Shasta College Erosion Control Training Facility Hydro Mulch Trials:

Does the Application Rate of 4,536kg/ha (4,000lbs/acre) of

Hydro Mulch Inhibit Native Grass Germination and Establishment?

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John McCullah, Watershed Geologist and CPESC #311, owns Salix Applied Earthcare, a consulting firm in Redding California. Since 1994, the company has been implementing Erosion Control, Watershed Restoration, Bioengineering and Biotechnical Stream bank Stabilization projects.
Mr. McCullah provides construction and biotechnical erosion control expertise for the purpose of training, developing educational materials, and implementing “on the ground” projects.
Mr. McCullah and Salix, along with their partner BlinkWorks produce the erosion control training video series *Dirt Time*.
He is also the developer of the popular software design manuals: *ErosionDraw, BioDraw*, and *ESenSS*.
Mr. McCullah was one of the principle researchers of National Cooperative Highway Research Program (NCHRP) Report 544 – Environmentally-Sensitive Channel and Bank Protection Measures.

Tara Petti, Watershed Manager, was recently employed by Salix Applied Earthcare in the spring of 2009. She has worked in the watershed restoration field; both on the east and west coast, since she graduated with a Bachelors of Science degree in Natural Resources Planning from Humboldt State University, CA in 2004.

Henry A.Green was educated at Parkland and Colby JR. Colleges, Beloit University, the University of Illinois, and is currently participating in classes at Shasta College in Redding, CA. He is a graduate of IAAM’s two-year Public Assembly Facility Management School and the Graduate Institute program at Oglebay, WV and IAAM’s Senior Executive Symposium at Cornell University. Henry was the student lead on the hydro mulch test study at the Shasta College Erosion Control Facility. He participated in the study design and was responsible for data collection and documentation.

Abstract:

Beginning in December of 2008, Shasta College's Instructor John McCullah and his students from the watershed restoration class started hydro mulch test trials, at the Shasta College Erosion Control Training Facility, with the goal of answering the question"Does the application rate of 4,536 kg/ha (vs. 2,268 kg/ha) inhibit native grass seed from germination and growth?"

The study included 18 test plots (15ft x 10ft) on a 2:1 grade that had been track walked by a bulldozer. Using native California grass seed (Nasella pulchra), the plots were seeded before being hydro mulched and chosen plots were fertilized using Biosol and AM120 Mychorrizae. Six different products were applied, including Cotton Fiber Matrix, Flexterra, Soilguard, Terrawood, HydroStraw and Compost. Two control plots were established. One was track walked with no further treatment and the other was track walked, seeded and fertilized at the same rate as the other test plots. The study included four test plots for each product. The application rate was set at 2,268 kg/ha and at 4,536 kg/ha. Students observed grass growth on each plot, each products' ability to prevent erosion, and product retention on the soil surface in order to compare the effectiveness of the tested applications and to determine if 4,536 kg/ha application rates would inhibit seed germination and grass growth.

Conclusions:
Student observations showed no indication that the application of any hydro mulch product tested in this study, at the rate of 4,536 kg/ha, inhibits seed germination or growth more than an application rate of 2,268 kg/ha. The application rate of 4,536 kg/ha appears to have performed better in terms of erosion control, soil stability and product retention through only one rain season.
Finally, the compost application of a 5cm (2") blanket of medium screened, locally produced compost product performed significantly better in all criteria (time to seed germination, quantity of seed germinated, growth , erosion control effectiveness, product retention on the plot) than any of the other hydro mulches tested.

Keywords: *Hydro Mulch, Erosion Control, Slope Protection*

I. Introduction:

The application of hydro mulch on slopes for erosion control and plant establishment is commonly used in the sediment and erosion control industry. Applying the proper amount of hydro mulch to protect slopes from soil loss and simultaneously promote seed germination and plant growth is imperative to permanent site stabilization. Product retention on the soil surface controls erosion, but will the application of too much hydro mulch inhibit seed germination and plant growth? Beginning in December of 2008, Shasta College's Instructor John McCullah and his students from the watershed restoration class, conducted hydro mulch trials to determine if *the application rate of 4,536kg/ha (4000lbs/acre) of hydro mulch (vs. the application rate of 2268kg/ha ((2000lbs/acre)) inhibits native grass seed germination and growth.*

Seed germination and plant growth in plots treated with various hydro mulches at rates equivalent to 2,268kg/ha (2,000lbs/acre) and 4,536kg/ha (4,000lbs/acre) was observed and photo-documented. The study also observed the effectiveness of each hydro mulch treatment, at the 2,268kg/ha (2,000lbs/acre) vs. 4,536kg/ha (4,000lbs/acre) application rates, in terms of erosion control and product retention on the soil surface.

