# Soil Effects on Nutrient Leaching when Part of Engineered Plant Growth Media, Sally Logsdon, USDA-ARS-NLAE

## Engineered soil mix components

**Sand**
- low water holding capacity
- low cation exchange capacity
- low nutrient levels
- low nutrient sorption capacity

**Sorbents**
- industrial by-products
- cost commercial products
- harm to plants
- cement soil

**organic material**
- good water holding capacity
- high nutrient load
- may result in leaching

**Soil**
- high water holding capacity
- high cation exchange capacity
- lower nutrient than compost

The goal of this study was to determine if soils differed in their ability to reduce leaching of phosphorus or nitrate when part of engineered plant growth media.

## Materials and Methods

Soils
Storden: Fine-loamy, mixed, superactive, mesic Typic Eutrudept
Sac: Fine-silty, mixed, superactive, mesic Oxyaguic Hapludoll
Killduff: Fine-silty, mixed, superactive, mesic Dystric Eutudept
Harps: Fine-loamy, mixed, superactive, mesic Typic Calciaquoll

Table 1. Properties of soils used in the study. Nutrient levels mg/kg. M3 is Mehlich-3.

| Soil | Fe -dpta | $P_{M3}$ | $Al_{M3}$ | $Fe_{M3}$ | $Ca_{M3}$ | pH |
|---|---|---|---|---|---|---|
| Storden | 11 | 1.9 | 65.1 | 6.9 | 367 | 6.9 |
| Sac | 44 | 2.7 | 92.8 | 13.6 | 425 | 6.4 |
| Killduff | 71 | 13.6 | 64.5 | 29.6 | 368 | 6.9 |
| Harps | 32 | 4.6 | 9.1 | 15.1 | 1185 | 7.3 |

| Soil | OC | IC | $NO_3$ | $NH_4$ | Sand | Clay |
|---|---|---|---|---|---|---|
| | g/100g | | | | g/g | g/g |
| Storden | 1.28 | 0.25 | 11.9 | 2.6 | 0.51 | 0.20 |
| Sac | 1.95 | | 34.6 | 9.0 | 0.03 | 0.37 |
| Killduff | 2.38 | | 16.7 | 4.5 | 0.02 | 0.40 |
| Harps | 2.77 | 1.89 | 20.0 | 4.4 | 0.29 | 0.35 |

Table 2. Properties of soils mixes averaged across those with and without compost blankets.

| Soil mix | Fe-dpta | $P_{M3}$ | $100*P_{M3}/(Al_{M3}+Fe_{M3})$ | $100*P_{M3}/Ca_{M3}$ |
|---|---|---|---|---|
| | mg/kg | mg/kg | | |
| Storden | 22c | 1.2b | 4.9b | 0.33b |
| Sac | 26b | 1.1b | 4.4b | 0.34b |
| Killduff | 29a | 2.2a | 9.0a | 0.64a |
| Harps | 25bc | 1.3b | 7.4a | 0.31b |

| Soil mix | OC | TN | $NO_3$ | $NH_4$ |
|---|---|---|---|---|
| | g/100g | g/100g | mg/kg | mg/kg |
| Storden | 0.76a | 0.06a | 14a | 0.72c |
| Sac | 0.77a | 0.06a | 13a | 1.26a |
| Killduff | 0.81a | 0.06a | 12a | 0.81b |
| Harps | 0.84a | 0.07a | 11a | 0.81b |

Table 3. Properties of soils mixes with or without compost blankets averaged across soils.

| Compost blanket | Fe-dpta | $P_{M3}$ | $100*P_{M3}/(Al_{M3}+Fe_{M3})$ | $100*P_{M3}/Ca_{M3}$ |
|---|---|---|---|---|
| | mg/kg | mg/kg | | |
| No | 25b | 1.1b | 5.1b | 0.33b |
| Yes | 27a | 1.7a | 7.7a | 0.48a |

| Compost blanket | OC | TN | $NO_3$ | $NH_4$ |
|---|---|---|---|---|
| | g/100g | g/100g | mg/kg | mg/kg |
| No | 0.67b | 0.06b | 2.9b | 0.87a |
| Yes | 0.92a | 0.07a | 21.8a | 0.92a |

Soil mixes by volume:
- no compost: 20% soil 80% sand
- with compost: 15% soil, 80% sand, 5% compost blanket

Disk infiltrometers
- ponded and -3 cm head
- before and after growing plants
- time to initial drainage
- saved first container of effluent: "saturated"
- saved last container of effluent: "unsaturated"

Plants grown 2 months
- Buffalo grass: *Buchloe dactyloides* (Nutt.) Engelm.
- Blue grama grass: *Bouteloau gracilis* H.B.K.
- Red clover: *Trifolium pratense* L.
- above ground dry matter and root depth

## Results and Discussion

Table 4. Nitrate in saturated and unsaturated effluent of soil mixes across compost treatments, before planting and after harvest. Also calculated total nitrate load in preplant and post-harvest effluent, based on outflow volumes for saturated and unsaturated effluent.

| Soil mix | Pre $NO_3$sat | Pre $NO_3$unsat | Pre $NO_3$ load |
|---|---|---|---|
| | mg/L | mg/L | mg |
| Storden | 15b | 26a | 28a |
| Sac | 68a | 36a | 55a |
| Killduff | 46ab | 17a | 42a |
| Harps | 64ab | 41a | 65a |

| Soil mix | Post $NO_3$sat | Post $NO_3$ unsat | Post $NO_3$ load |
|---|---|---|---|
| | mg/L | mg/L | mg |
| Storden | 221ab | 70a | 253ab |
| Sac | 263a | 79a | 270a |
| Killduff | 159bc | 63a | 190ab |
| Harps | 114c | 75a | 128b |

Table 4. Total P in saturated and unsaturated effluent of soil mixes across compost treatments, before planting and after harvest. Also calculated total phosphorus load in preplant and post-harvest effluent, based on outflow volumes for saturated and unsaturated effluent.

| Soil mix | Pre plant TPsat | Pre plant TPunsat | Pre plant P load |
|---|---|---|---|
| | mg/L | mg/L | mg |
| Storden | 0.24a | 0.71a | 0.64a |
| Sac | 0.09a | 0.40b | 0.23b |
| Killduff | 0.10a | 0.09c | 0.13b |
| Harps | 0.10a | 0.10c | 0.12b |

| Soil mix | Post harvest TPsat | Post harvest TPunsat | Post harvest P load |
|---|---|---|---|
| | mg/L | mg/L | mg |
| Storden | 0.08b | 0.05b | 0.11b |
| Sac | 0.09b | 0.07b | 0.11b |
| Killduff | 0.41a | 0.37a | 0.58a |
| Harps | 0.07b | 0.07b | 0.09b |

Other significant results preplant:
- Pre-pant columns with compost blanket significantly slower unsaturated infiltration (12 vs. 47 cm/h)
- Columns with compost blanket significantly longer time to drain (95 vs. 52 min)

**Conclusions**
- High post harvest nitrate in effluent: mineralization + nitrogen-fixation
- High nutrient compost blanket not increase nitrate leaching pre-plant
- Compost blanket significantly lower nitrate leaching post-harvest (59 v 86 mg/L)
- All soils sorbed P, especially those high in Al or carbonates
- Soils not harmful as sorbents might be (Logsdon and Sauer, 2016)

Logsdon, S.D., and P. Sauer. 2016b. Iron filings cement engineered soil mix. Agron. J. 108:1753-1757