# Techniques for Establishing Vegetation for Long-term Erosion Control on Disturbed Slopes in Alabama

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**Abstract**

One year results from 21 outdoor erosion and sediment control plots constructed in 2008 on a 4:1 slope are presented. The study objectives were to evaluate; 1) the effects of incorporating lime and fertilizer on establishment of bermudagrass on steep slopes, 2) the differences in bermudagrass establishment as a function of temporary covers including wheat straw, erosion control blankets, and hydromulch, 3) the effect of PAM with hydromulch on establishment of bermudagrass, and 4) the influence of above variables on runoff, sediment delivery and turbidity compared to control plots with no cover at planting. Treatments used in the study were: 1NC - no cover at planting; 1ECB - erosion control blanket; 1GM - hydromulch w/ pre-incorporation of lime and fertilizer; 1GMP - hydromulch+PAM w/ pre-incorporation of lime and fertilizer;1WS - wheat straw with incorporation of lime and fertilizer; 2GM - hydromulch w/o incorporation of lime and fertilizer; and 2GMP - hydromulch+PAM w/o incorporation of lime and fertilizer. Runoff and grow-in results indicated three vegetative cover phases; 1) a mechanical erosion control phase up to 90 days after planting (DAP), 2) a transition period at about 90 DAP, and 3) a vegetated erosion control phase following stand establishment following about 90 DAP. Results indicate the following ranking in terms of runoff reduction during the first phase (most effective to least effective); 2GM, 1GMP, 1WS, 2GMP/2GM, and 1ECB. Corresponding rankings in terms of soil loss reduction compared to the control treatment were; 1WS, 1GMP, 2GMP, 1ECB, 1GM, and 2GM. Observed percent bermudagrass cover ranking at approximately 60 DAP was (most to least); 1GM (84%), 2GM (73%), 1GMP (68%), 2GMP (67%), 1ECB (59%), 1WS (33%), and 1NC (30%). Adding PAM to hydromulch did not significantly improve cover establishment; however, hydromulch treatments had quicker percent establishment than erosion control blanket or loose straw treatments. Performance of cover treatments in terms of turbidity relative to the control plots at <90 DAP indicates the following ranking (most effective to least effective); 2GM, 1WS, 1GMP/2GMP, 1ECB, and 1GM. The addition of PAM to the two hydromulch treatments did not consistently decrease turbidity; nor did incorporation of lime and fertilizers into soil before planting. The decline of the common bermudagrass stand after 13 months in this study is a major concern that merits close attention as this study continues through its second year.

Keywords: erosion and sediment control, mulches, fertilizer incorporation

## INTRODUCTION

Failure of permanent seedings on steep slopes is quite common on roadbanks, borrow areas and other similar sites in the Southeast where grading, shaping, seeding and mulching are done according to accepted procedures of the erosion control industry. Even after re-establishment there is no assurance that new plantings will maintain a long-term stand. During the period of poor vegetative cover sites may contribute to sediment delivery offsite and high turbidity in the runoff. Auburn University's College of Agriculture began research in 2007 to address poor performance of permanent close-growing vegetation on non-irrigated disturbed areas such as steep roadbank slopes. In 2007, seven 10' x 25' plots on 4:1 slope were installed and monitored under natural rainfall for one year in Auburn, AL. In 2008, 21 plots were established to provide replicated treatments. First year results from a May 27, 2008 planting of common bermudagrass are reported in this paper.

The study objectives were to evaluate; 1) the effects of incorporating lime and fertilizer on establishment of bermudagrass on steep slopes, 2) the differences in bermudagrass establishment as a function of temporary covers including wheat straw, erosion control blankets, and hydromulch, 3) the effect of PAM with hydromulch on establishment of bermudagrass, and 4) the influence of the above variables on runoff, sediment delivery and turbidity compared to control plots with no cover at planting. Related learning objectives are: 1) to gain a better understanding of establishing vegetation on slopes; 2) to evaluate vegetative, mechanical, and chemical techniques for establishing long-term vegetative cover on disturbed slopes under natural rainfall; and 3) to evaluate the benefit of various temporary covers on newly seeded slopes to reduce runoff, sediment delivery, and turbidity.

### Site description

The study was located at the Alabama Agricultural Experiment Station's E.V. Smith Research Center located in Milstead, Macon County, Alabama. Average rainfall is 134.5 cm (53 in). Soils are typical of the Coastal Plain hill slopes, generally consisting of fine sandy loams and loamy sands.

## METHODS

### *Experimental setup*

Twenty one plots 10 feet x 25 feet long were constructed with each plot separated longitudinally by a 5 feet grassed alley. Fourteen plots had a south aspect and 7 plots had a northwest aspect. Prior to construction of the plots, upslope diversions and grassed swales were installed to prevent runon from adjoining areas. Appropriate silt fence sediment barriers were installed downslope of all plot areas. All 21 runoff plots were installed on nominal 4:1 slope and fitted at the bottom with household rain gutters and downspouts draining into separate water samplers during rain events. Seven treatments, including the control plots, were replicated three times. Each plot, including the control treatment, was seeded with *Cynodon dactylon* (common bermudagrass) on a prepared seedbed. Lime and fertilizer was applied based on individual soil tests for each plot. Fertility recommendations for roadside establishment of bermudagrass were made by the Auburn University Soil Testing Laboratory. N was applied as ammonium sulfate (21-0-0), P as triple phosphate (0-45-0), and K as potassium chloride (0-0-60) according to the soil test recommendations. Pelletized lime was used as the liming material.

