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***Supplementary Material***

**Title:** Short-termsoil physical responses to grazing and cover crops in an integrated crop-livestock agroecosystem

**List of authors:** Navdeep Singh, Sandeep Kumar, Virginia L. Jinand Sharon Schneider

**No. of Supplementary tables:** 3

**Supplementary Table S1** Soil organic carbon and total nitrogen stocks on equivalent soil mass basis (approximating 0-20 cm depth\*) as affected by different treatments of cover crops and grazing under integrated crop-livestock system at Northern-Brookings and Northwestern- Brookings sites for 2018 and 2019.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **SOC(Mg C ha-1)** | |  | **TN(Mg N ha-1)** | |
|  | 2018 | 2019 |  | 2018 | 2019 |
|  | **Northern-Brookings** | | | | |
| GdC† | 57.8†† | 57.3 |  | 4.92 | 4.29 |
| GdC+G | 57.1 | 51.9 |  | 4.11 | 3.65 |
| LdC | 54.8 | 55.8 |  | 3.98 | 3.90 |
| LdC+G | 60.6 | 55.0 |  | 4.79 | 4.09 |
| NC | 57.8 | 50.9 |  | 4.14 | 3.65 |
| Mean | 57.6 | 54.2 |  | 4.4 | 3.9 |
|  | **Northwestern-Brookings** | | | | |
| GdC | 54.7 | 56.2 |  | 3.75 | 3.82 |
| GdC+G | 58.5 | 59.2 |  | 4.17 | 4.03 |
| LdC | 56.2 | 56.0 |  | 3.97 | 4.00 |
| LdC+G | 54.4 | 60.5 |  | 3.79 | 4.12 |
| NC | 58.3 | 59.0 |  | 4.11 | 3.99 |
| Mean | 56.4 | 58.2 |  | 4.0 | 4.0 |

\*Equivalent soil mass approximating the top 20 cm for Northern-Brookings were 2620 and 2495 Mg ha-1 and for Northwestern-Brookings were 2818 and 2731 Mg ha-1 in 2018 and 2019, respectively.

†GdC, grass dominated cover crop blend; GdC+G, grazing of grass dominated cover crop blend; LdC, legume dominated cover crop blend; LdC+G, grazing of legume dominated cover crop blend; NC, no cover crop

††No letters are shown if there are no significant differences due to treatments within a column for each site at *p*<0.05.

**Supplementary Table S2** Soil organic carbon and total nitrogen stocks for 0-20 cm depth as affected by different treatments of cover crops and grazing under integrated crop-livestock system at Northern-Brookings and Northwestern Brookings sites for 2018 and 2019.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **SOC(Mg C ha-1)** | | |  | | **TN(Mg N ha-1)** | |
|  | | 2018 | 2019 | |  | 2018 | 2019 |
|  | | **Northern-Brookings** | | | | | |
| GZ† | | 58.8 | 53.5 | |  | 4.45 | 3.87 |
| UG | | 56.3 | 56.6 | |  | 4.45 | 4.10 |
| NC | | 57.8 | 50.9 | |  | 4.14 | 3.65 |
|  | | ANOVA *p*-values | | | | | |
| C | | ns | ns | |  | ns | ns |
| G | | ns | ns | |  | ns | ns |
| C × G | | ns | ns | |  | 0.01 | ns |
| UG vs. NC | | ns | ns | |  | ns | ns |
| GZ vs. UG | | ns | ns | |  | ns | ns |
| GZ vs. NC | | ns | ns | |  | ns | ns |
|  | | **Northwestern-Brookings** | | | | | |
| GZ | | 56.5 | 59.9 | |  | 3.98 | 4.08 |
| UG | | 55.4 | 56.1 | |  | 3.86 | 3.91 |
| NC | | 58.3 | 59.0 | |  | 4.11 | 3.99 |
|  | | ANOVA *p*-values | | | | | |
| C | | ns | ns | |  | ns | ns |
| G | | ns | ns | |  | ns | ns |
| C × G | | ns | ns | |  | ns | ns |
| UG vs. NC | | *0.09* | ns | |  | *0.10* | ns |
| GZ vs. UG | | ns | *0.10* | |  | ns | ns |
| GZ vs. NC | | ns | ns | |  | ns | ns |