The study took place in Redding California at the Shasta College Erosion Control Training Facility, during the 2008/2009 (December-May) rainy season. The facility is a testing ground for cutting edge erosion control products and BMP techniques, and a hands-on learning center for students in the Heavy Equipment Operators Certification Program. The site includes a mountain of soil for slope tests, flat land with a slight grade for sheet flow testing, and a flood channel for stream erosion studies.

II. Method:

The study was conducted on 18 test plots 3m x 4.57m (15ft x 10ft), including a compost plot, and two control plots. The study site was situated on a 2:1 grade. The soil is "tractor packed" imported subsoil, pretty typical of a construction site.

Students constructed an in-sloping bench behind the crest of the slope to prevent storm water inundation from the hillside above. The plots were vertically track-walked with a bulldozer, and then seeded on December 16, 2008 with 85 grams of a native seed blend (equivalent to 33.75kg/ha (30 lbs/ ac)). The blend contained 1/3 Nassella pulchra (Purple Needle Grass - the CA State Native Grass) and 2/3 Elymus glaucus (Blue Wild rye). Students uniformly hand seeded all treated plots. Biosol fertilizer (6-1-3 NPK) at a rate of 562.5kg/ha (500lbs/ac) and AM 120 Mycorrhizae at a rate of 22.5kg/ha (20lbs/acre) were applied to all the test plots (except the compost plot) by hand.

Subsequent to seeding and fertilizing, four different hydromulch products were applied using a Finn hydroseeder: Soilguard-Bonded Fiber Matrix, HydraCX2 Cotton Fiber Reinforced Matrix-NAG, Flexterra Flexible Growth Medium, TerraWood-hydraulic mulch. Each product was applied to four test plots, with the application rate set at 2,268kg/ha on two test plots and at 4,536kg/ha on two test plots. HydroStraw was applied to one test plot at a rate of 4,536kg/ha to determine if the application rate will inhibit seed germination and grass growth, and for comparative purposes with other products at the same application rate. Additionally, 5cm (2") of medium screened, locally produced compost was applied to one test plot over a seed application of the same grass species mix and rate as the other plots (33.75kg/ha). On December 18, the compost plot was split in half and seed was applied to the top of one half, leaving half the plot with the seed under 5cm (2") of compost and half the plot with seed under and on top. This test plot was installed to determine if a 5cm layer of compost would inhibit seed germination and grass growth and for comparative purposes with the other plots. Two control plots were established. One was track-walked, seeded and fertilized with Biosol at 562.5kg/ha and mycorrhizae at 22.5kg/ha, the same rate as the hydro mulched plots, and the other plot was track-walked with no additional treatment.

Observations were made at several times during the semester following the planting in December. Photo documentation was used to make comparative observations between the plots treated with different hydro mulches at the two application rates. The plots were viewed in detail and photographed, and a subjective grading system was employed to evaluate the differences in performance. Each plot was evaluated on three criteria: 1. Seed germination and grass growth. 2. Erosion control effectiveness of the product. 3. Retention of product on the plot.

The first two criteria were assessed by giving the performance a number from 1 – 5 (1 –low; 5 – high) comparing the plots to each other. The products that were applied more than once at particular application rates were evaluated individually, combined and averaged to formulate an overall score for each application rate for each product. Seed germination and grass growth were evaluated by observing how much of each plot was covered with grass in comparison to other plots. Erosion control effectiveness was evaluated by observing fine soil particle depletion on the slope and the resulting exposure of larger material i.e. pebbles/stones, and by the presence of fine soil plumes below the test plots. The third criteria assessment was made as an observation of degree of soil exposure. “Little product retention” was given a score of 1, “good product retention” was given a score of 2, and “no product retention” was scored 0 for comparative purposes.