### *Erosion and sediment control treatments*

Three cover types were evaluated, including wheat straw, erosion control blankets, and hydromulch. All treatments with a 1 prefix (1NC, 1WS, 1ECB, 1GM, and 1GMP) received incorporated lime and fertilizer for establishment of bermudagrass (Table 1). There were four hydromulch treatments evaluating hydraulic covers with and without polyacrylamide (PAM) and with and without lime and fertilizer incorporated into the soil. Treatment 2GMP, for example, represents the industry practice of adding fertilizer and/or PAM to a hydromulch mixture before application. Treatments were hand seeded on May 27, 2008 prior to the application of the cover treatments on the same date. A detailed description of each treatment is provided in Table 1.

Table 1. Summary of treatments used in study.

| Lime, fertilizer, & seed treatments | No Cover at Planting (NC) | Wheat Straw (WS) | Erosion Control Blanket [a] (ECB) | Hydro-Mulch [b] (GM) | Hydro-mulch + PAM [c] |
|---|---|---|---|---|---|
| 1. Lime, fertilizer & seed – soil incorporated | **1NC** | **1WS** | **1ECB** | **1GM** | **1GMP** |
| 2. Lime and fertilizer – not soil incorporated | NA | NA | NA | **2GM** | **2GMP** |

[a] Short-term mulch control netting Class Designation 2.A.
[b] A cotton plant-based hydromulch product was selected for this study` based on successful trials in 2007 by Auburn University.
[c] APS 700 Series Silt Stop polyacrylamide powder supplied by Applied Polymers Systems, Inc. dissolved in water and added to hydromulch.

Table 2. Description of treatments, including rates, and fertilizer application method applied in treatments.

| Treatment | Description |
|---|---|
| 1NC | No cover at planting (control) with incorporation of lime and fertilizer by tillage. Hand seeded with bermudagrass. |
| 1WS | Wheat straw was applied at 3000 lbs/ac following incorporation of lime and fertilizer by tillage. Hand seeded with bermudagrass. |
| 1ECB | Erosion control blanket with incorporation of lime and fertilizer by tillage. Two 6.67-ft widths of product were used for each plot, trenched and stapled per manufacturer's recommendations. Hand seeded with bermudagrass. |
| 1GM | Hydromulch product with incorporation of lime and fertilizer by tillage. Hydromulch was applied using a hydroseeder at 2000 lbs/ac, per manufacturer's recommendations. Hand seeded with bermudagrass. |
| 2GM | Hydromulch without incorporation of fertilizer by tillage. Hand seeded with bermudagrass. |
| 1GMP | Hydromulch and PAM with incorporation of lime and fertilizer by tillage. Polyacrylamide powder was applied in solution with the hydromulch based on soil tests and at rates recommended by the supplier. Hand seeded with bermudagrass. |
| 2GMP | Hydromulch and PAM without incorporation of fertilizer by tillage. Polyacrylamide powder was applied in solution with the hydromulch based on soil tests and at rates recommended by the supplier. Hand seeded with bermudagrass. |

**Sampling**

Runoff sampling after each natural rainfall runoff event began immediately after planting. Plastic 19-liter (5-gal) buckets collected plot runoff from 13 rain events from July 12, 2008 to May 29, 2009. Runoff data collected from each plot included runoff volume, sediment yield, and turbidity. For the first three months of the study, the rate of bermudagrass grow-in was monitored. At the end of one-year, an estimate of total cover conditions was made on all plots.

***Rainfall***

Rainfall data was collected on site with a tipping bucket raingage reading to the nearest 0.25 mm (0.01 in) and equipped with a datalogger. Recorded rainfall depths were confirmed using a manual rainfall gage as backup.

### *Runoff volume*

Stormwater runoff volume was collected with a proportional Coshocton wheel sampler, equipped to deliver 1/100$^{th}$ of the flow received at the top of the device. Coshocton wheels were installed immediately below a downspout leading from the gutter system of each plot (Figure 1). Sample buckets located below each Coshocton wheel sampler outlet began filling after a minimum runoff flow of 3.8 L/min (1 gpm) launched the wheel plate for sampling. The Coshocton sampler has one mobile component called the wheel plate which does not need regular maintenance or electric power. Flows from small, rural watersheds have been sampled with this device throughout the US and worldwide. The 15.2 cm (6 in) Coshocton samplers used in our study were fabricated of galvanized steel using plans available from USDA. The runoff volume from each plot was estimated by multiplying the collected sample volume by 100.


