition with *Pennisetum* | 1.467 | 0.167 |
|  | Control *vs* Competition with *Cynodon* | 1.385 | 0.187 |
|  | Competition with *Pennisetum vs* *Cynodon* | 0.141 | 0.898 |
| High N | Control *vs* Competition with *Pennisetum* | 2.583 | **0.028** |
| **Arg-N** |  |  |  |
| *Competition regime* |  |  |  |
| Control | High N *vs* low N | 3.998 | **0.002** |
| Competition with *Pennisetum* | High N *vs* low N | 6.358 | **0.002** |
| *Soil N availability* |  |  |  |
| Low N | Control *vs* Competition with *Pennisetum* | 1.056 | 0.317 |
|  | Control *vs* Competition with *Cynodon* | 0.098 | 0.951 |
|  | Competition with *Pennisetum vs* *Cynodon* | 0.794 | 0.418 |
| High N | Control *vs* Competition with *Pennisetum* | 2.199 | 0.060 |
| 1. ***Podocarpus*** | | | |
| **Gln-N** |  |  |  |
| *Competition regime* |  |  |  |
| Control | High N *vs* low N | 0.121 | 0.909 |
| Competition with *Pennisetum* | High N *vs* low N | 2.589 | **0.011** |
| *Soil N availability* |  |  |  |
| Low N | Control *vs* Competition with *Pennisetum* | 0.551 | 0.575 |
|  | Control *vs* Competition with *Cynodon* | 1.020 | 0.339 |
|  | Competition with *Pennisetum vs* *Cynodon* | 1.415 | 0.188 |
| High N | Control *vs* Competition with *Pennisetum* | 2.223 | **0.039** |
| 1. ***Cynodon*\*** | | | |
| **NO3-** |  |  |  |
|  | Control *vs* Competition with *Acacia* | 1.142 | 0.270 |
|  | Control *vs* Competition with *Podocarpus* | 2.106 | **0.036** |
|  | Competition with *Acacia vs* *Podocarpus* | 1.820 | 0.082 |

Significant values are indicated in bold.

\* at low soil N availability

Supplementary Table 5. PERMANOVA results of the differences between ammonium (NH4+), nitrate (NO3-), glutamine-N (Gln-N) and arginine-N (Arg-N) net uptake capacity of fine roots of *Acacia melanoxylon* and *Podocarpus elatus*.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | ***Acacia*** | | ***Podocarpus*** | |
| 1. ***Low soil N availability*** | | | | | |
| Control | *Main test* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
|  | N form | 4.855 | **0.004** | 18.023 | **<0.001** |
|  | *Pairwise comparisons* | *t* | *P(perm)* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 2.057 | **0.033** | 1.883 | 0.093 |
|  | NH4+ *vs* Gln-N | 2.358 | **0.017** | 4.912 | **0.005** |
|  | NH4+ *vs* Arg-N | 2.920 | **0.018** | 0.238 | 0.841 |
|  | NO3- *vs* Gln-N | 0.762 | 0.548 | 4.135 | **0.005** |
|  | NO3- *vs* Arg-N | 2.818 | **0.004** | 2.449 | **0.042** |
|  | Gln-N *vs* Arg-N | 4.240 | **0.002** | 5.353 | **0.001** |
| Competition with *Pennisetum* | *Main test* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
|  | N form | 4.003 | **0.008** | 12.086 | **<0.001** |
|  | *Pairwise comparisons* | *t* | *P(perm)* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 3.260 | **0.006** | 3.518 | **0.006** |
|  | NH4+ *vs* Gln-N | 2.088 | **0.015** | 4.231 | **0.003** |
|  | NH4+ *vs* Arg-N | 0.468 | 0.643 | 0.989 | 0.334 |
|  | NO3- *vs* Gln-N | 0.898 | 0.501 | 2.313 | 0.056 |
|  | NO3- *vs* Arg-N | 4.065 | **0.002** | 2.856 | **0.012** |
|  | Gln-N *vs* Arg-N | 2.253 | **0.003** | 3.921 | **0.002** |
| Competition with *Cynodon* | *Main test* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
|  | N form | 4.041 | **0.023** | 27.643 | **<0.001** |
|  | *Pairwise comparisons* | *t* | *P(perm)* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 1.445 | 0.154 | 3.359 | **0.002** |
|  | NH4+ *vs* Gln-N | 2.523 | **0.014** | 6.269 | **0.002** |
|  | NH4+ *vs* Arg-N | 1.307 | 0.232 | 2.473 | **0.035** |
|  | NO3- *vs* Gln-N | 0.956 | 0.371 | 4.532 | **0.007** |
|  | NO3- *vs* Arg-N | 2.057 | 0.053 | 2.017 | 0.070 |
|  | Gln-N *vs* Arg-N | 2.941 | **0.025** | 5.697 | **0.001** |
| 1. ***High soil N availability*** | | | | | |
| Control | *Main test* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
|  | N form | 1.985 | 0.105 | 6.781 | **<0.001** |
|  | *Pairwise comparisons* | *t* | *P(perm)* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | Not applicable | | 2.820 | **<0.001** |
|  | NH4+ *vs* Gln-N | 2.709 | **0.002** |
|  | NH4+ *vs* Arg-N | 2.333 | **0.018** |
|  | NO3- *vs* Gln-N | 0.689 | 0.508 |
|  | NO3- *vs* Arg-N | 2.012 | 0.083 |
|  | Gln-N *vs* Arg-N | 0.945 | 0.353 |
| Competition with *Pennisetum* | *Main test* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
|  | N form | 16.238 | **<0.001** | 3.297 | 0.035 |
|  | *Pairwise comparisons* | *t* | *P(perm)* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 3.732 | **0.005** | 2.599 | **0.012** |
|  | NH4+ *vs* Gln-N | 4.941 | **0.002** | 1.065 | 0.278 |
|  | NH4+ *vs* Arg-N | 4.148 | **0.002** | 1.552 | 0.226 |
|  | NO3- *vs* Gln-N | 1.228 | 0.291 | 2.539 | **0.010** |
|  | NO3- *vs* Arg-N | 0.342 | 0.734 | 1.244 | 0.249 |
|  | Gln-N *vs* Arg-N | 2.713 | **0.019** | 1.113 | 0.325 |