† GZ, grazed cover crop (average of grazed legume and grazed grass cover crop); UG, ungrazed cover crop (average of ungrazed legume and ungrazed grass cover crop); NC, no cover crop; C, cover-cropping; G, grazing

**Supplementary Table S3** Soil pore size distribution at 0-10 cm depth for different treatments of cover crops and grazing under integrated crop-livestock system at Northern-Brookings and Northwestern-Brookings sites for 2018 and 2019.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **Macro**  **pores** | **Coarse mesopores** | **Fine mesopores** | **Micro**  **pores** | **Total pores** |  | **Macro**  **pores** | **Coarse mesopores** | **Fine mesopores** | **Micro**  **pores** | **Total pores** |
|  | >1000µm | 60-1000µm | 10-60µm | <10µm |  |  | >1000µm | 60-1000µm | 10-60µm | <10µm |  |
|  | **Northern-Brookings** | | | | | | | | | | |
|  | **Cover crop phase (2018)** | | | | |  | **Corn phase (2019)** | | | | |
|  | ------------------------------------------------------------------------m3m-3---------------------------------------------------------------------- | | | | | | | | | | |
| GZ\* | 0.002 | 0.052 | 0.043 | 0.449 | 0.546 |  | 0.004 | 0.082 | 0.052 | 0.282 | 0.420 |
| UG | 0.007 | 0.056 | 0.061 | 0.484 | 0.608 |  | 0.010 | 0.087 | 0.050 | 0.325 | 0.471 |
| NC | 0.003 | 0.052 | 0.045 | 0.437 | 0.536 |  | 0.001 | 0.063 | 0.050 | 0.284 | 0.398 |
|  | ANOVA p-values | | | | | | | | | | |
| C | ns† | ns | ns | ns | 0.01 |  | ns | 0.04 | 0.02 | ns | *0.08* |
| G | *0.06* | ns | ns | ns | <0.01 |  | ns | ns | ns | <0.01 | 0.02 |
| C × G | ns | ns | ns | *0.10* | ns |  | ns | ns | *0.06* | ns | ns |
| UG vs. NC | ns | ns | ns | ns | 0.03 |  | 0.03 | *0.09* | ns | 0.02 | 0.01 |
| GZ vs. UG | *0.06* | ns | ns | ns | <0.01 |  | ns | ns | ns | 0.01 | 0.02 |
| GZ vs. NC | ns | ns | ns | ns | ns |  | 0.03 | ns | ns | ns | ns |
|  | **Northwestern-Brookings** | | | | | | | | | | |
|  | **Corn phase (2018)** | | | | |  | **Cover crop phase (2019)** | | | | |
|  | ------------------------------------------------------------------------m3m-3---------------------------------------------------------------------- | | | | | | | | | | |
| GZ† | 0.009 | 0.037 | 0.034 | 0.435 | 0.515 |  | 0.006 | 0.036 | 0.034 | 0.432 | 0.508 |
| UG | 0.010 | 0.059 | 0.044 | 0.435 | 0.548 |  | 0.010 | 0.056 | 0.035 | 0.476 | 0.577 |
| NC | 0.011 | 0.043 | 0.030 | 0.443 | 0.528 |  | 0.014 | 0.038 | 0.040 | 0.416 | 0.507 |
|  | ANOVA p-values | | | | | | | | | | |
| C | ns | ns | ns | ns | ns |  | ns | ns | ns | 0.02 | ns |
| G | ns | <0.01 | ns | ns | *0.08* |  | ns | <0.01 | ns | 0.02 | <0.01 |
| C × G | ns | ns | ns | ns | ns |  | ns | ns | ns | ns | ns |
| UG vs. NC | ns | <0.01 | ns | ns | ns |  | ns | 0.04 | ns | *0.05* | 0.01 |
| GZ vs. UG | ns | <0.01 | ns | ns | ns |  | ns | <0.01 | ns | 0.02 | <0.01 |
| GZ vs. NC | ns | ns | ns | ns | ns |  | ns | ns | ns | ns | ns |

\*GZ, grazed cover crop (average of grazed legume and grazed grass cover crop); UG, ungrazed cover crop (average of ungrazed legume and ungrazed grass cover crop); NC, no cover crop; †Non-significant *p*-values are shown as “ns” and marginally significant *p*-values (0.05<p<0.10) are italicized.