Figure 1. Proportional Coshocton wheel sampler installed with runoff downspout in excavated trenches at base of study plots. 1/100$^{th}$ proportional runoff sample flows into a 19-L (5-gal) bucket.

### *Modified total suspended solids*

Total suspended solids (TSS) were determined using a modified total suspended solids method (TSS2540 D), as follows. After the volume of water in each bucket was recorded in the field, the collected sample was poured through a 1µm filter bag (Ray Camp Company, GA) to separate sediment for subsequent determination of solids. Filled bags were brought to the laboratory where filter bags and soil residue were dried at 103 to 105 degrees Celsius for 24 hours. Total suspended solids were measured directly in kg. TSS event mean concentrations were determined for each storm by dividing TSS mass, in kg, by total storm volume, in L.

### *Turbidity*

Turbidity, in units of NTU, was determined in the laboratory by a portable turbidity meter (Hach model 2100P, CO). In the field, water filtered from the sample bucket was well stirred and sampled in 125 mL plastic bottles for subsequent water quality analysis. A sub-sample (20mL) was taken from the 125 mL field sample and inserted into the sampling compartment of the turbidity meter for replicate NTU determination (n=3) until the lowest reading was obtained. Because maximum threshold of the instrument was 1000 NTU, turbidities higher than 1000 NTU were determined by diluting sample 2x or 3x to obtain a readable value. Per manufacturer's recommendations, the lowest value was recorded.

### *Bermudagrass establishment*

For the first three months after planting, grow-in data for bermudagrass was taken by randomly placing a 1m stick, with 25 equally spaced marks, at three locations within each plot and counting the number of times a bermudagrass plant touched a mark. Recorded touches were converted to percent for each plot. This method was used as it was a relatively easy method to assess the growth of the target species within the first months of vegetation establishment.

### *Image processing for cover estimation*

In addition to the field measurement of bermudagrass grow-in during the first part of the study, a Windows-based image processing program (Hypercube) was used to quantify cover for all 21 plots at the end of the study. A fabricated PVC frame (0.5m×0.5m) was set on the ground and pictures of the area inside the plot frame were taken with a digital camera (Canon, 8 mega pixels). Images were digitally processed to quantify cover as a percent of bare soil, dead grass and live grass. Results were used to determine total and live grass cover of the 21 research plots at the end of the study.

### *Statistical comparisons*

SAS Institute version 9.1 was used to analyze the data for separation between treatment means using LSD on runoff, total suspended solid (TSS), and turbidity. Significant difference between treatments was obtained at a p-value=0.1. Regression analysis was used to investigate relationships between rainfall versus runoff, TSS load versus percent cover, and TSS concentration versus turbidity.

Calculation of a modified soil loss ratio (SLR) for each runoff event was used to compare cover treatment effectiveness against control plots with no cover at planting. Soil loss reductions were determined as one minus the soil loss ratio, with values used as a measure of erosion control performance against a comparable planted on a hillslope with no mechanical cover. Similar comparative values of relative runoff and relative turbidity were calculated for each treatment using formulas shown in Table 3. These values provided a means to compare treatment differences across changing cover and weather conditions.

Table 3. Formula for calculation of sediment loss ratio, relative runoff, and relative turbidity.

| Parameter | Sediment, TSS | Runoff, RO | Turbidity, NTU |
|---|---|---|---|
| Metric | Soil loss ratio, SLR | Relative runoff, RR[1] | Relative turbidity, RT[2] |
| Formula | $SLR = TSS_{TRT}/TSS_{NC}$ | $RR = RO_{TRT}/RO_{NC}$ | $RT = NTU_{TRT}/NTU_{NC}$ |

[1] Runoff relative to no cover plot. [2] Turbidity relative to no cover plot (also called turbidity ratio).

## RESULTS AND DISCUSSION

### *Rainfall and runoff*

A total of 13 rainfall events were captured from July 12, 2008 to May 29, 2009 for a total depth of 112.4 cm (44.2 in). Storm depths greater than 10 cm (4 in) were observed to produce noticeably larger runoff volumes, regardless of cover condition (Figure 2). A high runoff volume observed during the last event (May 29, 2009) was caused principally by a large storm event, but also because of widespread stand failure after one year on many plots (see section, Cover estimation at end of study). An average runoff coefficient of 0.36 for all plots was determined as the slope of runoff versus rainfall depth. During 10 out of 13 events, significant differences in runoff were observed between treatments, mainly between the seeded control plot (1NC) and the other seeded cover treatments.

