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Sludge Application Tested on Prairie Restoration (Iowa)

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Municipal governments must find safe ways to dispose of the sludge generated in their wastewater treatment facilities. Sludge disposal is strictly regulated in Iowa with specific requirements that prohibit placing it near waterways, on steep slopes, and on lands used for certain purposes such as growing vegetables for human consumption. Sludge is, however, applied to other agricultural lands and to strip-mine reclamation areas as a source of nutrients, especially nitrogen. With the current interest in restoring tallgrass prairie and the need to find new ways to use sludge, we decided to test the effects of Class II sludge on a tallgrass prairie restoration at the Black Hawk County Landfill near Waterloo, Iowa. Class II sludge contains higher levels of one or more heavy metals or pathogens than Class I sludge.

In the summer of 1994, workers capped a 6.8-ha (17-acre) portion of the landfill using topsoil enriched with approximately 4,000 gallons of Class II sludge and coarse compost. Later that summer, they seeded in a cover crop of Regreen(TM) (*Agropyron* x *Triticum*), timothy (*Phleum pratense*), bison tetraploid rye (*Lolium perenne*), and oats (*Avena sativa*). The Regreen, a sterile hybrid, germinated quickly and established a good cover through 1995. It has since faded out of the mix. Meanwhile, timothy has become dominant species to emerge from this planting.

In June 1995, we planted two different prairie mixes—one on a 0.2-ha (0.5-acre) research site located above the capped and cover-cropped portion, and the second on the remaining 6.6 hectares (16.5 acres). The mix for the smaller research plot contained big bluestem (*Andropogon gerardi*), little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), Indiangrass (*Sorghastrum nutans*), and 49 forbs—all from local seed sources. We planted the larger area with a mix that contained 24 forbs, the same grasses plus switchgrass (*Panicum virgatum*), and several non-native wildflower species. We planted all mixes with a Truax drill.

We divided the research area into four 0.05-ha (0.125-acre) plots and, in July 1996, applied different amounts of sludge to each plot. The low-treatment plot received 71 kg of nitrogen/ha (63 lbs/acre), the medium-treatment plot 142 kg of nitrogen/ha (125 lbs/acre), and the high-treatment plot 214 kg of nitrogen/ha (188 lbs/acre). The fourth plot served as a control. Workers mowed the entire site in late June.

We monitored permanent transects through these plots every month from June through September 1996. The analysis of our data revealed little change in vegetation following the sludge application. All observable species were present in all test plots regardless of the amount of sludge applied. However, the density and diversity of prairie species were higher in the control plot than in the other plots. We found little difference among the three treatment plots after the first year. Big bluestem and sideoats grama were more abundant than any of the other prairie grasses or forbs. Of the dozen or more native forb species we observed, a few were more abundant than others. They are prairie coreopsis (*Coreopsis palmata*), purple coneflower (*Echinacea purpurea*), pale purple coneflower (*E. pallida*), yellow coneflower (*Ratibida pinnata*), Illinois bundleflower (*Desmanthus illinoesis*), and black-eyed Susan (*Rudbeckia hirta*). This may indicate that these species are more adaptive and tolerant of higher nitrogen levels than other prairie species, or that they are more successful early in the restoration process.

We plan to apply sludge at the same rates one time in June or July 1997 and to monitor and analyze the results. We will keep readers of *R&MN* informed of our results, which we think may be some of the first experiments with prairie plants grown in sludge-amended soil.

Acknowledgments

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Sugar, Carbon Treatment Kills Plants in Soil Impoverishment Experiment (Oregon)

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Adding carbon to the soil, or "soil impoverishment" (Morgan, 1994), has been hailed as a way to suppress nitrogen-loving, weeds. The idea is to add large amounts of organic carbon, increase microbial activity and, thereby, decrease the available nitrogen in the soil. Various studies indicate that the low nitrogen condition starves out the weeds (Carson and Barrett, 1988; Tilman and Wedin, 1991). John Morgan (1994) reported that adding sugar and sawdust to plots sown with seeds of prairie species dramatically decreased weed abundance. Other prairie ecologists (Seastedt *et al.*, 1995; Wilson and Gerry, 1995) have reported mixed results with this method. Inspired by the possibility of a weed-free restoration, we began an experiment to learn whether carbon-rich soil amendments might suppress the weedy exotics in our local wetland prairies—communities inundated or saturated for much of the winter and spring. To our knowledge, this nitrogen-reducing technique has never been tried in wetland prairies.

We began our experiment in a degraded wetland prairie within the Fern Ridge Natural Area in Eugene, Oregon. We established six test blocks across the prairie, each with a carbon-amended plot and a no-carbon (control) plot. These blocks were rototilled, treated, and retilled on September 13, 1995. The carbon-amended plots received a 50/50 mixture of sugar and sawdust at a rate of 2.0 kg/m^2. In November 1995, we hand-seeded subplots within the treated plots with a mix of five native wetland prairie species: American sloughgrass (*Beckmannia syzigachne*), California oatgrass (*Danthonia californica*), tufted hairgrass (*Deschampsia caespitosa*), Oregon sunshine (*Eriophyllum lanatum*), and cut-leaved microseris (*Microseris laciniata*). To compare the responses of exotics, we also added six non-native species, including colonial bentgrass (*Agrostis tenuis*), sweet vernal grass (*Anthoxanthum odoratum*), velvet grass (*Holcus lanatus*), rough cat's ear (*Hypochaeris radicata*), hairy hawkbit (*Leontodon nudicaulis*), and reed canarygrass (*Phalaris arundinacea*).