III. Observations:

For approximately 6 weeks after planting the weather was cold with no precipitation. In early January, minimal seed germination and minor plant growth was observed on all plots due to generally cold and dry conditions. The one product that showed observable difference was the compost blanket. More seed germination and grass growth was observed on this plot than all other test plots.
See Figure 1: comparative photos of Flexterra FGM applied at 4,526 kg/ha and the compost plot.

Figure 1:

Flexterra FGM at 4,536kg/ha (4,000lbs/acre) showing minor growth. January 1, 2009

Compost Blanket showing more growth than other treatments. January 1, 2009

Observations in February 2009 showed that all of the plots continued to show minor growth under the same cold, dry weather conditions. See Figure 2.

Figure 2:

Minor plant growth was observed on test plots. February 6, 2009

More detailed observations were made during the week of Mar.19, 2009. These observations followed a period of accelerated precipitation and a ten year rain episode on Mar.14, 2009: 3.8cm (1.5") / hour for 1 hour. The subjective grading system was employed to evaluate differences in performance. See Table 1 for the students' observations of the hydro mulch applications.

The following figures depict photo representations of the students' observations.

Figure 3 is a comparison of the Cotton Fiber Matrix applied at 2,268kg/ha and 4,536kg/ha. Native grass established on each plot; marginally more grass growth was observed on the 4,536kg/ha test plot than the plot with the 2,268kg/ha application. Fine soil particle depletion on the slope and resulting exposure of larger material i.e. pebbles/stones was observed on the 2,268kg/ha test plot but not on the 4,536kg/ha plot. Product retention on the soil surface was evident on the 4,536kg/ha plot, but not evident on the 2,268kg/ha plot.

Figure 4 documents the comparison between applications of 2,268kg/ha and 4,536kg/ha of TerraWood. Native grass established on each plot; more grass growth was observed on the 2,268kg/ha test plot than the plot with 4,536kg/ha application. Fine soil particle depletion on the slope and resulting exposure of larger material i.e. pebbles/stones was observed on the 2,268kg/ha test plot but not on the 4,536kg/ha plot. Product retention on the soil surface was more evident on the 4,536kg/ha plot, than the 2,268kg/ha plot.

Figure 5 documents the comparison between applications of 2,268kg/ha and 4,536kg/ha of Flexterra. Native grass established on each plot; marginally more grass growth was observed on the 4,536kg/ha test plot than the plot with 2,268kg/ha application. Fine soil particle depletion on the slope and resulting exposure of larger material i.e. pebbles/stones was observed on the 2,268kg/ha test plot but not on the 4,536kg/ha plot. Product retention on the soil surface was more evident on the 4,536kg/ha plot, than the 2,268kg/ha plot.

Figure 6 documents the comparison between applications of 2,268kg/ha and 4,536kg/ha of SoilGuard. Native grass established on each plot; more grass growth was observed on the 4,536kg/ha test plot than the plot treated with 2,268kg/ha. Fine soil particle depletion on the slope and resulting exposure of larger material i.e. pebbles/stones was observed on the 2,268kg/ha test plot but not on the 4,536kg/ha plot. Product retention on the soil surface was more evident on the 4,536kg/ha test plot, than the 2,268kg/ha plot.

Figure 7 is a photo documentation of the compost plot on April 2nd and April 16th. More native grass growth was observed on the compost plot than any other test plot. There was no observable difference between the section with seed applied under the compost blanket and the section with seed applied under and on top of the compost blanket.

Figure 3:

	
HydraCX2 Cotton Fiber Reinforced Matrix-NAG Applied at 2,268kg/ha.(2,000lbs/acre) March 20,2009	*HydraCX2 Cotton Fiber Reinforced Matrix-NAG at 4,536kg/ha.(4,000lbs/acre) March 20, 2009*

Figure 4:

	
TerraWood Applied at 2,268kg/ha. (2,000lbs/acre) March 20, 2009	*TerraWood Applied at 4,536kg/ha. (4,000lbs/acre) March 20, 2009*

Figure 5:

Flexterra Applied at 2,268kg/ha. (2,000lbs/acre)
April 2, 2009

Flexterra Applied at 4,536kg/ha. (4,000lbs/acre)
April 2, 2009

Note the product retention on the plot treated with 4,536kg/ha (4,000lbs/acre) vs. the plot treated with 2,268kg/ha (2,000lbs/acre).

