Supplementary Material

**High phosphorus supply enhances leaf gas exchange and growth of young Arabica coffee plants under water deficit**

**Table S1**. Estimated means and nominal significance levels of ANOVA (*P*-values, n=3) for effects of phosphorus availability (PA), water regime (WR) and their interaction (PA\*WR) on soil variables. Soils received the recommended P fertilization (P) or high P supply (+P) and were well-watered (W) or subjected to water withholding (D). Small letters compare water regimes for a given phosphorus level and capital letters compare phosphorus levels for a given water regime.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variables | |  | Treatments | | | | *P-*values¶ | | |
| PD | | +PD | PW | +PW | PA | WR | PA\*WR | |
| OM (g dm-3) | 26.0 aA | | | 23.7 aB | 25.3 aA | 23.7 aB | **0.031** | 0.674 | 0.674 | |
| pH (CaCl) | 4.2 aA | | | 4.1 aA | 4.1 aA | 4.0 aA | 0.187 | 0.187 | 0.780 | |
| P (mg dm-3) | 97.3 aB | | | 177.7 aA | 112.7 aB | 183.3 aA | **<0.001** | 0.170 | 0.507 | |
| K (mmolc dm-3) | 3.1 aA | | | 3.1 aA | 2.8 aA | 3.1 aA | 0.431 | 0.431 | 0.431 | |
| Ca (mmolc dm-3) | 11.3 aA | | | 10.3 aA | 11.3 aA | 11.7 aA | 0.752 | 0.501 | 0.521 | |
| Mg (mmolc dm-3) | 8.0 aA | | | 6.3 aB | 9.0 aA | 5.7 aB | **0.041** | 0.875 | 0.441 | |
| B (mg dm-3) | 2.3 aA | | | 2.1 bA | 2.5 aA | 4.4 aA | 0.065 | **0.019** | **0.035** | |
| Cu (mg dm-3) | 2.6 aA | | | 3.0 aA | 3.1 aA | 3.4 aA | 0.436 | 0.313 | 0.835 | |
| Fe (mg dm-3) | 54.0 bB | | | 61.3 bA | 55.0 aB | 72.0 aA | **0.001** | **0.038** | 0.074 | |
| Mn (mg dm-3) | 5.7 aA | | | 5.7 aA | 5.2 aA | 4.4 aA | 0.349 | 0.056 | 0.280 | |
| Zn (mg dm-3) | 7.6 aB | | | 10.1 aA | 7.2 aB | 10.2 aA | **0.012** | 0.883 | 0.763 | |
| Al (mmolc dm-3) | 45.3 aA | | | 45.3 aA | 45.3 aA | 48.0 aA | 0.408 | 0.408 | 0.408 | |
| SB (mmolc dm-3) | 23.1 aA | | | 19.8 aB | 26.0 aA | 18.7 aB | **0.034** | 0.674 | 0.364 | |
| CEC (at pH 7) | 66.6 aA | | | 68.6 aA | 67.6 aA | 66.3 aA | 0.902 | 0.812 | 0.536 | |
| V (%) | 34.3 aA | | | 34.7 aA | 37.7 aA | 29.3 aA | 0.081 | 0.632 | 0.063 | |

¶*P*-values lower than 0.05 are marked in bold.