During the spring of 1996, we observed seedling growth and, in five of the six plots, it was easy to see which plants received the carbon treatments. Plants in those plots looked stunted and more yellow than plants in the control plots—evidence of nitrogen deficiency. We did not note, however, whether the carbon amendment affected exotic species any more than it affected the natives.

To sustain the effects of the nitrogen reduction, on May 12, 1996 we added another dose of sugar at a rate of 0.5 kg/m^2. The result was shocking! Nine days after we applied the additional carbon amendments, all the plants in these plots were dead. The sugar treatments, which were designed to favor prairie species in their competition with exotic weeds had, instead, killed all the species.

Immediately after the plants died, we collected 24 soil samples from all the plots and analyzed them for ammonium and nitrate levels. We found that ammonium levels were significantly lower ($P = 0.02$)in the carbon-treated plots (0.0064 mg NH_4/g soil) than the control plots (0.0138 mg NH_4/g soil), while nitrates did not differ significantly (0.0046 mg NO_3/g soil and 0.0040 NO_3/g soil). Thus, the carbon-addition treatments were successful in reducing nitrogen availability in these wetland prairie soils.

What went wrong? At this point, we can only speculate. We rejected the idea that a "sugar-loving" fungal pathogen was responsible because a pathogen would have affected plants adjacent to the plots. Then, after noting that the soil in the treated plots smelled strongly of hydrogen sulfide, we weighed the possibility that the sudden, severe anaerobic conditions induced by rapid microbial growth with the addition of sugar adversely affected the plants. We concluded, however, that a lack of oxygen, by itself, is not likely to have caused mortality because these species are adapted to anaerobic conditions. It may also be the case that the plants died due to the increased anaerobic respiration generated a surge of toxic by-products, such as alcohols and organic acids. We have also hypothesized that the plants may have become dehydrated due to negative osmotic pressure caused by sugar in the soil.

Whatever the case, we have begun new experiments to determine whether we can create nitrogen-reducing effects through carbon treatments without killing the plants. In these experiments we plan to include separate spring and fall treatments with various levels of organic matter being added, although some spring treatments will receive no organic matter. We would appreciate any comments or correspondence regarding this technique.

References

Carson, W.P. and G.W. Barrett. 1988. Succession in old-field plant communities: effects of contrasting types of nutrient enrichment. *Ecology* 69:984-994.

Morgan, J.P. 1994. Soil impoverishment: A little-known technique holds potential for establishing prairie. *Restoration & Management Notes* 12(1):55-56.

Seastedt, T.R., P.A. Duffy, and J.N. Knight. 1996. Reverse fertilization experiment produces mixed results (Colorado). *Restoration & Management Notes* 14(1):64.

Tilman, D. and D. Wedin. 1991. Dynamics of nitrogen competition between successional grasses. *Ecology* 72:1038-1049.

Wilson, S.D. and A.K. Gerry. 1995. Strategies for mixed-grass prairie restoration: herbicide, tilling, and nitrogen manipulation. *Restoration Ecology* 3:290-298.

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Native Prairie Restoration Incentive Program. 1996. Anon. **Native Warm-Season Grass Newsletter** 15(3):3.

The Missouri Department of Conservation reports that it enrolled 31 landowners during the two-month sign-up period for its 1996 Native Prairie Restoration Incentive Program. Since 1988, they have enrolled hundreds of landowners and nearly 4,000 hectares (10,000 acres) of remnant prairie. Participating landowners are paid $20 per acre per year for the first two years. During that time, the prairie lands are burned and invading trees are removed, but otherwise left to rest. After the two payment years, landowners follow a five-year grazing or haying management plan that allows the prairie to recover while providing forage for the landowner.

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At New Prairie Preserve, An Old Debate Resurfaces. 1997. Anon. **The New York Times** January 26.

The age-old debate of whether or not cattle grazing is an appropriate management tool has reared its head again, this time in Kansas where the newly-created, 4,358-ha (10,894-acre) Tallgrass Prairie National Preserve is taking shape. Ranchers argue that the grassland, which is located just north of Cottonwood Falls in Chase County, is in good shape due to their judicious grazing practices. They fear that tourists will ruin the site and that the land will be taken out of production, thereby driving up the cost of grazing leases in the region. Environmentalists, such as Ron Klataske, regional vice president of the Audubon Society, agree that the preserve can support cattle without destroying the prairie, but they want assurances that restoration of the grassland has top priority.

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Upland Restoration Challenge. 1996. Bissett, N. **The Palmetto** 16(2):8-11.

Bissett reports that restorationists used several innovative techniques to seed a large area with wiregrass (*Aristida beyrichiana*) and 30 other native species. First, they burned a wiregrass site in the spring so that it would yield seeds, a technique unknown until a few years ago. Later in the year, they used a leafblower to blow seeds and chaff onto soil that had been cultipacked. They, then, ran the cultipacker over the seeded ground to work the seeds into the soil. Finally, Bahai grass mulch was added to half of the seeded area. Nine months after the seeding, they found more