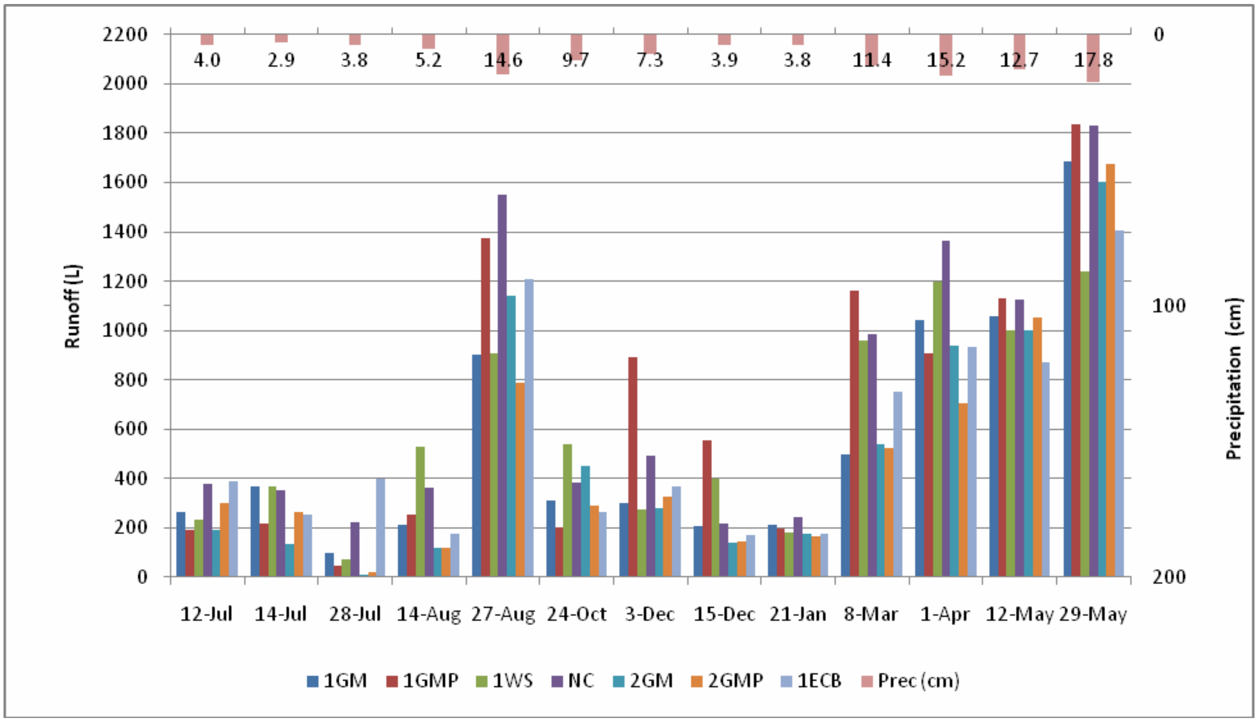



Figure 2. Runoff, L, for each treatment and storm during the study period, indicating response of runoff to variable storm depths, cm, indicated on top of graph.

Relative runoff was calculated to represent the volume of runoff observed from each treatment compared to the seeded no cover plot during the first 90 days of vegetation establishment. Because runoff increases detachment and transport of sediment from hillslopes, relative runoff values were considered to compare treatment effectiveness with respect to runoff reduction. Results indicate variable runoff reduction from treatments, with the following ranking of treatments from most effective to least effective; 2GM, 1GMP, 1WS, 2GMP/2GM, and 1ECB. All cover treatments were significantly different from each other, except for 2GMP and 2GM; and all cover treatments provided runoff reduction compared to the seeded no cover control.

***Modified TSS load and concentration***

Modified total suspended solids (TSS), in kg, were tabulated and averaged for each storm and treatment replication (Figure 3). Results indicate substantially reduced sediment yield during the initial period of vegetation establishment up to 90 days after planting (DAP). Figure 3 indicates three periods identified in this study related to sediment loss; phase I - a mechanical erosion control phase (4 storms from July 12$^{th}$ to August 14$^{th}$), transition phase - between mechanical and vegetative control (1 storm on August 27$^{th}$), and phase II - a vegetated erosion control phase after stand establishment (8 storms from October 24, 2008 to May 29, 2009).