Figure 6:

Soil Guard Applied at 2,268kg/ha.(2,000lbs/acre)
April 2, 2009

Soil Guard Applied at 4,536kg/ha. (4,000lbs/acre)
April 2, 2009

Figure 7:

Compost Application of 5cm
April 2, 2009

Compost Application of 5cm
April 16, 2009

Seed was applied under the compost blanket on half the plot and applied under and over the compost blanket on the other half of the plot.

IV. Results:

Based on the observational ratings by students, the following comparisons of application rates of each hydro-mulch tested in the study were made.

The 4,536kg/ha (4,000lbs/acre) application rate of the Cotton Fiber Matrix was marginally less effective in terms of established seed germination and plant growth than the 2,268kg/ha rate(2,000lbs/acre). The higher application rate was more effective at controlling erosion and was still visible on the soil after the first rain season. See figure 8

TerraWood was marginally less effective in terms of seed germination and plant growth at the 4,536kg/ha (4,000lbs/acre) application rate than the 2,268kg/ha (2,000lbs/acre) rate. However the higher application rate outperformed the 2,268kg/ha (2,000lbs/acre) rate in erosion control effectiveness and product retention. See figure 9.

Flexterra FGM was marginally less effective in terms of seed germination and plant growth at the 4,536kg/ha (4,000lbs/acre) rate than the 2,268kg/ha rate (2,000lbs/acre). The 4,536kg/ha rate performed substantially better in terms of erosion control effectiveness and product retention on the soil. See figure 10.

The 4,536kg/ha (4,000lbs/acre) application rate of Soil Guard was more effective than the 2,268kg/ha (2,000lbs/acre) rate in all aspects under study. See figure 11.

Figure 8:

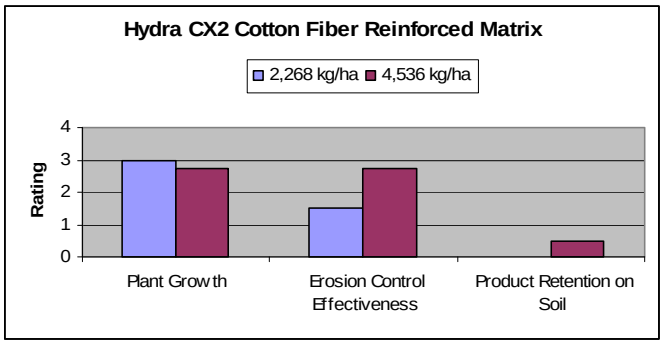


Figure 9:

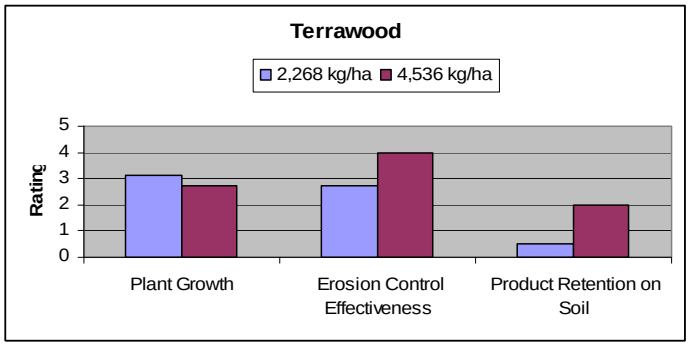


Figure 10:

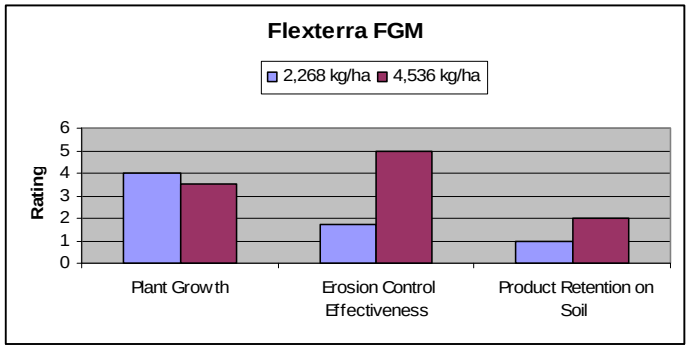
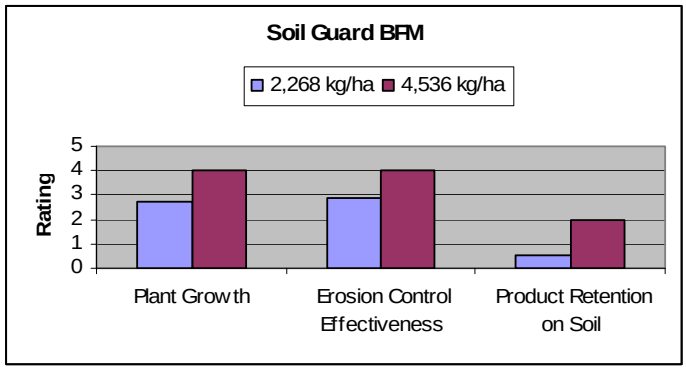


Figure 11:



Students also used the observational ratings to compare the performance of the hydro mulches to each other at the 4,536kg/ha application rate (and to the compost application at 5cm). Applications were compared for plant growth, erosion control effectiveness, and product retention on the soil. Figures 12, 13 and 14 represent the results of those comparisons.

The compost treatment out performed all products applied at 4,536kg/ha (4,000lbs/acre) in seed germination and grass growth. It scored the highest, along with Flexterra FGM, in erosion control effectiveness. Finally, it retained on the soil surface as well as all other products applied at 4,536kg/ha. At this time, the compost plot has the best grass establishment with no discernible difference between treatments (seed application under the compost only as opposed to seed under and on top of compost). See figure 15.

