FIVE DIFFERENT VEGETATIVE STABILIZATION METHODS USED ON COPPER TAILING IN CENTRAL ARIZONA.*

by
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ABSTRACT:

Five, one acre, test plots were established in 1990 to test the effects of various mulching and fertilizer techniques on soil covered copper tailing. The goal was to maximize vegetative establishment of seeded species, minimize salt cedar competition, and to stabilize the site from wind and water erosion at this arid Sonoran Desert site. Tests included: standard 1-ton/acre wood cellulose hydromulch, 1-ton/acre barley straw, 1/2-ton/acre wood cellulose hydromulch, and 1-ton/acre of humic based fertilizer with 1-ton/acre hydromulch. The results of this test point towards the use of the humic based fertilizer. While the straw mulching showed some improvement in overall vegetative cover, the humic based fertilizer proved to result in far less salt cedar (*Tamarix pentandra*) competition. These tests have led to further testing of the humic based fertilizer.

ADDITIONAL KEY WORDS: humic based fertilizer, Sonoran Desert, straw mulch, wood cellulose mulch, salt cedar competition,copper tailings.

*Paper to be presented at May, 1993 American Society for Surface Mining and Reclamation Annual Meeting, Spokane, WA.

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Proceedings America Society of Mining and Reclamation, 1993 pp 436-442
DOI: 10.21000/JASMR93010436

https://doi.org/10.21000/JASMR93010436

Introduction:

The copper tailings to be stabilized are located near the town of Hayden, AZ approximately 50 miles north and east of Tucson and 80 miles east and south of Phoenix. The site is located in the Sonoran Desert near the confluence of the San Pedro and Gila Rivers. The elevation of the site is approx. 2000 ft. MSL.

The climate at this site is characterized as semi-arid. Temperatures often reach more than 100 degrees fahrenheit for several consecutive weeks from May through September. In the winter temperatures can dip well below freezing for a few days from December through January. Rainfall, which averages 12.30 inches/year, falls in two distinctive rainy seasons. The largest amount of rain, 42% of annual precipitation (5.13 inches), falls during the summer in what is called the monsoon weather pattern. The other major rainy season runs from December through March with a total of 4.56 inches (26% of the annual total). May and June are the driest months of the year (see Table 1.). Often summer evaporation rates may exceed 100 inches/month, and coupled with the extreme temperatures, makes the revegetation sites that much more arid in character.

Table 1: Rainfall distribution

J	F	M	A	M	J	J	A	S	O	N	D
1.05	1.17	1.04	.34	.24	.25	1.72	2.30	1.16	.83	.90	1.3

Total Annual Rainfall = 12.30 inches
(data records from 1927-1991)

The test plots are located on the upper level of the tailing impoundment. This copper tailing slope had remained inactive for a period of 2 or more years. The tailing slope is constructed of the coarser sand materials deposited near the outer perimeter of the tailing impoundment in a upstream tailing disposal method. The outer dike is constructed utilizing wide tracked dozers pushing the coarse sands up to form the dike after the tailing has been allowed to dry for a few months. Each test plot is approximately 1-acre in size. Plots number one, two, and one-half of number three have a northern aspect with a slope of 1.5:1. Plots number four, five, and the second-half of number three have a western aspect with a slope of 2:1 to 2.5:1. The pH of the tailing on this level ranges from 7.44 to 7.88.

Stabilization Methods

Soil Capping:

Prior to applying any of the mulch and fertilizer treatments, all five plots were capped with a soil material borrowed from a sediment trap below the tailing impoundment. This soil material was extremely silty in nature, was extremely salty, and was not much of any improvement over the raw tailings. The soil material was also heavily infested with salt cedar (Tamarix pentandra). The pH of the soil material ranges from 7.72 to 8 with total salts at over 2300 ppm. A chemical analysis of the soil material is provided in Table 2. The capping was accomplished using scrappers and graders. The material was excavated by scrapper and hauled to the top of the tailing slope. On the western exposure of the slope (slope angle 2:1 or less) the scrapper simply drove down slope depositing the soil material as it traveled. On the northern exposure of the slope (angle of slope 1.5:1) the soil material was deposited on the top edge of the slope and pushed over the edge by a grader. Average depth of the soil capping was approximately 6-inches. The plots were all capped in May of 1990 with approximately 8600 cubic yards of the soil material spread over approximately 193,000 sq. feet of tailing slope. In the process of spreading the soil material over plots four, five, and one-half of three the soil was well mixed into the underlying tailing.