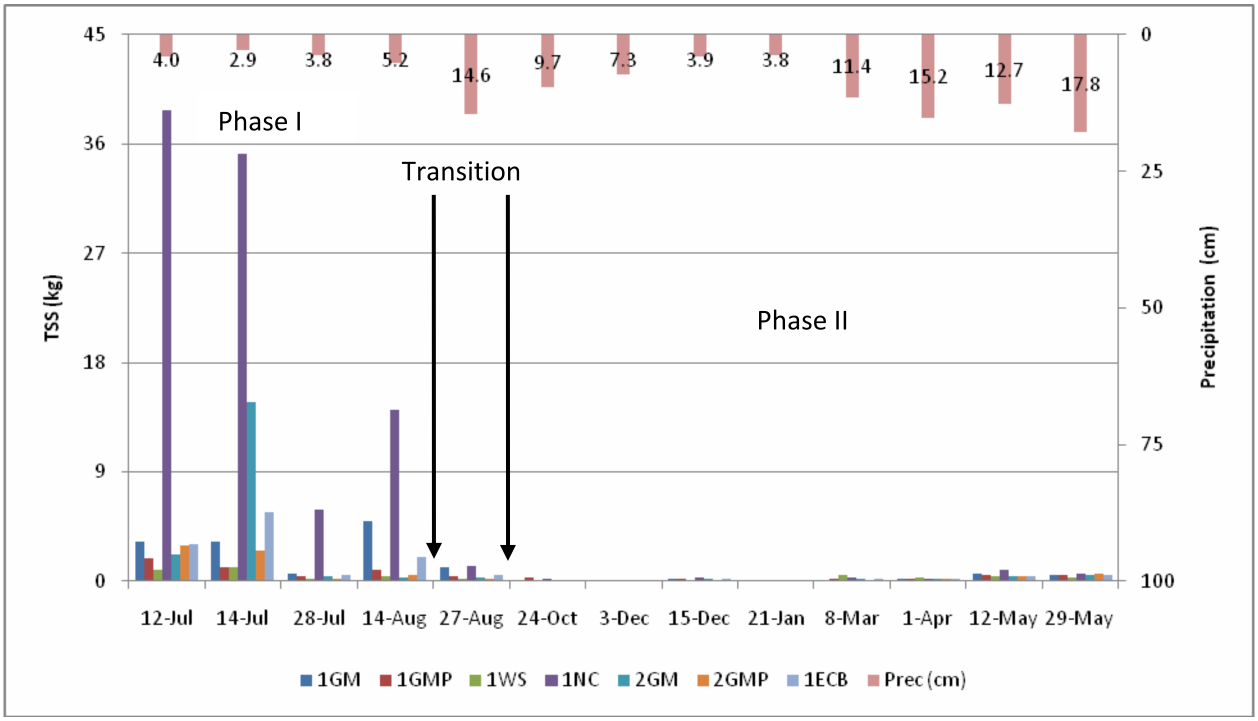



Figure 3. Modified TSS load, kg, for each treatment and rainfall event, indicating decreasing trend in sediment yield, July 12, 2008 to May 29, 2009.

During the first 4 storms significant differences were found between the seeded no cover control (1NC) and the seeded cover treatments. Similar results were observed for TSS concentrations (not shown). Significantly higher TSS loads for the control and 1GM plots were found on May 12, 2009 near the end of one year when bermudagrass stands began to show signs of failure. Significant rainfall events in spring 2009 contributed to the increased TSS loads observed in Figure 3 in May, 2009.

Soil loss ratios and reductions for each treatment were calculated from formulas presented in Table 3. The initial establishment period (phase I) was considered the most critical to evaluate with respect to soil loss. Soil loss reduction in each treatment compared to seeded no cover (1NC) control plots was determined as one minus the soil loss ratio. Resulting phase I soil loss reductions for each treatment compared to the control are shown in Figure 4.

Soil loss reductions in phase I were used to evaluate the short-term effect of various erosion control management practices compared to the no cover control. Results revealed the following ranking (most to least reduction); 1WS, 1GMP, 2GMP, 1ECB, 1GM, and 2GM. All cover treatments were significantly different from each other and all treatments provided sediment loss reductions in excess of 80% compared to the seeded no cover control.

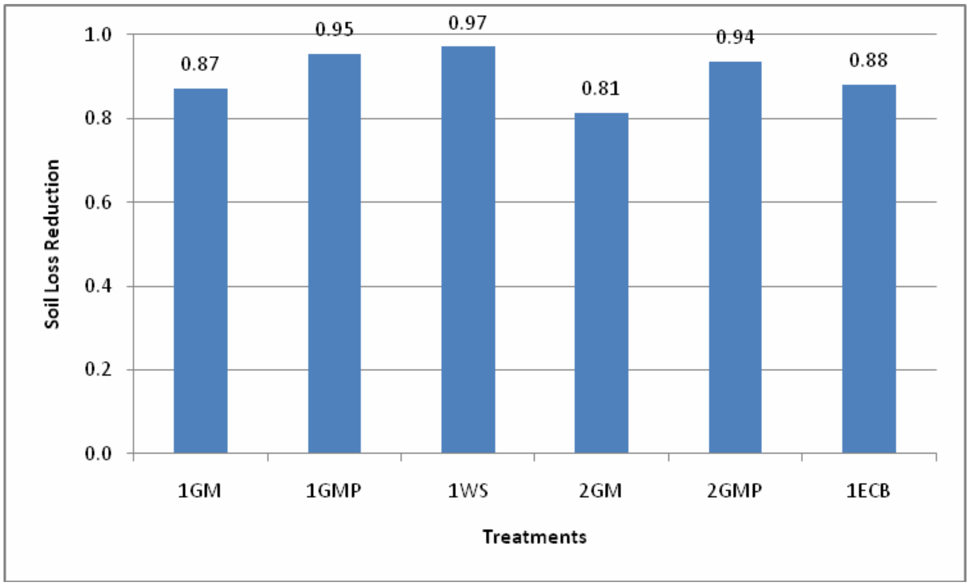



Figure 4. Phase I soil loss reductions, by treatment.

