

Table S1. Pseudototal concentration of trace elements (average \pm SD) in unamended soil and in soils amended with different doses of FYM, SSC or MSWC. Asterisks indicate significant differences from the content in the soil amended with the lowest dose of farmyard manure.

| | Cu | | | Co | | | Ni mg Kg ⁻¹ | | | Zn | | | Pb | | | Cd | | |
|-----------|------|-------|-------|-----|-------|-------|---------------------------|-------|-------|------|-------|-------|-----|-------|-------|------|-------|------|
| Unamended | 4.4 | \pm | 0.4 | 1.5 | \pm | 0.2 | 6.0 | \pm | 0.5 | 12.4 | \pm | 1.3 | 3.4 | \pm | 0.1 | 0.18 | \pm | 0.02 |
| FYM-20 | 5.1 | \pm | 1.7 | 1.6 | \pm | 0.1 | 7.4 | \pm | 0.2 | 25.0 | \pm | 0.3 | 2.5 | \pm | 0.4 | 0.31 | \pm | 0.05 |
| FYM-40 | 10.5 | \pm | 0.8 * | 1.9 | \pm | 0.2 | 9.1 | \pm | 1.2 | 35.9 | \pm | 3.6 * | 4.4 | \pm | 0.4 | 0.32 | \pm | 0.04 |
| FYM-60 | 11.2 | \pm | 1.3 * | 2.1 | \pm | 0.4 * | 11.1 | \pm | 2.2 * | 50.8 | \pm | 7.2 * | 6.6 | \pm | 0.2 * | 0.41 | \pm | 0.01 |
| SSC-20 | 5.4 | \pm | 0.5 | 1.8 | \pm | 0.0 | 9.2 | \pm | 0.9 | 22.4 | \pm | 2.4 | 2.8 | \pm | 0.5 | 0.29 | \pm | 0.03 |
| SSC-40 | 12.2 | \pm | 0.5 * | 2.0 | \pm | 0.4 | 11.6 | \pm | 2.5 * | 31.0 | \pm | 6.2 | 2.8 | \pm | 0.2 | 0.31 | \pm | 0.03 |
| SSC-60 | 15.7 | \pm | 1.3 * | 2.4 | \pm | 0.1 * | 13.3 | \pm | 0.8 * | 39.8 | \pm | 3.8 * | 4.8 | \pm | 0.9 * | 0.31 | \pm | 0.05 |
| MSWC-20 | 5.4 | \pm | 0.5 | 1.9 | \pm | 0.1 | 7.3 | \pm | 0.1 | 20.3 | \pm | 0.7 | 3.8 | \pm | 0.4 | 0.28 | \pm | 0.02 |
| MSWC-40 | 5.9 | \pm | 0.2 | 1.9 | \pm | 0.2 | 7.5 | \pm | 0.2 | 32.9 | \pm | 4.2 * | 4.2 | \pm | 0.2 | 0.30 | \pm | 0.05 |
| MSWC-60 | 10.6 | \pm | 2.0 * | 2.2 | \pm | 0.1 * | 8.0 | \pm | 0.6 | 43.6 | \pm | 1.2 * | 6.4 | \pm | 1.3 * | 0.35 | \pm | 0.03 |

Table S2. Effects of the application of the amendments on some macro-nutrient concentrations in grain and root of barley plants (mean, n = 3). Lower case letters indicate significant differences between treatments within the same harvest time. An asterisk indicates significant differences between harvest time within each treatment over time. *P < 0.05, **P < 0.01, ***P < 0.001.

