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# SLASH INCORPORATION FOR AMELIORATION OF SITE, SOIL AND HYDROLOGIC PROPERTIES ON POCOSINS AND WET FLATS IN NORTH CAROLINA'

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Abstract-it was hypothesized that mulching and incorporation of slash as part of site preparation treatments could affect soil water characteristics. Two forested wetland sites, an organic pocosin and a mineral wet flat. located in the lower coastal plain of North Carolina, were selected for treatments. Treatments consisted of slash mulching and incorporation in combinations with bedding and flat planting. These treatments were arranged in a randomized complete block design and an incomplete block design. Volumetric soil moisture percent, water table depths. and soil water chemical characteristics were monitored for one year following treatment installation. Preliminary results suggest that bedding in general affects soil water characteristics while differing methods of slash incorporation do not.

## INTRODUCTION

Many of these sites are logged during moist or wet conditions that may lead to negative site quality impacts (Gent and Morris 1986). This research is designed to explore the possibility of incorporating post harvest slash residues into site preparation treatments as a means of reversing negative site impacts. It is possible that this incorporation of organic matter into site preparation treatments would have significant impacts on soil water characteristics through the alteration of soil physical properties, rooting environment elevation. and organic matter decomposition rates.

Near surface water table depth, soil volumetric moisture, and soil water chemistry are the major variables being considered. Water chemistry concerns include the presence and movement of nitrate, ammonium, and orthophosphate. These issues could have significant effects on short and/or long term tree growth.

## SITE DESCRIPTIONS

Two sites in Beaufort County N.C. in the lower coastal plain south of the town of Washington N.C. were selected for treatment. Site elevations range from approximately 10 to 20 feet above mean sea level. The average daily maximum temperature in January is 55 degrees F and the average daily minimum temperature is 34 degrees F. The average daily maximum temperature in July is 87 degrees F and the average daily minimum temperature is 70 degrees F. Total annual precipitation is approximately 53 inches with 55 percent falling in April through September (USDA NRCS 1995).

The soil of the mineral wet flat is a Lenoir series, Clayey, mixed, thermic, Aeric Paleaquult, while the soil of the organic pocosin is a Pantego series, Fine, loamy, siliceous, thermic, Umbric Paleaquult (USDA NRCS 1995). The mineral wet flat has an ochric epipedon. while the organic pocosin has a histic epipedon (USDA SCS 1997). Drainage ditches are common along roads on the wet flat site. Drainage is more extensive on the pocosin site and tertiary ditches are connected to road ditches.

Both sites were intensively managed for loblolly pine (*Pinus taeda)* production. Other common species present were water oak (Quercus *nigra*), cherrybark oak *(Quercus* pagoda), red maple (*Acer rubrum*), and sweet gum *(Liquidambar styraciflua*).

## METHODS

### Experimental Design

Treatment plots measuring 2 chains by 2 chains were arranged in blocks of five plots on the wet flat site and four plots on the pocosin site. There are four blocks on each site. A ½ chain buffer was left between each treatment plot and between each block. A 1150 acre circular measurement plot was deliheated in the center of each treatment plot. The design on the wet flat site is an incomplete block design while the design on the pocosin site is a randomized complete block design. In some cases the plots were split by soil horizon. All hypothesis test results are based on an alpha level of .10. In some cases an individual significance value will be reported for a parameter. Tukey's stucientized range test was used to determine any significant differences between treatment means.

### Treatments

Treatment one consisted of conventional site preparation methods for the North Carolina coastal plain. The conventional treatment utilized a tractor mounted V-shear blade to push slash and debris away from the bed-lines followed by traditional bedding with a tractor mounted plow. Treatment two consists of strip surface mulching of slash and stumps along the bedline followed by traditional bedding. A tractor mounted Rayco hydra stumper mulching head was used to perform the mulching tasks. This mulching head was used to mulch all slash and stumps in a 6.5 feet wide strip along the left and right side of the bed line. The resulting mulched strip was 13 feet wide centered on the bed lines. This mulched material was then incorporated into

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the beds by the tractor mounted plow. Treatment three consists of the exact manipulations described for treatment two except that the Rayco mulching head was set to till the soil to a depth of 4 inches which incorporated the mulch into the soil surface prior to bedding. Treatment four consists of broadcast surface mulching of all slash and stumps within the treatment plot followed by bedding along the bed lines. The mulching was again be performed by the Rayco mulching head and no soil tilling was involved. Treatment five is identical to treatment four except that the plot was not bedded after broadcast mulching. Treatment six is the control treatment and was left in post-harvest condition and flat planted. All of the above treatments were installed on the wet flat site while only treatments one, two, three, and six were installed on the pocosin site. In this case, treatment six above is renumbered as treatment four. All treatments were planted with genetically improved loblolly pine seedlings.

