

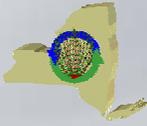
Designing an Evapotranspiration Cover Using Shrub Willow and Organic

Amendments on the Solvay Wastebeds in Syracuse, NY

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Background

- Soda ash (sodium carbonate) and other chemicals were produced from naturally occurring salt brines and limestone from 1881 – 1986 in Syracuse, NY
- Wastebeds: About 600 ha were created by depositing a 5% solid slurry in settling ponds, ranging in depth from 16 to 21 m (Fig. 1).
- Willow and cottonwood are the first woody plants to naturally establish on the wastebeds.



Figure 1. Aerial photo of three wastebeds. The white region shows an area of higher salt concentrations.

Challenges

- Wastebeds primarily contain calcium, magnesium and sodium compounds (Fig. 2)
- Consists of silt (>70%) and sand size particles
- High pH increases with depth to (8.0 - 11.7).
- High salt concentrations (E_c of 0.5 – 9.2 dS m^{-1}), especially at greater depths.



Figure 2. Solvay wastebeds consist of fairly uniform material. This trench is about 3m below a layer of soil and gravel cap that has been installed to create parking space.

Project Goals and Tasks

- Quantify the impact of a willow biomass crops on the overall water balance at the Solvay wastebeds
- Use a phased approach including a series of greenhouse screening trials, on-site field trials, soil and shrub willow characterization
- Model overall water balance of the wastebeds to design an effective system using inputs from greenhouse and field trials
- Turn the wastebeds into productive areas by growing renewable fuel for use in the local community

Shrub Willow Field Trial

Objective

- Assess establishment and growth rates of 10 willow varieties on Solvay waste amended with biosolids in the early 1990s.

Treatments

- 10 willow varieties selected based on results of a greenhouse screening trial with 40 varieties
- Two cutting lengths – 25 and 50 cm

Methods

- Site preparation: chemical and mechanical weed control
- Planted in May 2004 at a density of 15,400 plants ha^{-1}

Results and Discussion

- Survival was >75% for all but one variety after the first growing season (Fig. 3)
- No differences in cutting length survival in the first year.
- Survival dropped dramatically the second growing season, emphasizing the need for long term trials.
- After two years the yield of seven varieties was >15 odt ha^{-1} for the 50cm cutting treatment and >10 odt ha^{-1} for the 25 cm long cutting treatment (Fig. 4).



Figure 5. Delivery (A), applications (B) and incorporation (C) of brewery biosolids to the Solvay wastebeds

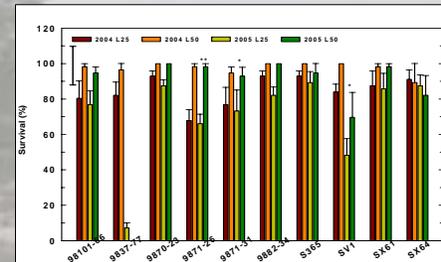


Figure 3. Survival of 10 willow varieties planted using 50 cm (L 50) or 25 cm (L 25) long cuttings over the first two growing seasons. Asterisks indicate significant differences between cutting lengths at 0.10 (*) or 0.05 (**) levels

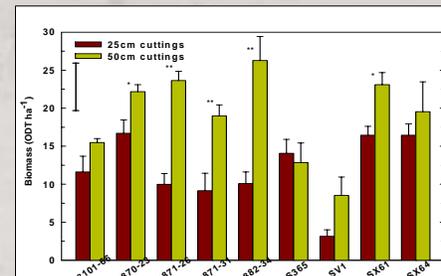


Figure 4. Aboveground biomass of 10 willow varieties planted using 50 cm (L 50) or 25 cm (L 25) long cuttings at the end of the second growing season. Asterisks indicate significant differences between cutting lengths at 0.10 (*) or 0.05 (**) levels

Organic Amendment Field Trial

Objective

- Test effect of incorporating three different organic amendments into the wastebeds on biomass production

Treatments and Methods

- Organic amendments included local brewery biosolids, wastewater treatment plant biosolids, and local yard waste
- Seven different treatments, combining organic amendments and yard waste, based on results of greenhouse trial (Fig. 5). Control is unamended Solvay waste.
- Organic amendments incorporated in the summer and fall of 2005
- Two willow varieties were planted in the spring of 2006 using 50 cm long cuttings

Modeling Water Budget with SHAW

Objective

- Assess the impact of a shrub willow evapotranspiration (ET) cover on the water balance at the Solvay wastebeds using the Simultaneous Heat and Water (SHAW) model.

Background

- Used daily weather data for Syracuse, NY from 1974 - 2003.
- Model parameters based on preliminary field data from wastebeds and/or established willow trials in central NY.
- Root zone limited to 0.5 meters, stormwater runoff held to 0 mm to simulate surface ponding.
- Ran two shrub willow crop management scenarios and a no vegetation control.
 - Constant size crop (CS) where willow was not harvested.
 - Short rotation coppice (SRC) where willow was harvested on a 3-year rotation.

Results and Discussion

- The shrub willow ET cover is capable of limiting deep percolation to less than 30 mm/yr (approximately 3% of average annual precipitation) in 21 out of 28 years (Fig. 6) for CS crop.
- Average percolation was 71 mm for CS and 130 mm for SRC
- Substantial improvement in ET cover performance occurred following first four years of crop establishment.
- The difference in annual percolation between the SRC and CS management regimes was significant ($p=0.001$).
- Stand establishment and extreme precipitation had impact on results. The three extremely wet years during willow establishment greatly increased percolation.
- Percolation decreased to 32 mm for the CS regime and 71 mm for SRC when the four establishment years (three of which had very high precipitation) were excluded from the calculation.

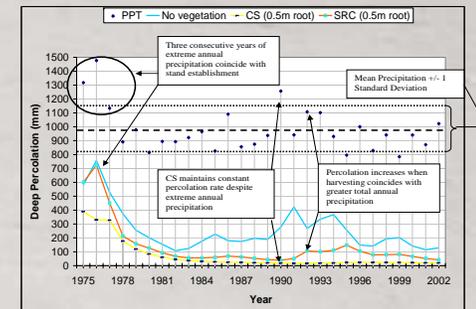


Figure 6: Predicted deep percolation (mm/yr) for three vegetation management scenarios (viz., control or no vegetation, constant-age (CS) and short-rotation crop (SRC)) with 0.5m rooting depth (Johnson, 2005).