| | | Grain | | | Root | | |
|---------------------------|----|-------------------------|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|
| | | K (g kg ⁻¹) | Ca (g kg ⁻¹) | Mg (g kg ⁻¹) | K (g kg ⁻¹) | Ca (g kg ⁻¹) | Mg (g kg ⁻¹) |
| 1 st harvest | | | | | | | |
| CNT | 0 | 1.8 ± 0.1 e | 0.3 ± 0.0 e** | 0.7 ± 0.0 f* | 1.8 ± 0.0 e** | 4.3 ± 0.0 f *** | 0.3 ± 0.0 h*** |
| FYM (t ha ⁻¹) | 20 | 3.1 ± 0.0 bc*** | 0.3 ± 0.0 de*** | 1.2 ± 0.0 cd | 1.9 ± 0.1 e*** | 4.5 ± 0.4 f* | 0.4 ± 0.0 gh*** |
| | 40 | 3.3 ± 0.0 b*** | 0.4 ± 0.0 cd*** | 1.2 ± 0.0 bcd** | 2.2 ± 0.2 cd*** | 5.4 ± 0.1 e | 0.5 ± 0.0 f*** |
| | 60 | 3.8 ± 0.2 a*** | 0.4 ± 0.0 b*** | 1.3 ± 0.0 a** | 2.5 ± 0.3 b*** | 8.5 ± 0.1 c*** | 0.7 ± 0.1 d*** |
| SSC (t ha ⁻¹) | 20 | 3.1 ± 0.2 bc*** | 0.4 ± 0.0 cd*** | 1.2 ± 0.0 bc*** | 2.0 ± 0.1 de*** | 7.1 ± 0.3 d*** | 0.8 ± 0.0 c** |
| | 40 | 3.2 ± 0.0 b*** | 0.4 ± 0.0 cd*** | 1.2 ± 0.0 b*** | 2.3 ± 0.2 bcd*** | 9.1 ± 0.2 b*** | 0.8 ± 0.0 b** |
| | 60 | 3.3 ± 0.0 b*** | 0.4 ± 0.0 a*** | 1.3 ± 0.0 a*** | 2.9 ± 0.1 a*** | 12.5 ± 0.1 a*** | 1.2 ± 0.0 a |

| | | | | | | | |
|-------------------------------|----|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|
| MSWC (t ha ⁻¹) | 20 | 2.5 ± 0.2 d | 0.3 ± 0.0 de*** | 1.1 ± 0.0 e*** | 1.9 ± 0.2 e*** | 4.6 ± 0.3 f** | 0.4 ± 0.0 g*** |
| | 40 | 2.9 ± 0.3 c | 0.4 ± 0.0 cd*** | 1.1 ± 0.0 d*** | 2.2 ± 0.0 cd*** | 5.4 ± 0.0 e* | 0.6 ± 0.1 e*** |
| | 60 | 3.2 ± 0.0 b*** | 0.4 ± 0.0 c*** | 1.3 ± 0.0 a | 2.4 ± 0.2 bc*** | 12.4 ± 0.1 a*** | 1.2 ± 0.0 a** |
| 2nd harvest | | | | | | | |
| CNT | 0 | 1.6 ± 0.2 f | 0.4 ± 0.0 g** | 0.7 ± 0.0 f* | 2.6 ± 0.2 f** | 3.2 ± 0.0 f*** | 1.1 ± 0.1 abc*** |
| FYM (t ha ⁻¹) | 20 | 5.5 ± 0.1 ab*** | 1.4 ± 0.1 de*** | 1.5 ± 0.1 de | 6.9 ± 0.0 d*** | 3.2 ± 0.2 f* | 1.0 ± 0.0 d*** |
| | 40 | 5.6 ± 0.2 ab*** | 1.7 ± 0.0 c*** | 1.6 ± 0.1 cde** | 7.7 ± 0.2 c*** | 5.4 ± 0.0 d | 1.0 ± 0.0 cd*** |
| | 60 | 5.8 ± 0.1 a*** | 1.8 ± 0.1 b*** | 1.7 ± 0.1 b** | 8.6 ± 0.1 b*** | 6.5 ± 0.0 b*** | 1.2 ± 0.0 ab*** |
| SSC (t ha ⁻¹) | 20 | 5.4 ± 0.2 b*** | 1.4 ± 0.0 ef*** | 1.6 ± 0.0 cd*** | 6.5 ± 0.1 e*** | 4.5 ± 0.1 e*** | 1.0 ± 0.0 d** |
| | 40 | 5.5 ± 0.1 ab*** | 1.5 ± 0.1 de*** | 1.7 ± 0.1 bc*** | 7.7 ± 0.1 c*** | 6.2 ± 0.2 c*** | 1.1 ± 0.1 abc** |
| | 60 | 5.7 ± 0.3 ab*** | 1.5 ± 0.0 d*** | 1.9 ± 0.1 a*** | 8.6 ± 0.2 b*** | 7.3 ± 0.2 a*** | 1.3 ± 0.1 a |
| MSWC (t ha ⁻¹) | 20 | 2.6 ± 0.3 e | 1.3 ± 0.1 f*** | 0.8 ± 0.0 f*** | 7.8 ± 0.1 c*** | 3.2 ± 0.2 f** | 1.0 ± 0.1 d*** |
| | 40 | 3.0 ± 0.2 d | 1.3 ± 0.1 ef*** | 0.8 ± 0.1 f*** | 7.8 ± 0.0 c*** | 5.6 ± 0.1 d* | 1.0 ± 0.1 bcd*** |
| | 60 | 4.7 ± 0.2 c*** | 2.1 ± 0.1 a*** | 1.4 ± 0.1 e | 8.9 ± 0.1 a*** | 6.5 ± 0.1 b*** | 1.2 ± 0.0 ab** |

