Impacts of Drainage Patterns and Other Site Factors on the Movement of Magnesium Chloride-Based Dust Suppressant Products from Gravel Roads

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Introduction

Magnesium chloride ($MgCl_2$) is applied to gravel roads during summer months for dust suppression and road stabilization. Dust suppressants are used to control maintenance costs, erosion, and fugitive dust. The use of dust suppressants is increasing in order to control particulates in the interest of air quality and maintenance costs.

Research quantifying the impacts of $MgCl_2$ on vegetation is limited. Based on previous sodium chloride research, symptoms of salt damage can include tip or marginal burn, necrosis, delays in germination, or early fall defoliation (Bicknell and Smith 1975, Kozlowski 1997). Salts in soils can depress osmotic potentials and restrict water uptake by plant roots (Munns 2002). Ion accumulation in woody plants can also cause osmotic stress in plant tissues (Munns 2002, Bernstein 1975).

Site factors such as slope, topography, drainage patterns, elevation and precipitation may influence the spatial distribution and amount of salt in roadside soils and vegetation. One objective of this multifaceted, three year field study focused on the impacts these site factors have on the movement of $MgCl_2$ ions from roads into roadside environments.

Literature Cited

Bernstein, L. 1975. Effects of salinity and sodicity on plant growth. *Annu. Rev. Phytopathol* **13**: 295-312.

Bicknell, S. and W. Smith. 1975. Influence of soil salt, at levels characteristic of some roadside environments, on the germination of certain tree seeds. *Plant and Soil* **43**: 719-722

Kozlowski, T. 1997. Responses of woody plants to flooding and salinity. *Tree Physiology Monograph No.1*: 1-29.

Munns, R. 2002. Comparative physiology of salt and H_20 stress. *Plant, Cell and Environment* **25**: 239-250.

Objectives

Determine if site factors affect the spatial distribution and amount of salt ions in roadside soils and plant tissue.

Site factors of interest:

- drainage patterns
- precipitation
- slope
- topography
- road application procedures

Methods

This research poster focuses on the effect road drainage patterns have on the distribution and amount of salt ion movement from gravel roads.

Drainage vegetation health plots were established to follow potential movement of water from gravel roads into roadside ecosystems. These drainage plots were variable in length, dependent upon the amount and distance of visible tree crown damage in the drainage pattern.

All trees within the 20 foot wide, variable length transect were assessed for health, crown characteristics, biotic and abiotic damage agents. Ground cover subplots along the transect were also assessed for health, percent cover, and visible damage.

Foliar and soil samples were collected at increasing distances from the road to represent the area where water drainage occurs. These samples were analyzed for ion content.

A potential amount of surface water flow was measured for each plot, dependent upon the surface area of road and the length and slope of roadside ditches that emptied into the plot. We hypothesized that a higher value of potential surface water flow into a plot would equal more water flow during precipitation and carry salt ions to greater distances from the road.

Plot Design and Summary

75 drainage vegetation health plots were established in summers 2005 and 2006 on 19 treated and non-treated roads. Plots were distributed in four dominant vegetation types.

Figure 2 illustrates measurements taken to obtain a potential surface water flow index value for each plot. These measurements include the amount of road surface area draining into the plot and the length and slope of roadside ditches that drained into the plot. Figures 3 and 4 illustrate typical drainage plots in different habitat types.

Figure 2. Measurements for potential water surface flow index values.

Figure 3. Drainage plot in mixed stand (illustrates similar measurements as Figure 2).

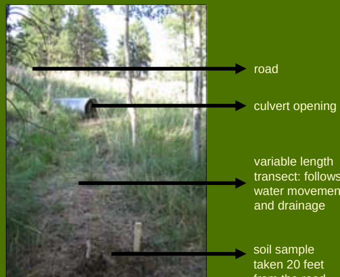

Figure 4. Drainage plot in typical aspen stand.

Preliminary Results and Discussion

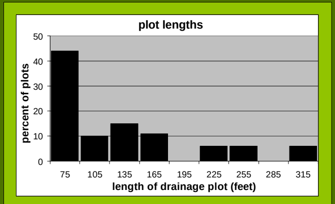

Figure 5. Distribution of drainage plot lengths along treated roads (n=48).

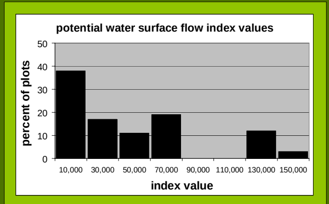

Figure 6. Distribution of water surface flow index values in drainage plots along treated roads (n=48).

- Plot length ranged from 60 to 320 feet along treated roads (Figure 5).
- Plots were variable in length dependent upon the presence or absence of tree crown damage similar to symptoms of salinity damage in the drainage area. The length of each plot was based on how far from the road this damage was seen. Analysis to determine the causal factors of crown damage is underway.
- Potential water surface flow index values ranged from 10,00 to 150,000 (Figure 6).
- Some drainage plots had high potential surface water flow values (Figure 6). We hypothesized that higher potentials for surface water to flow into plots would result in further movement of water and salt ions into the roadside systems. Analysis to determine whether these index values correlate with amount and spatial distribution of salt ions in soils and plant tissue is underway.
- Soil chloride in drainage plots along non-treated roads ranged from 8 to 92 ppm with a mean value of 18.5 ppm (Figure 7).
- In drainage plots along treated roads, soil chloride values ranged from 8 to 4300 ppm, with a mean value of 535 ppm (Figure 8). Mean soil chloride values along treated roads are significantly higher than untreated roadside areas and may be contributing to tree crown damage seen in drainage plots along treated roads.

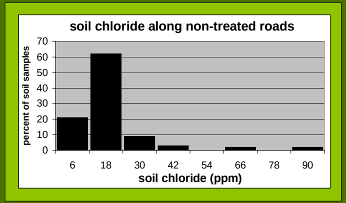

Figure 7. Soil chloride in drainage plots along non-treated roads (n=88).

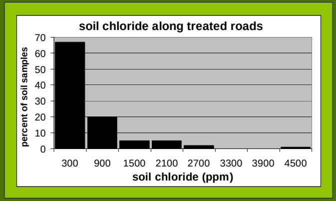

Figure 8. Soil chloride in drainage plots along treated roads (n=269).

Continued Analysis

This project is due for completion in the spring of 2007. We will determine which site factors influence movement of $MgCl_2$ ions from treated gravel roads into roadside systems, and determine if they cause adverse effects to roadside soils and plants. Other site factors of interest in analysis include precipitation, sedimentation in plots, road application procedures, topography, and slope.

We will work with county officials to determine better management practices for salt application treatments. This information will help environmental managers, transportation officials, arborists, and the scientific community more fully understand the environmental impacts of applying dust suppressants along various roadside systems and focus on the site factors that determine the movement.

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