Figure 12

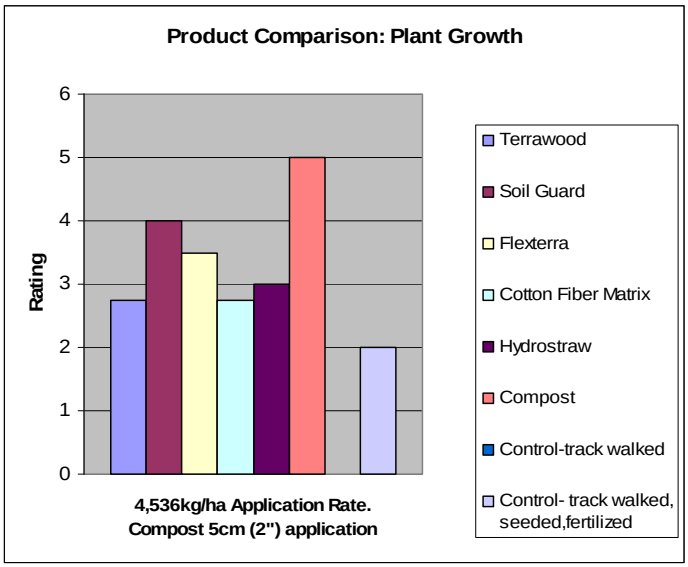


Figure 13

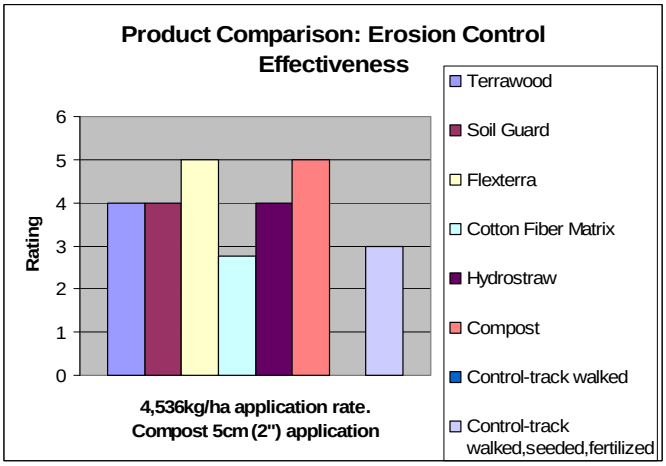


Figure 14

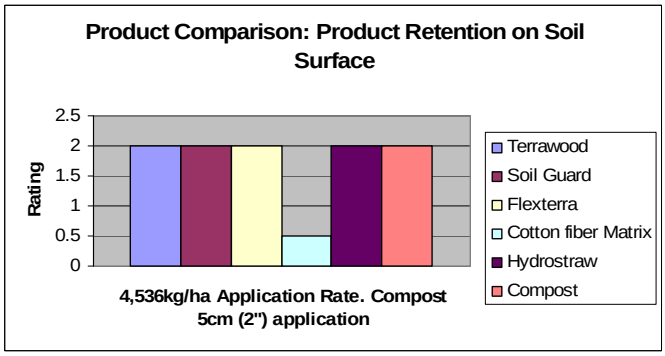


Figure 15

Compost plot in foreground showing more growth than other test plots.

V. Conclusion:

The application rate of 4,536kg/ha (4,000lbs/acre) of the hydro mulch products utilized in this study resulted in no observable difference in seed germination or plant growth than the application rate of 2,268kg/ha (2,000lbs/acre). The observations indicate that the application rate of 4,536kg/ha does not inhibit seed germination and plant growth. Furthermore, plots treated with 2,268kg/ha applications did not perform as well as those treated with 4,536kg/ha in terms of erosion control effectiveness, soil stability and product retention through the first rain season.

The plot treated with two inches of compost outperformed the hydro mulch products utilized in this study in all observed criteria: time to seed germination, quantity of seed germinated, rate of growth, erosion control effectiveness, and product retention on the soil surface.

Hydro mulch should be applied at rates that effectively limit erosion and still allow seed germination and growth of vegetation for permanent stabilization. While application rates of 2,268kg/ha allow seed germination and plant growth, the study found such a rate is not as effective in preventing surface erosion as a 4,536kg/ha rate. The long, intense winters in northern California, coupled with the slow establishment rate of native grasses make temporary soil surface stabilization imperative to control erosion and establish vegetation on disturbed areas. Product retention on the soil is the only defense against soil loss until vegetation gets established. Since there was no observable difference in seed germination or plant growth between both application rates, but there was a visible difference in product retention, the study participants from Shasta College Erosion Control Training Facility recommend applying hydro mulch at 4,536kg/ha to prevent erosion and facilitate the establishment of native grass cover on 2:1slopes.

One cannot overlook the performance of the compost blanket in preventing soil loss and establishing native grass cover. Native seed (Nassella and Elymus specifically) will, in fact, germinate and grow from under a 5cm (2") compost blanket.

It should be noted that the native seeds used in the study are relatively large seeds. Germination and establishment of species with smaller seed (i.e. forbs or annuals) under an application of 4,526kg/ha of hydromulch was not evaluated in this study.

Table 1:

Treatment	Plot Number	Seed Growth Density	Erosion Control Effectiveness	Product Retention on Soil	Notes
Control	n/a	0	0	0	Track walked
Control	17	2	3	n/a	Track walked, Seed and Fertilizer applied
Compost- 2" layer	n/a	5	5	100%-1	
Terrawood					
2,268kg/ha	1	2.75	2.5	0	
2,268kg/ha e	11	3.5	3	Little product retention-1	
4,536kg/ha	12	3	4	Good product retention-2	
4,536kg/ha	16	2.5	4	Good product retention-2	
Soil Guard					
2,268kg/ha	2	2.5	2	Little product retention-1	
2,268kg/ha	7	3	3.75	0	
4,536kg/ha	4	4	4	Good product retention-2	Seeds slow to germinate
4,536kg/ha	10	4	4	Good product retention-2	
Flexterra					
2,268kg/ha	8	4.5	2.5	Little product retention-1	
2,268kg/ha	13	3.5	1	Little Product retention-1	
4,536kg/ha	3	4	5	90%-1	Seeds slow to germinate
4,536kg/ha	5	3	5	100%-1	
Cotton Fiber Matrix					
2,268kg/ha	6	3	2.5	0	
2,268kg/ha	14	3	.5	0	
4,536kg/ha	9	3.5	2.5	Little product retention-1	
4,536kg/ha	18	2	3	Good product retention-1	
Hydrostraw					
4,536kg/ha	15	3	4	Good product retention-1	