Table S3. Effects of the application of the amendments on some micro-nutrient concentrations in barley grains and roots (mean, n = 3). Lower case letters indicate significant differences between treatments within the same harvest time. Asterisks indicate significant differences between harvest time within each treatment over time. *P < 0.05, **P < 0.01, ***P < 0.001

| | | Grain | | | | Root | | | |
|-------------------------------|----|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| | | Fe (mg kg ⁻¹) | Mn (mg kg ⁻¹) | Zn (mg kg ⁻¹) | Cu (mg kg ⁻¹) | Fe (mg kg ⁻¹) | Mn (mg kg ⁻¹) | Zn (mg kg ⁻¹) | Cu (mg kg ⁻¹) |
| 1st harvest | | | | | | | | | |
| CNT | 0 | 30.6 ± 0.3 e | 7.9 ± 0.2 c | 24.2 ± 0.2 c | 2.2 ± 0.2 e | 111.0 ± 0.7 g* | 6.7 ± 0.1 e* | 8.1 ± 0.0 f*** | 3.4 ± 0.1 f |
| FYM (t ha ⁻¹) | 20 | 37.5 ± 0.1 d** | 8.5 ± 0.3 bc | 25.3 ± 0.2 bc* | 3.5 ± 0.2 d*** | 137.9 ± 8.9 f** | 6.7 ± 0.5 e** | 12.4 ± 0.4 de*** | 3.5 ± 0.2 f |
| | 40 | 38.7 ± 0.2 cd** | 8.9 ± 0.7 b | 25.7 ± 1.5 bc* | 5.1 ± 0.8 c** | 230.6 ± 23.3 e | 9.5 ± 0.6 cde* | 13.9 ± 0.7 d*** | 4.0 ± 0.2 e*** |
| | 60 | 47.7 ± 1.0 b | 9.2 ± 0.1 b | 27.0 ± 0.1 b*** | 6.3 ± 0.1 b*** | 255.9 ± 26.6 d** | 10.0 ± 0.8 cd* | 13.8 ± 0.6 d*** | 4.6 ± 0.3 d** |
| SSC (t ha ⁻¹) | 20 | 39.0 ± 2.7 cd | 9.3 ± 0.8 b | 24.6 ± 0.3 c | 4.8 ± 0.6 c | 159.2 ± 18.6 f | 10.3 ± 1.1 cd | 17.4 ± 0.7 bc*** | 5.1 ± 0.3 c |
| | 40 | 41.3 ± 2.7 c | 10.7 ± 1.0 a* | 26.0 ± 1.7 bc | 6.2 ± 0.7 b | 257.5 ± 10.5 d | 11.7 ± 1.4 c | 18.9 ± 1.7 ab*** | 6.3 ± 0.2 b*** |