***Bermudagrass establishment***

Percent grow-in of bermudagrass during the first 55 days after planting (DAP) is presented in Table 4. On June 26th, at 30 DAP, the 2GMP treatment had the highest percent bermudagrass cover (49%); the lowest was 1NC and 1WS (7%). On July 8th and 22nd, bermudagrass cover on the 1GM treatment was 72% and 84% cover, respectively, the highest cover of any treatment; and the1NC treatment had the lowest cover (24 and 30%). Observed percent bermudagrass cover ranking at 55 DAP was (most to least); 1GM (84%), 2GM (73%), 1GMP (68%), 2GMP (67%), 1ECB (59%), 1WS (33%), and 1NC (30%). (Table 4).

Table 4. Vegetative establishment at erosion control plots at E.V. Smith Experiment Station, Shorter, Alabama, 2008.

| | Bermudagrass cover, percent | | |
|---|---|---|---|
| Treatment | 30 DAP June 26 | 41 DAP July 8 | 55 DAP July 22 |
| 1NC | 7† | 24† | 30† |
| 1WS | 7† | 47 | 33 |
| 1ECB | 17 | 56 | 59 |
| 1GM | 42 | 72† | 84† |
| 2GM | 34 | 69 | 73 |
| 1GMP | 34 | 45 | 68 |
| 2GMP | 49† | 63 | 67 |

DAP = days after planting
† Values represent high and low percent establishment for each date.

Hydromulch treatments had quicker percent establishment than erosion control blanket or wheat straw and adding PAM to hydromulch did not significantly improve cover establishment (Table 5). Incorporating lime and fertilizer into the soil through tillage did not improve vegetation establishment significantly (Table 5). At approximately 12 months after planting, it was observed that that common bermudagrass stands were decreasing (see following section, Cover estimation at end of study).

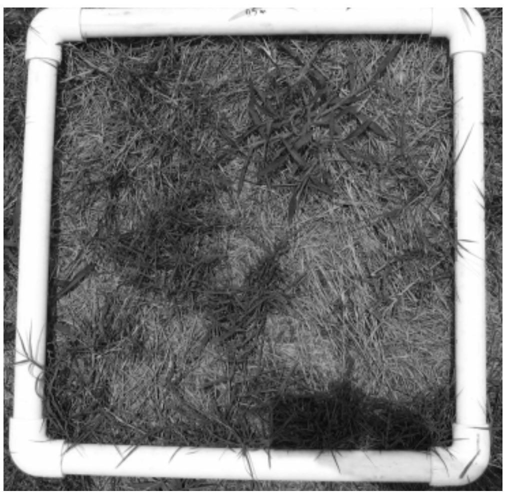
Table 5. Contrasts to compare selected percent establishment treatments from June 26 to July 22, 2008.

| Treatments | Pr > F June 26 | July 8 | July 22 |
|---|---|---|---|
| PAM versus No PAM (hydromulch treatments) | 0.61 | 0.27 | 0.24 |
| Hydromulch versus ECB treatment | 0.0008 | 0.37 | 0.005 |
| Hydromulch versus loose wheat straw treatment | 0.01 | 0.69 | 0.19 |
| Incorporated fertilizer versus surface application (hydromulch treatments) | 0.64 | 0.61 | 0.52 |

Pr values < 0.1 indicate significant difference between treatments.

***Cover estimation at end of study***

Approximately one year after planting, the percentage of vegetative cover and bare soil was estimated for all 21 plots using image processing. Figure 5 presents an example of digital pixel separation into three sub-groups; live plants, dead grass, and bare soil. Resulting per pixel counts and estimated percent cover for each category are shown in Table 6. Results indicate wide variability of cover between plots and a high percent of bare soil (average 22%) and dead grass (average 43%), providing evidence of bermudagrass stand failure across many of the treatment plots 13 months after planting.



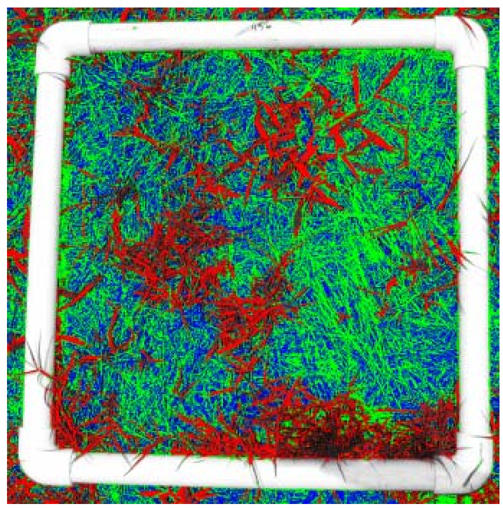


Figure 5. Images processed from plot 2GMP$_b$, taken on July 7, 2009, approximately 13 months after planting. Image at left shows B&W image. Image at right shows the processed image in false color indicating dead grass (green), bare soil (blue), and live plants (red).

