**Table 1.** Experimental treatments and corresponding olivine application rates (t $ha^{-1}$).

| ID | Treatment | Olivine dose g $pot^{-1}$ | Olivine dose t $ha^{-1}$ |
|---|---|---|---|
| 1 | Ctrl | 0.0 | 0.0 |
| 2 | $KNO_3$ 1g | 0.0 | 0.0 |
| 3 | $K_2SO_4$ 1g | 0.0 | 0.0 |
| 4 | OLIV10 g | 10.0 | 5.7 |
| 5 | OLIV10 g + $KNO_3$ 1g | 10.0 | 5.7 |
| 6 | OLIV10 g + $K_2SO_4$ 1g | 10.0 | 5.7 |
| 7 | OLIV20 g | 20.0 | 11.3 |
| 8 | OLIV20 g + $KNO_3$ 1g | 20.0 | 11.3 |
| 9 | OLIV20 g + $K_2SO_4$ 1g | 20.0 | 11.3 |

OLIV: Olivine, $KNO_3$: potassium nitrate, $K_2SO_4$: potassium sulfate

**Table 2**. Summary of $CO_2$ sequestration, weathering efficiency, and Mg distribution across treatments

**(a) Weathering & $CO_2$ metrics**

| ID | [a]F Weather | $CO_2$ sequestration |
|---|---|---|
| | % | t ha$^{-1}$ |
| **1** | 0 | 0 |
| **2** | 0 | 0 |
| **3** | 0 | 0 |
| **4** | 8.83 | 0.60 |
| **5** | 15.51 | 1.05 |
| **6** | 11.00 | 0.75 |
| **7** | 6.75 | 0.92 |
| **8** | 14.53 | 1.97 |
| **9** | 5.10 | 0.69 |

[a]F Weather: Weathering efficiency (F Weather) was calculated using Eq. (3).

**(b) Soil, plant, and leachate Mg pools**

| ID | Soil Mg | Extractable Mg | Plant Mg | Leachate Mg |
|---|---|---|---|---|
| | g pot$^{-1}$ | g pot$^{-1}$ | g pot$^{-1}$ | g pot$^{-1}$ |
| 1 | 0.79 ± 0.17 | 0.05 ± 0.01 | 0.20 ± 0.04 | 0.002 ± 0.000 |
| 2 | 0.82 ± 0.17 | 0.06 ± 0.00 | 0.16 ± 0.00 | 0.045 ± 0.012 ** |
| 3 | 1.00 ± 0.34 | 0.08 ± 0.05 | 0.14 ± 0.07 | 0.036 ± 0.001 ** |
| 4 | 1.30 ± 0.48 | 0.15 ± 0.01 ** | 0.34 ± 0.01 | 0.004 ± 0.001 ** |
| 5 | 1.82 ± 0.65 | 0.15 ± 0.01 ** | 0.42 ± 0.03 | 0.066 ± 0.007 ** |
| 6 | 1.48 ± 0.24 | 0.16 ± 0.02 ** | 0.34 ± 0.23 | 0.035 ± 0.003 ** |
| 7 | 2.39 ± 0.35 * | 0.17 ± 0.02 ** | 0.43 ± 0.03 | 0.005 ± 0.001 ** |
| 8 | 1.95 ± 0.26 * | 0.17 ± 0.03 ** | 0.76 ± 0.10 ** | 0.064 ± 0.002 ** |
| 9 | 1.62 ± 0.51 * | 0.15 ± 0.01 ** | 0.28 ± 0.01 | 0.048 ± 0.012 ** |

Statistical significance was evaluated using one-way ANOVA followed by Tukey's HSD test. Asterisks denote treatments that differ significantly from the control (ID 1). Significance codes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

**Table 3.** Mass balance of Mg across compartments

| ID | soil | plant | extractable | leachate | unknown soil pool |
|---|---|---|---|---|---|
| | | | g pot$^{-1}$ | | |
| 1 | 0.79 | 0.20 | 0.05 | 0.002 | -0.298[a] |
| 4 | 1.30 (38.8%) | 0.34 (10.1%) | 0.15 (4.5%) | 0.004 (0.1%) | 1.557 (46.5%) |
| 5 | 1.82 (54%) | 0.42 (12.5%) | 0.15 (4.6%) | 0.066 (2.0%) | 0.895 (26.7%) |
| 6 | 1.48 (44%) | 0.34 (10.0%) | 0.16 (4.9%) | 0.035 (1.0%) | 1.336 (39.9%) |
| 7 | 2.39 (40%) | 0.43 (7.2%) | 0.17 (2.8%) | 0.005 (0.1%) | 2.964 (49.8%) |
| 8 | 1.95 (33%) | 0.76 (12.8%) | 0.17 (2.9%) | 0.064 (1.1%) | 3.006 (50.5%) |
| 9 | 1.62 (27.2%) | 0.28 (4.7%) | 0.15 (2.5%) | 0.048 (0.8%) | 3.855 (64.8%) |

Initial Mg input: 0.743 g pot$^{-1}$ (control, ID 1); 3.349 g pot$^{-1}$ (10 g olivine, IDs 4–6); 5.953 g pot$^{-1}$ (20 g olivine, IDs 7–9). Soil = Mg retained in soil solids; Plant = Mg taken up by plants; extractable = extractable Mg fraction; leachate = leached Mg; unknown soil pool = unaccounted Mg (not recovered in measurable pools, inferred by mass balance). [a] Negative values in the control arise from analytical uncertainty in the mass balance when no olivine-derived Mg is added.