| | | | | | | | | | |
|-------------------------------|----|------------------|----------------|------------------|-----------------|-------------------|----------------|------------------|-----------------|
| MSWC (t ha ⁻¹) | 60 | 51.9 ± 0.5 a** | 11.1 ± 0.3 a** | 29.7 ± 1.5 a* | 8.9 ± 0.0 a** | 421.3 ± 8.8 b*** | 15.1 ± 2.2 b | 19.7 ± 1.6 a*** | 8.5 ± 0.1 a*** |
| | 20 | 32.0 ± 2.1 e** | 8.7 ± 0.4 bc* | 24.3 ± 1.1 c*** | 4.7 ± 0.1 c*** | 227.6 ± 8.8 e** | 7.5 ± 0.9 de** | 11.7 ± 0.6 e*** | 4.2 ± 0.4 e |
| | 40 | 38.6 ± 1.6 cd* | 9.0 ± 0.5 b | 24.9 ± 1.5 bc*** | 5.2 ± 0.3 c | 313.9 ± 7.3 c | 10.1 ± 1.3 cd | 16.6 ± 0.1 c | 5.1 ± 0.4 cd |
| | 60 | 39.4 ± 2.8 cd*** | 9.4 ± 0.3 b | 26.1 ± 2.0 bc | 6.5 ± 0.1 b*** | 588.0 ± 1.8 a** | 28.7 ± 3.4 a** | 17.9 ± 1.0 bc*** | 8.4 ± 0.1 a*** |
| 2nd harvest | | | | | | | | | |
| CNT | 0 | 34.0 ± 2.2 f | 8.0 ± 1.7 b | 21.5 ± 2.0 c | 1.7 ± 0.4 g | 135.3 ± 10.7 e* | 8.9 ± 0.5 d* | 12.4 ± 0.6 f*** | 3.3 ± 0.1 f |
| FYM (t ha ⁻¹) | 20 | 34.2 ± 0.7 f** | 7.8 ± 0.2 b | 22.0 ± 2.0 c* | 1.8 ± 0.0 g*** | 190.4 ± 10.0 d** | 11.3 ± 0.9 c** | 23.8 ± 1.1 e*** | 3.5 ± 0.1 f |
| | 40 | 41.4 ± 0.6 e** | 8.1 ± 0.3 b | 22.5 ± 1.2 c* | 2.4 ± 0.5 f** | 255.2 ± 5.7 c | 11.4 ± 0.4 c* | 29.0 ± 1.7 c*** | 5.3 ± 0.1 d*** |
| SSC (t ha ⁻¹) | 60 | 50.3 ± 3.6 b | 9.1 ± 0.4 b | 25.3 ± 0.1 ab*** | 3.7 ± 0.2 e*** | 374.4 ± 17.5 b** | 13.4 ± 1.2 b* | 31.9 ± 1.5 b*** | 6.4 ± 0.3 c** |
| | 20 | 42.2 ± 1.4 de | 8.1 ± 0.6 b | 23.1 ± 1.9 bc | 4.5 ± 0.1 d | 193.3 ± 15.3 d | 11.3 ± 0.7 c | 28.1 ± 0.7 cd*** | 4.8 ± 0.2 de |
| | 40 | 45.5 ± 0.8 cd | 8.3 ± 0.2 b* | 26.2 ± 1.1 a | 5.5 ± 0.3 b | 256.1 ± 9.9 c | 11.6 ± 0.3 c | 33.1 ± 1.9 b*** | 9.4 ± 0.5 b*** |
| MSWC (t ha ⁻¹) | 60 | 47.5 ± 0.9 bc** | 8.6 ± 0.3 b** | 26.8 ± 0.3 a* | 7.5 ± 0.3 a** | 275.2 ± 19.4 c*** | 16.1 ± 1.9 a | 39.8 ± 1.6 a*** | 14.3 ± 0.9 a*** |
| | 20 | 44.0 ± 1.9 cde** | 7.8 ± 0.1 b* | 9.3 ± 0.6 d*** | 3.3 ± 0.2 e*** | 194.3 ± 3.6 d** | 13.7 ± 0.6 b** | 26.7 ± 0.7 d*** | 4.2 ± 0.1 e |
| | 40 | 45.9 ± 1.2 cd* | 8.3 ± 0.7 b | 10.8 ± 0.6 d*** | 4.7 ± 0.1 cd | 258.3 ± 36.4 c | 16.4 ± 1.4 a | 32.0 ± 0.9 b | 5.3 ± 0.1 d |
| | 60 | 62.6 ± 4.0 a*** | 10.4 ± 1.2 a | 23.3 ± 1.6 b | 5.2 ± 0.1 bc*** | 427.1 ± 47.5 a** | 17.3 ± 0.6 a** | 39.3 ± 0.3 a*** | 6.4 ± 0.1 c*** |