Table 6. Results of digital image processing used to quantify percent cover for plot 2GMP$_b$.

| Pixel count | Description | False color | % of total |
|---|---|---|---|
| 599721 | Dead grass | green | 47.4 |
| 405612 | Bare soil | blue | 32.1 |
| 259141 | Live plants | red | 20.5 |
| Sum: 1264474 | -- | -- | 100.0 |

At the end of the one-year study period, the following total cover rankings were observed (most to least); 1GMP (80%), 1WS (78%), 2GM (78%), 1NC (76%), 1GM (75%), 1ECB (70%), and 2GMP (69%). The average live plant cover for all plots was 36%. These results raise major questions and concerns regarding the cause(s) of failure on a seeded slope during a year with sufficient rainfall on plots that were limed and fertilized according to soil tests.

TSS load, in kg, for each of the 21 plots on May 29, 2009 was plotted as a function of July 7, 2009 total cover (live plants+dead grass). The resulting negative relationship ($R^2$=0.11) indicates that observed TSS loads decreased with increased vegetative cover, as expected. The low regression coefficient is due to the limited range of TSS loads and percent covers recorded 13 months after planting. Also, since digital image capture was performed more than 30 days after the storm data, the image may not accurately represent surface conditions at the time of the storm event. In future work, it is recommended that percent cover determinations be started immediately after planting and continued throughout the study period.

***Turbidity (NTU)***

Turbidity measurements for each storm and treatment are presented in Figure 6. Similar to TSS loads and concentrations, the highest turbidities were recorded during the first 90 days (phase I) as vegetation was established. The seeded no cover (1NC) treatment had the highest turbidity during 5 of the first 9 storms. Figure 6 indicates that approximately one year after planting, turbidity increased similar to TSS loads (Figure 3) due to failing bermudagrass stands and a series of spring storms. Average turbidity values presented in Figure 7 provide an indication of NTU differences between treatments across the entire one-year study period and indicate that all treatments reduced runoff turbidity compared to plots with no cover at planting.

Relative turbidity values were calculated for each treatment based on formulas provided in Table 3. Resulting values were used to evaluate phase I turbidity compared to seeded no cover (1NC) control plots. Lower relative turbidity indicated more effective turbidity reduction compared to plots with no cover at planting. As in TSS analysis, phase I was considered the most critical period because of the need to limit high turbidities during vegetation establishment. Performance ranking of treatments during phase I indicates the following, with relative turbidities (least to highest); 2GM (0.21), 1WS (0.22), 1GMP/2GMP (0.28), 1ECB (0.46), and 1GM (0.51). Means of all treatment turbidities were significantly different, except for 1GMP and 2GMP.

Comparisons of relative turbidities during phase I indicated that the addition of PAM to the two hydromulch treatments did not consistently decrease turbidity. In addition, the relative turbidity for 1GM plots was not lower than 2GM plots, indicating that incorporation of lime and fertilizers into soil before planting did not decrease turbidity.

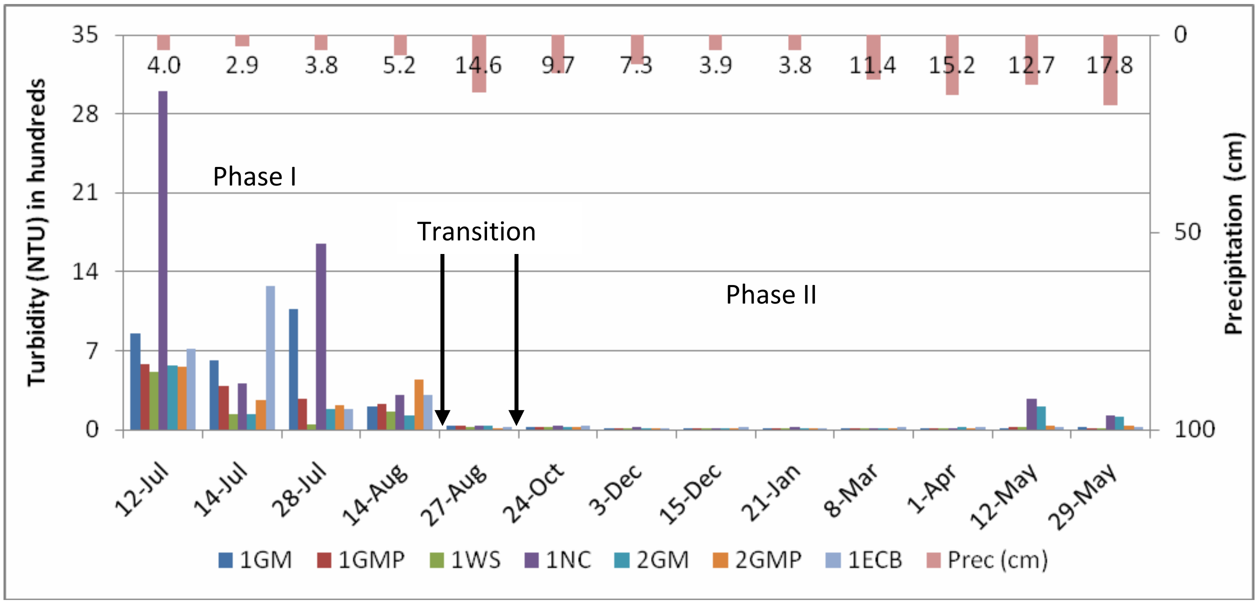



Figure 6. Turbidity, NTU, by treatment and storm event.