Approximately 40 lbs elemental phosphorous and 35 lbs elemental nitrogen were applied to each treatment plot as diammonium phosphate. Arsenal and Oust herbicides were banded to control herbaceous competition (Weyerhaeuser 1998).

## Measurements

'One bar tension lysimeters were installed into the soil profile to collect soil water samples from the soil profile (Wagner 1962). The water samples were analyzed using cclorومeiric procedures to determine the concentrations of nitrate and ammonium (Technicon 1973). Soil volumetric moisture percentage was monitored using Time Domain Reflectometry. Iron rods were installed into the soil profile to a depth of 32 inches to monitor the depth of iron reduction within the profile. Near surface water table wells were installed to monitor water table depth below the soil surface in each treatment plot. Measurements were taken monthly beginning in May 1998 continuing through April 1999.

## RESULTS AND DISCUSSION

The results are based on preliminary data that was gathered between May 1998 and September 1998. The chemical data from water samples was collected in May 1998 and all current findings are based on that single data set. Findings based on the entire data set from May 1998 to April 1999 will be made available upon completion of the study.

### Soil Water

**Wet** flat-There were no significant differences between treatment means for nitrate (ppm) in soil water (table 1). The effect of high variability between treatments is evident. However there are significant differences between soil horizon means (table 2). The nitrate concentrations in soil water from the Bt clay subsurface horizon was significantly higher than in the water from the Ap surface horizon. 'These results imply that the decomposition of surface and. incorporated organic material, as well as the applied fertilizer, has caused nitrate to leach into the Bt horizon with downward water flow. The ammonium from the fertilizer and decomposing organic material is readily converted to nitrate in the presence of oxygen (Tisdale and others 1993). This seems reasonable because of the wetting and drying cycles common on this site.

Table I-Soil water nitrogen concentration results **for the wet flat** site by treatment

| Treatment | Nitrate | Ammonium |
|---|---|---|
| | - - - - - - - - - - *Ppm* - - - - - - - - - | |
| 1 shear bed | 0.35 | 1.66 a |
| 2 mulch bed | 1.60 | .66 ab |
| 3 till bed | 1.51 | .28 b |
| 4 broadcast | .71 | .49 ab |
| 5 broad bed | .47 | .39 b |
| 6 flat plant | 1.26 | .40 b |

Table 2—Soil water nitrogen concentration results for **the wet flat** site by soil horizon **where all treatments** are combined

| Horizon | Nitrate | Ammonium |
|---|---|---|
| | - - - - - - - - - *Ppm* - - - - - - - - - - | |
| Ap surface | 0.15 b | 1.03 a |
| Bt subsurface | 1.84 a | .24 b |

Additionally there are significant differences between treatment means for ammonium (ppm) in soil water (table 1). These unexpected differences can not be explained at this time and the data dc not correlate with changes in slash incorporation or bedding procedures. There are also significant differences between soil horizons means for ammonium in water (table 2). The ammonium concentrations in waier from the Ap surface horizon are significantly higher than in the Bt subsurface horizon. This is probably due to the decomposition of surface and incorporated organic material and fertilizer application in the Ap horizon (Tisdale and others 1993). The lower ammonium values in the Bt subsurface horizon are reasonable given the tendency of ammonium cations to be retained on soil cation exchange sites, thus resisting leaching.

Pocosin-There are no significant differences between treatment means for nitrate (ppm) in soil water (table 3). There also are no significant differences between horizon means for nitrate in water (table 4). The pocosin site is very often saturated at or just below the soil surface. This creates a generally anaerobic soil environment that is not conducive to the conversion of ammonium derived from organic material and fertilizer to nitrate (Tisadle and others 1993).

