Research Report
KTC-08-16/SPR360-08-1F

KENTUCKY TRANSPORTATION CENTER

COMPOST FOR STEEP SLOPE EROSION

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Compost for Steep Slope Erosion

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16. **Abstract**

This study was initiated to develop guidelines for maintenance erosion control measures for steep slopes. The study focused on evaluating and monitoring KY-31 fescue germination rates using two media treatments 1) 100 percent by weight compost and 2) 70 percent compost with 30 percent soil) with different seeding rates on a pilot project to establish vegetation on slopes with grades of 3:1 or steeper.

The pilot program demonstrated that weed infestation and erosion problems on slopes can be minimized by use of properly formulated compost with sufficient seed. It also showed that the seeding rate of 1 lb/1,000 ft^2 slope area currently employed by KYTC for erosion control was not sufficient for the steeper slopes.

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EXECUTIVE SUMMARY

The Kentucky Transportation Cabinet (KYTC) initiated the study KYSPR 08-360 "Compost for Steep Slope Erosion" to develop guidelines for maintenance erosion control measures for steep slopes. KYTC also sought to implement improved practices for controlling erosion along stream embankments. The study tasked UK/KTC researchers with evaluating and monitoring KY-31 fescue germination rates using two media treatments 1) 100 percent by weight compost and 2) 70 percent compost with 30 percent soil) with different seeding rates on a pilot project to establish vegetation on slopes with grades of 3:1 or steeper.

The study incorporated seeding rates at 1, 3 and 5 lb/1,000 ft^2 slope area using the two aforementioned media treatments that covered the ground to a depth of approximately 2". A pilot program was initiated at mile marker 92 on I 64 Westbound near Lexington to evaluate germination rates and ground coverage. The ground coverage was estimated from the germination rates of grass. This location was chosen as it had an embankment slope approximating 3:1 on the right-of-way and was facing south for maximum sun exposure. The site was prepared by clearing all existing vegetation on the embankment and establishing twenty four 12 foot-square plots. Application of media and seeding was contracted to a local firm. The site was monitored during the application of media/seeding and thereafter for six months beginning in October 2007 thru March 2008 to determine the resulting ground coverage and seed germination rates.

The major study finding was that the seeding rate of 1 lb/1,000 ft^2 slope area currently employed by KYTC for erosion control was not sufficient for the steeper slopes. Other conclusions based solely on this pilot program are 1) for immediate coverage of at least 50%, a seeding rate of 5 lbs per 1,000 ft^2 with compost/soil media was the best alternative, 2) for coverage in the long term, a seeding rate of 3 lbs with compost/soil media was the best alternative.

Recommendations for this study are: 1) increase the seeding rate to at least 3 lbs per 1,000 ft^2 to get a coverage of at least 50%, 2) conduct more pilot programs with more variety of seeds to check their germination rates, at sites with different soils, slopes and exposures, and 3) perform cost analysis to identify the best seeding rates and varieties for the various geographical regions in Kentucky.

1. INTRODUCTION

1.1 BACKGROUND

The Kentucky Transportation Cabinet (KYTC) has much land on rights-of-way adjoining highways that must be maintained. That includes embankments with different slopes that should be stabilized and protected from erosion. Stabilization and erosion control are currently problematic on steep slopes (3:1 or greater). KYTC is seeking to implement improved practices for controlling steep slope erosion. The agency also desires to use compost as cover material for slopes to assist in stabilization and establishment of vegetation and elimination of weed infestation. This study, KYSPR 08-360 "Compost for Steep Slope Erosion", was performed to develop guidelines for erosion control measures for steep slopes as a maintenance activity by conducting a pilot program on one particular seed.

The study advisory committee specifically asked University of Kentucky (UK) researchers to determine the suitability of seeding rates of one pound per 1,000 ft^2 (and greater) for erosion control and proper establishment of ground vegetation. Budgetary constraints required UK researchers to narrow the focus to only KY 31 fescue for evaluation and limit testing to one pilot site.

1.2 OBJECTIVES AND RESEARCH SCOPE

The objectives approved by the Study Advisory Committee were:

1. Evaluate KY-31 germination rates in a 2-inch compost application using two media treatments (compost and compost with soil) on a road cut slope of 3:1 or greater;
2. Evaluate the germination/stand from seeding rates of 1, 3 and 5 lbs per 1,000 ft^2 of KY 31 fescue using the two media treatments;
3. Compare both compost treatments and the three seeding rates to develop a criteria for the establishment of vegetation on 3:1 or greater slopes and determine which media and seeding rate is more acceptable for establishing vegetation and reducing erosion on 3:1 or greater;
4. Project cost differences and percentage of improvement (if any) between the different trials;
5. Identify future research needs for the establishment of other vegetative species (creeping red fescue, crown vetch, sericea lespedeza, etc.) and other growth media (excelsior blankets, different compost/soil mixes, etc.).

To address these goals the UK researchers were assigned 3 tasks:

Task 1. Establish and monitor a pilot project with the following depth of compost, seeding application method, types of compost used, seeding rates and type of seed used. Two inches

deep compost will be applied using a blower truck, compost blended with soil and without soil, seeding rates at 1, 3 and 5 pounds per 1000 ft^2 using KY31 fescue.

Task 2. Prepare recommendations for design of compost for erosion control, compost application operations, necessary equipment, compost testing, worker safety requirements, estimation of compost cycle times, manpower requirements, and estimated costs.

Task 3. Prepare a final report reviewing all research work performed. Provide recommendations and guidelines on when seeding needs to take place, the appropriate seeding rates for KY31 seeds that are used for germination.

1.3 CURRENT KYTC PRACTICES

Current KYTC practice involves applying one pound of seed per 1,000 ft^2 and then spreading straw over top of the ground for erosion control. This resulted in plots/embankments being overcome by weeds and other unwanted vegetation. Also straw encourages weed growth.