Table 2. Chemical Analysis of the Soil Capping Material

Element	Units
Iron	< .1 ppm
Magnesium	56 ppm
Manganese	< .05 ppm
Sodium	38 ppm
Nitrogen	1.8 mg/kg
Phosphorous	3.4 mg/kg
Potassium	274 mg/kg
Cation Exchange Capacity	9.4 meq/100g
Total Dissolved Solids	2318 ppm

Species Seeded:

Each of the plots was hydroseeded in late August of 1990 with the following seed mix:

3 lbs. "Cochise" lovegrass (Eragrostis trichophora)
5 lbs. Lehman's lovegrass (E. lehmanniana)
15 lbs. bufflegrass (Cenchrus ciliare)
8 lbs. alkali sacaton (Sporobolus airoides)
10 lbs. bermuda (Cynodon dactylon)
12 lbs. Klien's grass (Panicum colorastrum)
(all ssed rates = bulk lbs./ac.)

The bermuda grass was only applied to the upper edge of the slope to maximize erosion control along the top edge. This seed mix was applied as the first-step of a 2-step hydroseeding technique. This first step involves hydroseeding the seed mix along with 200 lbs. of hydromulch material onto the slope first. The final rates of hydromulch were then applied on top of this mix in a second-step. This technique helps to alleviate the problem of fine, tiny seeds being suspended away from the soil surface in a heavy layer of mulch.

Mulching Methods:

Immediately after the plots were hydroseeded the plots were mulched according to the tests to be evaluated. Plot #1 was treated with 1-ton of wood cellulose hydromulch. Plot #2 was treated with 1-ton of barley straw mulch tackified with 300 lbs. of wood cellulose hydromulch and 150 lbs. of "AZTAC" natural gum binder. Plot #3 was topmulched with 1/2-ton of wood cellulose hydromulch. Plot #4 was not topmulched. Plot #5 was treated with 1-ton of humic based fertilizer (combined with the seed mix in the first-step hydroseeding) and topmulched with 1-ton of wood cellulose hydromulch. The humic based fertilizer used was a product known as "GRO-POWER". This product is a 5-3-1 formula fertilizer with 50% humus. The guarenteed analysis is provided in Table 3.

Table 3. Guarenteed Analysis of "GRO-POWER"

Element:	Measure:
Total N	5%
1% Ammoniacal N	
4% Urea N	
Available P2O5	3%
Soluble K2O	1%
Fe	1%
Mn	.05%
Zn	.05%
Humic Acids (derived from compost)	15%
Bacteria (common aerobic/anaerobic soil & airborne organisms)	min. 60,000/100gr.

Irrigation:

Due to the extreme aridity of the site, supplemental irrigation was installed. This technique involved "micro-sprinklers" set on 25 foot centers. This type of sprinkler irrigation waters a 25-30 foot diameter circle. The "micro-sprinklers operate on low water pressure (15-20 psi) and distribute 32-45 gallons per hour. Irrigation schedules were set at approx. 8 hours/day, every other day. The irrigation began immediately after seeding. There was some wind distortion of the sprinkler patterns which left some areas between the sprinklers dry. This produced uneven germination and establishment of the seeded species. Irrigation began to be reduced in November 1990 and continued sporadically through 1991. In January 1992 the irrigation was discontinued completely.

Observations

The first germination of seeded species was noted in September 1990. Some evidence of salt burn and chlorosis of the leaves was observed at this time. This was probably due to the high salinity of the capping material (2800 ppm TDS). By November 1990 all plots had overall good germination and some seeded species were beginning to become established. Some species were beginning to develop seed heads. Salt cedar seedlings were beginning to become noticeable by this time. It appeared that bermuda and the lovegrasses were the dominat species. The first vegetative transects were conducted on all plots at the end of January 1992. Each transect consisted of a simple 100-foot linear lape randomly laid diagonally across the slope of each test plot. A single transect was taken on each plot. At each 1-foot interval point was dropped to the ground and the observation of intercept recorded. If the point intercepted the root crown or main stem of the plant it was recorded as a "basal" intercept. If the point passed through the vegetative crown or top growth of the plant it was recorded as a "crown" intercept. Only 1-transect was permanently established between 2-metal stakes on each of the plots. Future transects taken on each plot will document changes in vegetative ground cover or denisty and species composition. These transects were conducted to determine total groundcover, species composition, and percent of bare ground. The following observations were made at that time:

<u>Plot #1:</u>

The 1-ton/acre hydromulch had 73% total vegetative cover, consisting of 27% basal and 46% crown cover. A total of 2% of the slope had litter cover and 7% of the slope had bermuda stolon runners covering the surface. Only 18% of the slope was bare ground. Of the total 73% basal and crown vegetative ground cover, 63% was bermuda, 23% was lovegrass, 10% was salt cedar seedlings, and 4% was sacaton.