**Table S2**. Estimated means and nominal significance levels of ANOVA (*P*-values) for effects of phosphorus availability (PA), water regime (WR) and their interaction (PA\*WR) on parameters estimated in young Arabica coffee plants related to the Figs. 1-6 and Fig. S1.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Figure | Parameters | Time  (days) | | | |  | *P*-values¶ |  |
| PA | WR | PA xWR |
| **Fig. 1** | leaf P | | 36 | | **<0.0001** | | 0.2960 | 0.2695 |
|  | stem P | | 36 | | **<0.0001** | | **<0.0001** | **<0.0001** |
|  | root P | | 36 | | **<0.0001** | | 0.1190 | **0.0446** |
| **Fig. 2** | *Ψ*w | | 1 | | 0.7599 | | 0.7599 | 0.7599 |
|  |  | | 16 | | **0.0085** | | **<0.0001** | **0.0017** |
|  |  | | 27 | | 0.3892 | | **<0.0001** | 0.2594 |
|  |  | | 32 | | 0.1682 | | **<0.0001** | 0.1519 |
|  |  | | 33 | | 0.1012 | | **0.0094** | 0.0628 |
|  |  | | 36 | | 0.4537 | | 0.4537 | 0.4537 |
|  | *g*s | | 1 | | **0.0005** | | 0.1177 | 0.1247 |
|  |  | | 16 | | **0.0007** | | **0.0005** | 0.1209 |
|  |  | | 27 | | **0.0009** | | **<0.0001** | 0.9345 |
|  |  | | 32 | | **0.0152** | | **<0.0001** | 0.2255 |
|  |  | | 33 | | **0.0087** | | **<0.0001** | 0.0705 |
|  |  | | 36 | | 0.7108 | | 0.1695 | 0.1746 |
|  | *A* | | 1 | | **0.0005** | | 0.5749 | 0.8001 |
|  |  | | 16 | | **0.0011** | | **<0.0001** | 0.6328 |
|  |  | | 27 | | **<0.0001** | | **<0.0001** | 0.0557 |
|  |  | | 32 | | **<0.0001** | | **<0.0001** | 0.7709 |
|  |  | | 33 | | **<0.0001** | | **<0.0001** | 0.4641 |
|  |  | | 36 | | **<0.0001** | | 0.9819 | 0.5159 |
|  | *E* | | 1 | | **0.0001** | | 0.1241 | 0.1870 |
|  |  | | 16 | | **0.0013** | | **0.0110** | 0.1862 |
|  |  | | 27 | | **<0.0001** | | **<0.0001** | **0.0253** |
|  |  | | 32 | | **0.0030** | | **<0.0001** | **0.0210** |
|  |  | | 33 | | **<0.0001** | | **<0.0001** | **0.0028** |
|  |  | | 36 | | **0.0001** | | 0.9540 | 0.6748 |
| **Fig. 3** | iWUE | | 32 | | **0.0012** | | 0.0506 | **0.0039** |
|  | iCE | | 32 | | **0.0002** | | **<0.0001** | 0.6405 |
|  | PSII | | 32 | | **<0.0001** | | **<0.0001** | 0.9518 |
|  | qp | | 32 | | **0.0297** | | **0.0018** | 0.4575 |
|  | NPQ | | 32 | | 0.0580 | | 0.7300 | 0.7900 |
| **Fig. 4** | Chl *a* | | 32 | | 0.1236 | | **0.0003** | 0.3108 |
|  |  | | 36 | | **<0.0001** | | 0.1790 | 0.1144 |
|  | Chl *b* | | 32 | | **0.0013** | | **0.0010** | 0.6553 |
|  |  | | 36 | | **0.0037** | | 0.8654 | 0.7492 |
|  | Chl *a + b* | | 32 | | **0.0025** | | **0.0001** | 0.4288 |
|  |  | | 36 | | **0.0003** | | 0.6688 | 0.3798 |
|  | X + C | | 32 | | **0.0282** | | 0.3264 | 0.0986 |
|  |  | | 36 | | 0.6010 | | 0.5073 | 0.5688 |
| **Fig. 5** | Starch | | 32 | | 0.2121 | | 0.1389 | 0.0518 |
|  |  | | 36 | | **0.0066** | | **0.0002** | 0.0274 |
|  | Sucrose | | 32 | | **<0.0001** | | **0.0004** | 0.0728 |
|  |  | | 36 | | 0.6307 | | 0.8130 | **0.0003** |
|  | Soluble sugars | | 32 | | **0.0010** | | **<0.0001** | 0.4526 |
|  |  | | 36 | | 0.8104 | | 0.0821 | **0.0007** |
|  | NSC | | 32 | | **0.0011** | | **0.0001** | 0.7379 |
|  |  | | 36 | | 0.4265 | | 0.9788 | **0.0030** |
| **Fig. 6** | Leaf DM | | 36 | | **<0.0001** | | **<0.0001** | **0.0002** |
|  | Stem DM | | 36 | | **<0.0001** | | **<0.0001** | **0.0022** |
|  | Root DM | | 36 | | **<0.0001** | | **<0.0001** | 1.0000 |
|  | Root: shoot ratio | | | 36 | **<0.0001** | | **0.0007** | 0.9891 |
|  | Leaves (units) | | 36 | | **<0.0001** | | **<0.0001** | **0.0487** |
|  | Leaf area | | 36 | | **<0.0001** | | **<0.0001** | **0.0002** |
|  | Branches (units) | | 36 | | **<0.0001** | | **0.0002** | 0.6755 |
|  | Trunk diameter | | 36 | | **<0.0001** | | **<0.0001** | 0.7072 |
| **Fig. S1** | RWC | |  | | **0.0053** | | **<0.0001** | **0.0079** |

¶*P*-values lower than 0.05 are marked in bold.