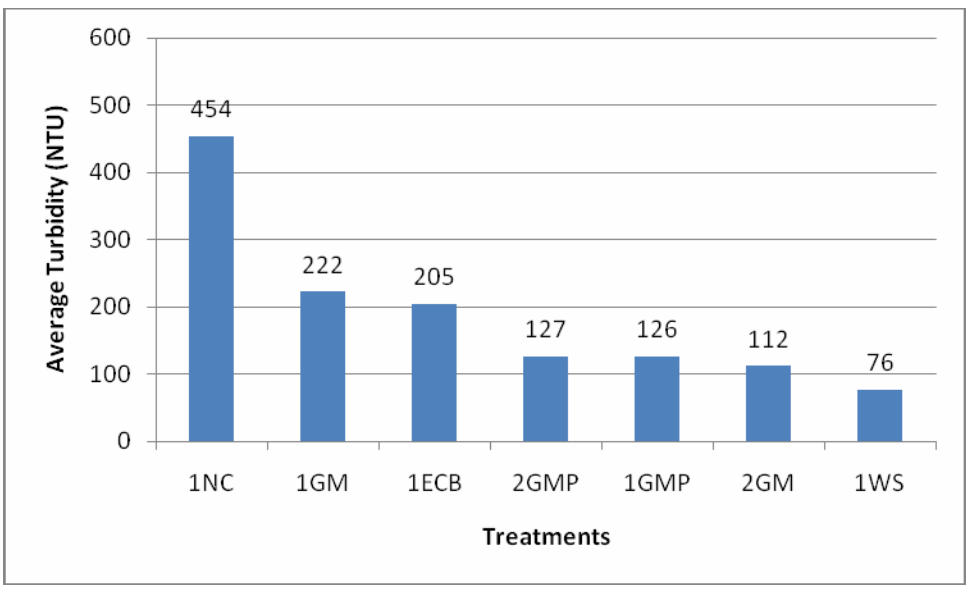



Figure 7. Average turbidity, NTU, during the one year study, by treatment.

***Correlation between TSS concentration and turbidity***

Moderate correlation ($R^2$=0.53) was observed between log values of TSS concentration and turbidity, indicating a positive relationship between the two, as expected. It is recognized that this relationship is valid only for the soils and under the test conditions of this study. Further validation using more rigorous sampling methods and analytical equipment may provide improved correlation.

## CONCLUSIONS

In this paper, one year results from 21 outdoor erosion and sediment control research plots are presented. The study objectives were to evaluate; 1) the effects of incorporating lime and fertilizer on establishment of bermudagrass on disturbed slopes, 2) the differences in bermudagrass establishment as a function of temporary covers including wheat straw, erosion control blankets, and hydromulch, 3) the effect of PAM with hydromulch on establishment of bermudagrass, and 4) the influence of above variables on runoff, sediment delivery and turbidity compared to seeded no cover control plots. Bermudagrass seeded treatments used in the study were: 1NC – seeded no cover (control); 1ECB - erosion control blanket; 1GM - hydromulch w/ pre-incorporation of fertilizer; 1GMP - hydromulch+PAM w/ pre-incorporation of fertilizer;1WS - wheat straw; 2GM - hydromulch w/o incorporation of fertilizer; and 2GMP - hydromulch+PAM w/o incorporation of fertilizer (2GMP).

Results indicated three vegetative cover phases; 1) a mechanical erosion control phase before 90 DAP, 2) a transition period at about 90 DAP, and 3) a vegetated erosion control phase following stand establishment after 90 DAP. Results indicate the following ranking in terms of runoff reduction during the most critical first phase (most to least); 2GM, 1GMP, 1WS, 2GMP/2GM, and 1ECB; and corresponding ranking in terms of soil loss reduction; 1WS, 1GMP, 2GMP, 1ECB, 1GM, and 2GM. Observed percent bermudagrass cover ranking at approximately 60 DAP was (most to least); 1GM (84%), 2GM (73%), 1GMP (68%), 2GMP (67%), 1ECB (59%), 1WS (33%), and 1NC (30%). Adding PAM to hydromulch did not significantly improve cover establishment; however, hydromulch treatments had quicker percent establishment than erosion control blanket or loose straw. Performance of treatments in terms of turbidity relative to the seeded no cover control at <90 DAP indicates the following ranking (most to least); 2GM, 1WS, 1GMP/2GMP, 1ECB, and 1GM.

The addition of PAM to the two hydromulch treatments did not consistently decrease turbidity; nor did incorporation of lime and fertilizers into soil before planting. Lime and fertilizer incorporation and PAM, when applied together, did not lessen turbidity. The decline of common bermudagrass after the first year of this study is a major concern that merits close attention as this work continues through 2009. Additional replicated studies and sites are recommended to further evaluate the effects of incorporating lime and fertilizer during seedbed preparation on grass stand establishment and longevity, as well as effects of PAM on stand establishment.