<u>Plot #2:</u>

The 1-ton/acre barley straw mulch had a total of 80% vegetative ground cover, consisting of 28% basal and 52% crown cover. A total of 16% of the slope had straw litter, with 3% of the slope with bermuda stolon runners. Only 1% of the slope was actual bare ground. Of the total 80% basal and crown vegetative ground cover, 78% was bermuda, 19% was lovegrass, 2% was salt cedar seedlings, and 1% was sacaton.

<u>Plot #3:</u>

The 1/2-ton/acre hydromulch had a total vegetative ground cover of 76%, split between 25% basal and 51% crown cover. A total of 2% of the slope was covered with litter and 8% had bermuda stolon runners on the surface. A total of 14% of the slope surface bare. Of the total 76% basal and crown vegetative ground cover, 57% was bermuda, 40% was lovegrass, and 3% was salt cedar. No sacaton was found in this plot.

<u>Plot #4:</u>

The plot with no hydromulch had a total vegetative ground cover of only 62%, 12% of this was basal cover, while 50% was crown cover. A total of 1% of the slope was covered with litter with 8% of the slope covered by bermuda stolon runners. A total of 29% of the slope surface remained bare. Of the total 62% basal and crown vegetative ground cover, 63% was bermuda, 31% lovegrass, and 6% was sacaton. Although no salt cedar was recorded within the transect, it constituted a major component of the species composition on the plot.

Plot #5:

The 1-ton/acre hydromulch, plus 1-ton/acre humic fertilizer, had a total vegetative ground cover of 79%, with 35% basal cover and 44% crown cover. The remainder of the transect showed 1% bermuda stolon runners with very little litter observed. A total of 20% of the plot was bare. Of the total 79% basal and crown vegetative ground cover, 63% was lovegrass, with 29% bermuda and 8% sacaton. There was very little evidence of any salt cedar in the entire plot.

Table 4. Results of Transects

Plot:	Total % Veg.Grd.Cover:	Total % Cover by Species: Cyda	Er.sp.	Spai	Tape
1	73	63	23	4	10
2	80	78	19	1	2
3	76	57	40	0	3
4	62	63	31	6	0
5	79	29	63	8	0

(Cyda=Cynodon dactylon; Er.sp.=Eragrostis sp.; Spai=Sporobolus airoides; Tape=Tamarix pentandra)

Conclusions

Of all the plots, Plot #2, the 1-ton/acre straw mulch, produced the most overall vegetative cover. This plot also had the most litter over bare ground (as may well be anticipated). Plot #5, with the 1-ton/acre hydromulch PLUS 1-ton/acre humic fertilizer, was very close in total vegetative ground cover was the most impressive visually. Plot #5 had the highest percentage of basal cover, the most vigorous growth, and the best response of lovegrass and sacaton establishment (see Table 4.). Also Plot #5 had the very least infestation of salt cedar. This may be due to the early stimulation of germination and establishment of the grasses. This grass competition may have been too much for the salt cedar to become established.

There appears to be very little difference between Plots #1 and #3, 1-ton/acre hydromulch vs. 1/2-ton/acre. This could indicate that 1/2-ton of hydromulch is just as effective as 1-ton. The cost savings by reducing hydromulch could be as high as $100 or more per acre. The advantages of using the 1-ton/acre humic based fertilizer (with 1/2-ton hydromulch) over the 1-ton/acre barley straw could be as much as $500 per acre.

These tests indicated that significant savings in revegetation costs could be achieved while maintaining a very high level of vegetative establishment. Further testing of the humic based fertilizer is being conducted to determine rates of application and vegetative responses. Tests conducted without supplemental irrigation resulted in very poor establishment the first growing season due to insufficient rainfall that year. As the seasons progress perhaps enough data can be collected to determine the effect of rates on vegetative establishment. Other tests are being conducted to also test alternative humic based fertilizer products that may save even more money.