**Table S3**. Estimated means and nominal significance levels of ANOVA (*P*-values, n=2-4) for effects of phosphorus availability (PA), water regime (WR) and their interaction (PA\*WR) on stem, leaf, and root mineral composition of young Arabica coffee plants that received the recommended P fertilization (P) or high P supply (+P) and grown under well-watered (W) or water deficit (D) conditions. Small letters compare water regimes for a given phosphorus level and capital letters compare phosphorus levels for a given water regime.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Organ | Element | Treatments | | | | *P*-values¶ | | |
| PD | +PD | PW | +PW | PA | WR | PA\*WR |
| Stems | N (g kg-1) | 28.1 aA | 23.1 aA | 21.0 bA | 19.6 bA | 0.097 | **0.012** | 0.341 |
| K (g kg-1) | 13.8 aA | 12.5 aA | 14.1 aA | 13.2 aA | 0.719 | 0.434 | 0.719 |
| Ca (g kg-1) | 4.6 aA | 2.4 aB | 4.0 aA | 2.0 aB | **<0.001** | 0.088 | 0.605 |
| Mg (g kg-1) | 3.2 aA | 1.8 aB | 2.9 aA | 1.7 aB | **<0.001** | 0.208 | 0.566 |
| S (g kg-1) | 1.5 aA | 1.2 aB | 1.4 aA | 1.0 aB | **0.010** | 0.181 | 0.817 |
| B (mg kg-1) | 19.6 aA | 12.9 aB | 20.0 aA | 10.9 aB | **0.002** | 0.692 | 0.552 |
| Cu (mg kg-1) | 16.0 aA | 8.6 aB | 17.7 aA | 6.8 aB | **0.001** | 1.000 | 0.426 |
| Fe (dag kg-1) | 1.6 aA | 0.7 aB | 1.8 aA | 0.5 aB | **0.006** | 0.102 | 0.498 |
| Mn (mg kg-1) | 87.0 aA | 68.3 aB | 95.5 aA | 65.3 aB | **0.002** | 0.669 | 0.378 |
| Zn (mg kg-1) | 39.9 aA | 43.3 aA | 36.1 aA | 33.1 aA | 0.555 | 0.098 | 0.440 |
| Leaves | N (g kg-1) | 45.9 bA | 44.3 bB | 50.9 aA | 47.3 aB | **0.003** | **<0.001** | 0.169 |
| K (g kg-1) | 15.7 aA | 15.6 aA | 15.0 aA | 16.7 aA | 0.126 | 0.641 | 0.080 |
| Ca (g kg-1) | 12.7 aA | 8.9 aB | 9.7 bA | 9.5 aA | **0.002** | **0.042** | **0.005** |
| Mg (g kg-1) | 4.7 aA | 3.9 aB | 4.2 aA | 4.4 aA | 0.145 | 0.899 | **0.030** |
| S (g kg-1) | 2.0 aB | 2.2 bA | 1.9 aB | 2.5 aA | **0.001** | 0.365 | **0.015** |
| B (mg kg-1) | 37.2 bA | 36.1 bA | 44.8 aA | 46.2 aA | 0.945 | **0.001** | 0.569 |
| Cu (mg kg-1) | 3.8 bA | 3.3 bB | 5.3 aA | 3.9 aB | **0.009** | **0.003** | 0.147 |
| Fe (dag kg-1) | 3.4 aA | 5.2 aA | 2.4 aA | 2.7 aA | 0.561 | 0.407 | 0.820 |
| Mn (mg kg-1) | 311.5 aA | 274.3 bB | 302.8 aB | 333.8 aA | 0.838 | 0.116 | **0.042** |
| Zn (mg kg-1) | 10.0 aA | 15.2 aA | 10.8 aA | 12.9 aA | 0.117 | 0.739 | 0.505 |
| Roots | N (g kg-1) | 25.5 aB | 29.2 aA | 22.7 aB | 31.1 aA | **0.003** | 0.786 | 0.172 |
| K (g kg-1) | 26.2 aB | 30.2 aA | 12.0 bB | 27.0 aA | **0.001** | **0.001** | **0.013** |
| Ca (g kg-1) | 6.7 aA | 6.3 aA | 3.5 bB | 6.2 aA | **0.007** | **0.001** | **0.001** |
| Mg (g kg-1) | 8.3 aA | 7.9 aA | 4.6 bB | 7.1 aA | 0.713 | 0.399 | **0.047** |
| S (g kg-1) | 3.2 aB | 5.1 aA | 2.0 bB | 3.9 bA | **<0.001** | **0.001** | 1.000 |
| B (mg kg-1) | 58.2 aA | 73.8 aA | 50.7 aA | 64.8 aA | 0.206 | 0.446 | 0.937 |
| Cu (mg kg-1) | 25.6 aA | 39.2 aA | 40.8 aA | 38.2 aA | 0.215 | 0.115 | 0.076 |
| Fe (dag kg-1) | 87.4 aA | 110.6 aA | 104.1aA | 127.7 aA | 0.295 | 0.433 | 0.988 |
| Mn (mg kg-1) | 168.0 aB | 256.5 aA | 106.3 bB | 226.0 bA | **<0.001** | **0.014** | 0.352 |
| Zn (mg kg-1) | 72.7 aB | 144.0 aA | 74.5 aB | 179.6 aA | **<0.001** | 0.198 | 0.243 |

¶*P*-values lower than 0.05 are marked in bold.