Land Application of Wood and Paper Residuals and Wastewater

Karl Shaffer, L.S.S., CNMP

Shaffer Soil Services, Inc.

Land Application of Wood and Paper Residuals and Wastewater

- The southeastern U.S. has much wood and fiber industrial processing
- Much of the by-product material from this processing is land applied as a cost-effective and potentially beneficial way to use the residual's organic material and wastewater
- Land application of these products may result in special concerns and require intense management to remain agronomically sound.

Land Application of Wood and Paper Production Byproducts

- These materials typically have the following issues of concern:
  - High organic component (BOD,COD)
  - High fiber content
  - Low nutrient content
  - Potentially high concentrations of:
    - process materials such as K, Na, Ca
    - high pH and/or ag-lime equivalence

Land Application of Wood and Paper Production Byproducts

- Two cases in progress
- Case 1- residuals from paper processing
- Case 2 – wastewater from OSB manufacturing
- GOAL: to manage the land application sites in a sustainable system, or recommend alternative management techniques

Case 1- Paper Residuals

- Material Characterization:
  - 38-45% solids
  - 8.2 % calcium
  - 0.0083% plant-available N
  - 0.00008% phosphorus
  - 0.0094 % potassium
  - 0.071% magnesium
  - Ag-Lime Equivalence (ALE) = 3.1 – 3.7
- (In lbs/DT: PAN=0.166, K= 0.188, P = 0.0015)

Site Conditions

- Many years of residuals application to Wakulla (siliceous, thermic psammentic hapludults)/Candor (sandy, kaolinitic, thermic grossarenic kandiudults) soil complex
- Soils naturally low in fertility with low humic matter, droughty
- Application rate 30 – 40 dry tons/acre-year
- Material applied 1x/year, tilled to 12-14 inches, then crops planted
- Crop stresses- poor germination and yield in select areas with select crops

Soil Fertility Results of Land Application Fields (0-6 inch soil depth)

Sample	CEC	BS	AC	pH	P-I	K-I	Ca	Mg	Na
1	54	100	0	8.2	12	4	99	1	0.1
2	80	100	0	8.1	14	6	98	2	0
3	56	100	0	8.3	12	5	99	1	0
4	36	100	0	8.4	16	14	99	1	0.1
5	47	100	0	8.2	15	12	99	1	0.1
6	49	100	0	8.3	14	11	98	2	0
7	54	100	0	8.2	12	6	98	2	0.1
8	38	100	0	8.4	14	4	99	1	0
MEAN	51.75	100	0	8.2625	13.625	7.75	98.625	1.375	0.05

Site Observations

- Germination and plant growth are stressed
- Nutrient deficiencies are suspected due to:
  - High soil pH and induced deficiencies
  - Tie-up of N with high organic material loading
- Droughty soil conditions are greatly buffered by O.M. additions

Remedies in progress

- Reduced loading rates/acre
- New land added with lime needs
- Macro and micro nutrient amendments
- Use of sulfur fertilizers
- Crop strip trials for assessment of better alternatives:
  - Rapeseed, soybeans, annual ryegrass, oats, wheat, grain sorghum

Case 2- Process Wastewater

- Present wastewater characterization (past 5 years):
  - BOD: 3,100 mg/L
  - NH_3-N: 13-47; mean = 36
  - Na: 664 mg/L
  - Ca: 276 mg/L
  - SAR: 8.9
  - K: 3112 mg/L
  - PAN: 151 mg/L
  - TDS: 15,500 mg/L

- Irrigation of 20-25 inches per year for 25-30 years onto Fairview clay loam (fine, kaolinitic, mesic, typic kanhapludults). Fescue hay crop. Past wastewater characterization assumed similar but unavailable.

Soil Fertility Results of Land Application Fields (0-6 inch depth)

	W/V	CEC	BS	AC	pH	K-I	MnA-I	Na
1	0.89	29	100	0	7.6	1300	499	1.7
2	1.05	26	100	0	9.2	1719	625	2.5
3	1.2	23	100	0	8.4	969	462	1.6
4	0.98	31	100	0	8.4	1214	497	1.4
5	0.94	33	100	0	8.6	1734	552	2.5
6	0.84	32	100	0	8.5	1936	704	2.6
7	1.11	23	100	0	9.2	1361	512	2
8	0.87	29	100	0	8.4	1237	1111	1.4
MEAN	0.985	28.25	100	0	8.54	1433.75	620.25	1.9625

Additional Soil Characteristics

- Exchangeable Sodium % (ESP):
  - Range 3.6 – 10.4; mean =5.3 (CEC is elevated)
- Bulk Density
  - Fairview soils un-irrigated Bt horizon: 1.37 g/cc
  - Fairview soils irrigated: 1.98 g/cc
- Saturated Hydraulic Conductivity (Ksat)
  - Fairview soils un-irrigated upper Bt horizon: 0.12 in/hr
  - Fairview soils irrigated upper Bt horizon : <0.01 in/hr

Soil physical parameters

Non-irrigated Bt horizon

- Friable to firm
- Slightly sticky
- Slightly plastic
- Low to moderate shrink/swell
- Moderate SBK structure

Irrigated Bt horizon

- Very firm
- Very sticky
- Very plastic
- High to very high shrink/swell
- Massive

Symptoms

- Chronic site saturation
  - Ponding, runoff with light irrigation events
  - Site permitted at 40 inches AHLR. Estimated current capacity driven by ET only (12-18 in.)
- Crop stress
  - Physical
  - Chemical/fertility
- Soil compaction: not tested

Remedies in progress

- Addition of irrigation area
- Enhanced wastewater treatment recommended
- Irrigation to existing fields at rates dictated by evapotranspiration (requires high storage volumes)

Troubleshooting thoughts

- Look at conventional soil fertility and chemistry parameters
- Look at waste characterization
- Look at soil physical parameters:
  - Bulk density, porosity
  - Permeability/conductivity/surface infiltration
  - C.O.L.E., plasticity and structure
  - Soil compaction assessment
- **Plant tissue testing (both predictive and diagnostic) !!**

Summary

- Neither scenario could be considered “sustainable” at current rates and current waste characteristics
- Always base loading rates as closely as possible to agronomic recommendations. Some allowances can be made.
- Close monitoring of waste chemistry is necessary, as this may change over time. Closely monitor soils (both chemical and physical parameters), groundwater, crops. Consider crop options.
- Additional research into cropping patterns and soil amendments may offer better management scenarios.

Acknowledgements

- Dr. David Hardy and David Dycus-
  N.C. Department of Agriculture
  and Consumer Services