Also, there are significant differences between treatment means for ammonium (ppm) in soil water (table 3). Treatments one, two, and three are bedded treatments while treatment four is non-bedded. Any difference between bedded and non-bedded treatments is probably due to the

Table 3—Soil water nitrogen concentration results for the pocosin site by treatment

| Treatment | Nitrate | Ammonium |
|---|---|---|
| | Ppm | |
| 1 shear bed | 0.3'1 | 1.76 a |
| 2 mulch bed | .10 | 1.77 a |
| 3 till bed | .12 | 1.59 ab |
| 4 flat plant | .06 | .80 b |

Table 4—Soil water nitrogen concentration results for the pocosin site by soil horizon where all treatments are combined

| Horizon | Nitrate | Ammonium |
|---|---|---|
| | Ppm | |
| Ap surface | 0.18 | 3.54 3 |
| A subsurface | .08 | .70 b |
| Btg subsurface | .10 | .20 b |

increased aeration and incorporated organic material in the bed. This combination would increase the decomposition of organic material in the bed thus releasing ammonium into the soil and water (Mitsch and Gosselink 1993). It is also likely that fertilizer applied to non-bedded plots was lost to surface water movement away from the plot. There are however significant differences between soil horizon means for ammonium in water (table 4). The Ap surface horizon ammonium concentration is significantly higher than the A and Btg subsurface horizons. This is due to the fertilizer and organic material that was incorporated into the beds.

### Depth of Iron Reduction

Wet flat and pocosin-Iron reduction depth means for the bedded treatments are all significantly greater than the means for the non-bedded treatments (table 5 and 6). This is true for both sites. This is due to the increased aeration within the beds. Increased aeration is due to the increased soil surface elevation above the water table as well as increased porosity resulting from tillage and organic material incorporation (Allen and Campbell 1988).

### Depth of Water Table

Wet flat and pocosin-The results indicate that there are no significant differences between treatment means on the wet flat site (table 5). The effects of high data variation between plots within treatments is evident. There are significant differences between treatments on the pocosin site (table 6). The results show that the bedded treatment means are significantly higher than the non-bedded treatments. This is due to the increased elevation of the soil surface on the bed.

### Volumetric Soil Moisture

Wet flat and pocosin-The results indicate that there are no significant differences betweeh treatment means for the wet fiat site (table 5). There are significant differences between treatment means on the pocosin site (table 6). The results show that the bedded treatment means are significantly lower than the non-bedded treatment means. This is due to the increased porosity and subsequent drainage within the beds as well as the increased elevation of the soil surface above the water table on the beds. The increased porosity in the beds is due to tillage and incorporation of organic material (Allen and Campbell 1988).

Table 5—Soil moisture and water table results for the wet flat site

| Treatment | Volumetric moisture | Water table depth | Iron reduction depth |
|---|---|---|---|
| | Percent | Cm | |
| 1 shear bed | 30.8 | 54.2 | 27.5 a |
| 2 mulch bed | 31.1 | 72.5 | 26.5 a |
| 3 till bed | 29.2 | 78.8 | 33.0 a |
| 4 broadcast | 48.8 | 38.4 | 12.2 b |
| 5 broad bed | 25.1 | 68.6 | 30.0 a |
| 6 flat plant | 36.4 | 67.4 | 17.4 b |

Table 6—Soil moisture and water table results for the pocosin site

| Treatment | Volumetric moisture | Water table depth | Iron reduction depth |
|---|---|---|---|
| | Percent | Cm | |
| 1 shear bed | 45.2 a | 44.1 a | 14.5 a |
| 2 mulch bed | 47.9 a | 41.3 a | 15.7 a |
| 3 till bed | 42.6 a | 40.0 a | 15.2 a |
| 4 flat plant | 62.2 a | 25.5 b | 6.7 b |

## CONCLUSIONS

### Wet Flat

The diammonium phosphate fertilizer applications have made it difficult to determine the effects of bedding and organic material incorporation on nitrate and ammonium in soil water. It is apparent that ammonium from the fertilizer and organic material is being converted to nitrate in the presence of oxygen and is moving downward into the Bt subsurface clay horizon with precipitation inputs.

The relatively dry nature of the wet flat site has negated any possible effects of bedding and organic material incorporation on water table depths below the soil surface as well as soil volumetric moisture. The iron reduction depths do indicate that bedding affects aeration within the early period of seedling rooting environment. In this case the differing methods of organic material incorporation did not affect water table depth, soil moisture, or soil aeration within the beds.

## Pocosin

it is apparent that fertilizer and organic material has elevated the ammonium levels in soil water in the Ap surface horizon in the bed. The results suggest that the very wet nature of this site has restricted the conversion of ammonium in the beds to nitrate. As a result there is no apparent movement of nitrate downward into the soil profile.

The very wet nature of this site has made obvious the effects of bedding on rooting environment aeration, water table depth, and soil moisture. The iron reduction depths show the aeration increase within the beds that is critical to early seedling survival. The depth to water table is increased with bedding while volumetric soil moisture is decreased. These factors all contribute to enhanced seedling survival and growth on wet sites. It is evident that the differing methods of organic material incorporation did not affect these soil moisture and aeration properties.

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