**Table 4.** Plant shoot length and dry biomass for different treatments

| ID | Shoot Length | Relative shoot length | Dry Biomass | Relative biomass |
|---|---|---|---|---|
| | cm | % | g | % |
| 1 | 23.83 ± 1.04 | 0.00 | 1.09 ± 0.23 | 0.00 |
| 2 | 25.50 ± 2.18 | 6.99 | 0.98 ± 0.19 | -10.37 |
| 3 | 26.33 ± 2.08 | 10.49 | 1.12 ± 0.23 | 2.44 |
| 4 | 27.00 ± 2.00 | 13.29 | 1.28 ± 0.05 | 16.77 |
| 5 | 28.33 ± 0.58 | 18.88 | 1.73 ± 0.05 | 58.23 |
| 6 | 29.00 ± 6.00 | 21.68 | 1.68 ± 0.55 | 53.96 |
| 7 | 29.33 ± 4.16 | 23.08 | 1.51 ± 0.09 | 38.41 |
| 8 | 33.67 ± 1.15 * | 41.26 | 3.46 ± 0.42 ** | 216.77 |
| 9 | 27.00 ± 4.58 | 13.29 | 1.47 ± 0.28 | 34.76 |

Statistical significance was evaluated using one-way ANOVA followed by Tukey's HSD test. Asterisks denote treatments that differ significantly from the control (ID 1) (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Relative shoot length and relative biomass (%) were calculated according to Eq. (5).

**Table 5.** Elemental composition (g pot$^{-1}$) of harvested plant tissues under different olivine and fertilizer treatments.

| ID | Na | Ca | Fe |
|---|---|---|---|
| | g pot$^{-1}$ | g pot$^{-1}$ | g pot$^{-1}$ |
| 1 | 1.01 ± 0.13 | 0.52 ± 0.11 | 0.07 ± 0.02 |
| 2 | 0.21 ± 0.07** | 0.37 ± 0.03* | 0.08 ± 0.00 |
| 3 | 0.15 ± 0.04** | 0.32 ± 0.13 | 0.08 ± 0.03 |
| 4 | 0.98 ± 0.05 | 0.58 ± 0.03 | 0.10 ± 0.04 |
| 5 | 0.19 ± 0.01** | 0.48 ± 0.07 | 0.18 ± 0.08* |
| 6 | 0.16 ± 0.05** | 0.46 ± 0.18 | 0.36 ± 0.46 |
| 7 | 1.01 ± 0.04 | 0.71 ± 0.03** | 0.16 ± 0.05** |
| 8 | 0.33 ± 0.06** | 1.02 ± 0.00** | 0.83 ± 0.64 |
| 9 | 0.18 ± 0.03** | 0.44 ± 0.02 | 0.11 ± 0.02 |

Potassium (K) concentrations were measured, but several values exceeded the ICP-OES calibration range due to $KNO_3$ fertilization. These values were therefore considered analytically unreliable and are not reported in Table 5. Statistical significance was evaluated using one-way ANOVA followed by Tukey's HSD test. Asterisks denote treatments that differ significantly from the control (ID 1) (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

**Table 6.** Soil and Leachate pH under Different Treatments over 28 days

| ID | Soil | | Leachate | | | |
|---|---|---|---|---|---|---|
| | Day 0 | Day 28 | Day 7 | Day 14 | Day 21 | Day 28 |
| 1 | 4.10 | 4.40 ± 0.26 | 6.34 ± 0.61 | 7.20 ± 0.78 | 7.61 ± 0.47 | 7.39 ± 0.65 |
| 2 | 4.10 | 4.20 ± 0.10 | 4.45 ± 0.28 | 4.83 ± 0.15 | 5.16 ± 0.21 | 6.03 ± 0.64 |
| 3 | 4.10 | 4.23 ± 0.15 | 4.83 ± 0.72 | 4.90 ± 0.33 | 5.73 ± 0.83 | 5.88 ± 0.62 |
| 4 | 4.10 | 4.50 ± 0.10 | 6.58 ± 0.27 | 6.31 ± 0.47 | 7.22 ± 0.27 | 7.42 ± 0.29 |
| 5 | 4.10 | 4.47 ± 0.06 | 4.74 ± 0.31 | 4.62 ± 0.05 | 5.47 ± 0.71 | 6.70 ± 0.11 |
| 6 | 4.10 | 4.33 ± 0.12 | 5.84 ± 0.23 | 5.78 ± 0.41 | 6.51 ± 0.30 | 6.48 ± 0.29 |
| 7 | 4.10 | 4.57 ± 0.06 | 7.07 ± 0.14 | 6.76 ± 0.19 | 7.33 ± 0.09 | 6.98 ± 0.33 |
| 8 | 4.10 | 4.50 ± 0.10 | 5.40 ± 0.82 | 6.23 ± 0.38 | 7.15 ± 0.24 | 6.79 ± 0.14 |
| 9 | 4.10 | 4.60 ± 0.00 | 6.46 ± 0.45 | 6.54 ± 0.29 | 6.96 ± 0.02 | 6.13 ± 0.70 |

Values are presented as mean ± standard deviation (n = 3). All treatments shared the same initial soil pH (Day 0). Differences in soil pH among treatments at Day 28 were evaluated using one-way ANOVA followed by Tukey HSD multiple comparisons. Leachate pH (Days 7, 14, 21, and 28) was analyzed using a two-way repeated-measures ANOVA with treatment as the between-subject factor and day as the within-subject factor, followed by Tukey's HSD for post hoc comparisons when applicable. Statistical significance was set at $\alpha = 0.05$. Detailed statistical outputs are provided in Tables S3–S4.