**Supplementary Material**

**Phosphorus solubilization by lupines (L. angustifolius and L. albus) in four contrasting soils**

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| **Table S1**. ANOVA for soil PBray1 concentration at 103 days after planting. | | | |
| Treatment effect | DF | F Value | Pr > F† |
| Species | 2 | 23.40 | **<0.0001** |
| Soil type | 3 | 60.09 | **<0.0001** |
| Species x Soil type | 6 | 3.81 | **0.0048** |
| C1: Lupine vs. Oat in Site 1 | 1 |  | **0.0008** |
| C1: Lupine vs. Oat in Site 2 | 1 |  | **0.0002** |
| C1: Lupine vs. Oat in Site 3 |  |  | **0.0340** |
| C1: Lupine vs. Oat in Site 4 | 1 |  | **0.0009** |
| C2: L. albus vs L.angustifolius in Site 1 | 1 |  | **0.0039** |
| C2: L. albus vs L.angustifolius in Site 2 | 1 |  | **0.0290** |
| C2: L. albus vs L.angustifolius in Site 3 | 1 |  | **0.0301** |
| C2: L. albus vs L.angustifolius in Site 4 | 1 |  | 0.1849 |
| † Significant effects (p < 0.05) are in bold. | | | |

*Note:* For this model species and soil type were considered as fixed factors.

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| **Table S2.** ANOVA for soil pH at 87 days after planting. | | | |
| Treatment effect | DF | F Value | Pr > F† |
| Species | 2 | 28.25 | **<0.0001** |
| Soil type | 3 | 65.05 | **<0.0001** |
| Species x Soil type | 6 | 2.56 | **0.0365** |
| C1: Lupine vs. Oat in Site 1 | 1 |  | **0.0372** |
| C1: Lupine vs. Oat in Site 2 | 1 |  | **0.0005** |
| C1: Lupine vs. Oat in Site 3 |  |  | **<.0001** |
| C1: Lupine vs. Oat in Site 4 | 1 |  | **0.0001** |
| C2: L. albus vs L.angustifolius in Site 1 | 1 |  | 0.9322 |
| C2: L. albus vs L.angustifolius in Site 2 | 1 |  | 0.8250 |
| C2: L. albus vs L.angustifolius in Site 3 | 1 |  | **0.0017** |
| C2: L. albus vs L.angustifolius in Site 4 | 1 |  | 0.2385 |
| † Significant effects (p < 0.05) are in bold. | | | |

*Note:* For this model species and soil type were considered as fixed factors.

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| **Table S3.** Orthogonal contrasts for Biomass measurements. | | | | | | | |
| Constrast Label | Aboveg. biomass | Plant P conc. | Plant P content | Plant N conc. | Plant N content | N:P ratio | C:N ratio |
| C1: Oat vs lupine in Site 1 | **0.0058** | 0.2001 | **0.0201** | **<.0001** | **<.0001** | **<.0001** | **<.0001** |
| C1: Oat vs lupine in Site 2 | **<.0001** | **<.0001** | **<.0001** | **<.0001** | **0.0173** | **<.0001** | **<.0001** |
| C1: Oat vs lupine in Site 3 | 0.1525 | 0.6802 | 0.1277 | **<.0001** | **<.0001** | **<.0001** | **<.0001** |
| C1: Oat vs lupine in Site 4 | **0.0005** | **0.0399** | 0.3391 | **<.0001** | 0.9579 | **<.0001** | **<.0001** |
| C2:L.albus vs L. angustifolius in Site 1 | **0.0046** | 0.4438 | **0.0040** | 0.0853 | **<.0001** | 0.0977 | 0.6541 |
| C2:L.albus vs L. angustifolius in Site 2 | **0.0032** | 0.7289 | **0.0002** | **0.0002** | **<.0001** | 0.0624 | **0.0014** |
| C2:L.albus vs L. angustifolius in Site 3 | **0.0009** | **0.0008** | **0.0354** | 0.7395 | **<.0001** | **0.0026** | 0.7717 |
| C2:L.albus vs L. angustifolius in Site 4 | **0.0491** | 0.0876 | 0.0906 | 0.336 | **0.0394** | **<.0001** | 0.6324 |
| Significant effects (p<0.05) are in bold. | | | | | | | |

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| Species | BNF | | N fixed content | |
| % | | mg pot-1 | |
| Lupinus albus | 66.2 | ns | 237.4 | a |
| Lupinus angustifolius | 60.3 | ns | 105.3 | b |
| Site (Soil type) |  |  |  |  |
| Site 1 (Pachic Argiudoll) | 71.7 | b | 197.0 | a |
| Site 2 (Typic Dystrutepts) | 59.4 | c | 187.9 | a |
| Site 3 (Typic Argiudoll) | 82.5 | a | 244.7 | a |
| Site 4 (Typic Hapludults) | 39.3 | d | 55.9 | b |
| Significance of treatment effect |  | | | |
| Species | <0.1206 | | **<.0001** | |
| Soil type | **<0.0001** | | **0.0011** | |
| Species\*soil type | <0.0644 | | 0.8933 | |
| Significant effects (p < 0.05) are in bold. Different lowercase letters within a column indicate differences between species or sites, at p-level of 0.05. ns: means no significant difference. | | | | |

**Table S4.** Mean values of BNF proportion (% BNF) and N fixed content of lupines as affected by species and soil type.

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| **Table S5.** Pearson correlation coefficients (r) within each species across all four soils type. | | | | | | | |
| Variables | | L. albus | | L. angutifolius | | A. strigosa | |
| ΔpH- initial | Shoot dry weight | -0.61 | \* | -0.75 | \* | -0.71 | \*\* |
| ΔpH- initial | Plant N content | -0.72 | \*\* | -0.71 | \* | -0.42 |  |
| ΔpH- initial | Plant P content | -0.75 | \*\* | -0.71 | \* | -0.91 | \*\*\* |
| ΔpH- initial | NP ratio | 0.53 | \* | 0.59 |  | 0.70 | \*\* |
| pH\_87dap | Plant Mn concentration | 0,66 | \*\* | -0,76 | \* | -0.06 |  |
| PBray1-48dap | NP ratio | -0.47 |  | -0.67 | \* | -0.76 | \*\* |
| PBray-87dap | NP ratio | -0.60 | \* | -0.75 | \* | -0.77 | \*\* |
| PBray-87dap | Plant Fe concentration | -0.54 | \* | -0.08 |  | -0.72 | \*\* |
| PBray-87dap | Plant Mn concentration | -0.01 |  | 0.68 | \* | -0.56 | \* |
| Shoot dry weight | NP ratio | -0.54 | \* | -0.68 | \* | -0.09 |  |
| Plant N content | Plant P content | 0.94 | \*\*\* | 0.93 | \*\*\* | 0.65 | \*\* |
| Plant N content | NP ratio | -0.49 |  | -0.61 |  | 0.23 |  |
| Plant P content | NP ratio | -0.71 | \*\* | -0.79 | \*\* | -0.54 | \* |
| Significant at \*p <0.05; \*\*p <0.01; \*\*\*p <0.001. | | | | | | | |