Supplementary Table 6. PERMANOVA results of the differences between ammonium (NH4+), nitrate (NO3-), glutamine-N (Gln-N) and arginine-N (Arg-N) net uptake capacity of fine roots of *Pennisetum clandestinum* and *Cynodon dactylon.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | ***Pennisetum*** | | ***Cynodon\**** | |
| 1. ***Low soil N availability*** | | | | | |
| Control | *Main test* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
|  | N form | 5.924 | **0.006** | 2.415 | **0.044** |
|  | *Pairwise comparisons* | *t* | *P(perm)* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 2.163 | **0.046** | 1.815 | **0.021** |
|  | NH4+ *vs* Gln-N | 0.690 | 0.751 | 2.700 | **0.025** |
|  | NH4+ *vs* Arg-N | 1.186 | 0.242 | 0.914 | 0.388 |
|  | NO3- *vs* Gln-N | 2.637 | **0.040** | 0.836 | 0.536 |
|  | NO3- *vs* Arg-N | 3.168 | **0.013** | 1.624 | 0.074 |
|  | Gln-N *vs* Arg-N | 1.467 | 0.198 | 2.061 | 0.070 |
| Competition with *Acacia* | *Main test* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
|  | N form | 3.252 | **<0.001** | 5.953 | **0.008** |
|  | *Pairwise comparisons* | *t* | *P(perm)* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 1.767 | **0.019** | 3.236 | **0.016** |
|  | NH4+ *vs* Gln-N | 0.445 | 0.673 | 1.055 | 0.329 |
|  | NH4+ *vs* Arg-N | 1.798 | 0.097 | 0.472 | 0.755 |
|  | NO3- *vs* Gln-N | 1.735 | **0.025** | 2.270 | 0.076 |
|  | NO3- *vs* Arg-N | 1.904 | **0.004** | 2.231 | 0.059 |
|  | Gln-N *vs* Arg-N | 3.138 | **0.010** | 0.893 | 0.456 |
| Competition with *Podocarpus* | *Main test* | *Pseudo-F* | *P(perm)* | *Pseudo-F* | *P(perm)* |
|  | N form | 7.070 | **<0.001** | 5.975 | **<0.001** |
|  | *Pairwise comparisons* | *t* | *P(perm)* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 2.641 | **0.006** | 2.471 | **0.003** |
|  | NH4+ *vs* Gln-N | 1.242 | 0.238 | 2.086 | 0.064 |
|  | NH4+ *vs* Arg-N | 3.151 | **0.009** | 0.241 | 0.800 |
|  | NO3- *vs* Gln-N | 2.589 | 0.100 | 2.347 | **0.006** |
|  | NO3- *vs* Arg-N | 2.743 | **0.002** | 2.482 | **0.002** |
|  | Gln-N *vs* Arg-N | 4.643 | **0.003** | 2.403 | **0.035** |
| 1. ***High soil N availability*** | | | |
| Control | *Main test* | *Pseudo-F* | *P(perm)* |
|  | N form | 10.764 | **0.001** |
|  | *Pairwise comparisons* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 2.614 | **0.040** |
|  | NH4+ *vs* Gln-N | 6.444 | **0.005** |
|  | NH4+ *vs* Arg-N | 5.311 | **0.005** |
|  | NO3- *vs* Gln-N | 1.652 | 0.163 |
|  | NO3- *vs* Arg-N | 0.884 | 0.435 |
|  | Gln-N *vs* Arg-N | 2.339 | **0.041** |
| Competition with *Acacia* | *Main test* | *Pseudo-F* | *P(perm)* |
|  | N form | 3.637 | **0.020** |
|  | *Pairwise comparisons* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 0.565 | 0.585 |
|  | NH4+ *vs* Gln-N | 4.744 | **0.002** |
|  | NH4+ *vs* Arg-N | 2.792 | **0.014** |
|  | NO3- *vs* Gln-N | 1.880 | **0.006** |
|  | NO3- *vs* Arg-N | 1.031 | 0.403 |
|  | Gln-N *vs* Arg-N | 2.456 | **0.014** |
| Competition with *Podocarpus* | *Main test* | *Pseudo-F* | *P(perm)* |
|  | N form | 3.380 | **0.034** |
|  | *Pairwise comparisons* | *t* | *P(perm)* |
|  | NH4+ *vs* NO3- | 0.958 | 0.372 |
|  | NH4+ *vs* Gln-N | 3.287 | **0.003** |
|  | NH4+ *vs* Arg-N | 2.552 | **0.007** |
|  | NO3- *vs* Gln-N | 1.596 | 0.185 |
|  | NO3- *vs* Arg-N | 1.080 | 0.426 |
|  | Gln-N *vs* Arg-N | 2.498 | **0.026** |

Significant values are indicated in bold.

\* at low soil N availability