2. PILOT PROGRAM AND OBSERVATIONS

The study pilot program began on October 15, 2007 with marking of twenty four 12 foot-square plots and clearing of all existing vegetation by spraying Roundup on the embankment with approximate slope of 3:1 at 92 mile marker along the westbound right-of-way on I 64 as shown in Figure 2. The plots were marked with spray paint and flags to differentiate between the different media treatments and composition of seeding rates that were to be applied. This particular location was chosen as it was south facing and will have lot of sunlight, within driving distance for University of Kentucky researchers to perform regular evaluations, and to keep travel costs down. The site had some top soil and rocks and was typical of the sites that KYTC was attempting to establish vegetation. The Study Advisory Committee was aware of the different soils and conditions between eastern and western Kentucky regions.

Advance Mulching Technologies Inc. of Lexington, KY was contracted to apply the two different media treatments (100% by weight compost and 70 % compost - 30 % soil mixture) for evaluation at a lump sum cost of about $1100. The treatments were applied on to designated plots using a truck mounted dispensing unit that covered all the plots with about 2" deep of media (Figure 3) and then the plots were hand seeded using a seed broadcaster. Figure 4 shows the plots after the application of treatments. For this pilot program, the cost of seed was estimated to be $1.25 to $1.75 per lb. The estimated hauling costs of media treatments by Advance Mulching Technologies Inc are $0.20 per mile per cubic yard. The cost of media treatments are 1) 100% compost is $25 per cubic yard and 2) 70% compost mix with 30 % soil is $35 per cubic yard. The price for applying approximately 5lbs of seed per 1000 ft^2 would be 0.45 to 0.65 cents a square foot.

KY-31 fescue grass seed at 1, 3, and 5 lb per 1000 ft^2 was blended into the two media treatments. This resulted in six combinations each of which was replicated four times yielding a

total of 24 plots. On November 16, 2007 the site was revisited and grass stands were counted. Data from Table 1 indicated that the seed germination rates of compost with soil mixtures were significantly better than those that only used compost. Three counts were taken within each plot by randomly throwing a one foot-square tube onto the plots and grass counts were recorded as blades per square foot (Figure 5). These results also showed that the treatment of 5 lbs of seed with compost/soil mix had the highest germination rates. On December 14, 2007 the site was reexamined to evaluate ground coverage. Once again the 5 lbs of seed in the compost/soil mixture showed the best results with just over 50 percent ground coverage (Table 2). One interesting note from this evaluation was that the 3 lbs of seed with compost only treatment had slightly better ground coverage than 5 lbs of seed with compost only treatment as shown in Table 2. I-64 site was evaluated for a third and final time on April 21, 2008. For ground coverage after six months (long term), 3 lbs and 5 lbs of seed with compost/soil mixture had 74 % coverage as evident from Table 3. The plots with 5 lbs of seed with compost had ground coverage of 65 percent. Figures 6 thru 32 progressively show the seed germinations of different compositions and media treatments.

3. CONCLUSIONS AND RECOMMENDATIONS

The pilot program proved that the current KYTC practice of applying one pound of seed per 1,000 ft^2 for growing vegetation for erosion control on steep slopes is not adequate. The use of 1 lb of seed with both compost only and compost/soil mix cannot be recommended as ground coverage was only in the 20 – 30% range and had extensive weed invasion. Other conclusions based solely on this pilot program are 1) for immediate coverage of at least 50%, a seeding rate of 5lbs per 1,000 ft^2 with compost/soil media was the best alternative as evident from Table 2, 2) for coverage in the long term, a seeding rate of 3lbs with compost/soil media was the best alternative.

Recommendations are: 1) increase the amount of seeding rate to at least three pounds per 1,000 ft^2, 2) to do more pilot programs with more variety of seeds to check their germination rates, at sites with different soils and exposure, and 3) based on one and two; perform cost analysis to narrow down the best seeding rates and variety for a particular geographical region in Kentucky.

Transportation costs of hauling compost and compost/soil mix to sites will have to be considered if the site locations are 50 miles away. The costs of hauling and application of media were kept to a minimum as the pilot project site was within driving distance to Lexington, KY. The primary goal of establishing vegetation on the slopes is more important than any cost additions due to extra seed quantity. The pilot program has shown that by using compost that has the right ingredients for supporting vegetation growth and with the right amount of seed, erosion problems on slopes and weed infestation can be minimized.

Table 1 Seed Germination - evaluated 11/16/2007

Number of Germinated Grass Seeds per Square Foot						
Replication	1 lb/1000ft^2 KY 31- 100% Compost	3 lb/1000ft^2 KY 31- 100% Compost	5 lb/1000ft^2 KY 31- 100% Compost	1 lb/1000ft^2 KY 31-70% Compost & 30% Soil	3 lb/1000ft^2 KY 31-70% Compost & 30% Soil	5 lb/1000ft^2 KY 31-70% Compost & 30% Soil
1	62	54	75	57	57	256
	12	4	135	133	101	272
	63	98	70	110	42	210
2	45	73	0	74	240	211
	5	211	102	88	113	212
	61	179	252	197	47	217
3	16	222	173	44	29	115
	51	215	64	97	310	207
	21	198	190	86	195	226
4	16	76	107	0	247	149
	0	221	273	46	297	319
	7	10	181	116	231	5
Mean	29.92	130.08	135.17	87.33	159.08	199.92
Median	18.50	138.50	121.00	87.00	154.00	211.50
Std Dev.	24.48	85.70	81.06	50.32	105.16	80.74

Table 2 Ground Coverage - evaluated 12/4/2007

Percentage ground covered by grass						
Replication	1 lb/1000ft^2 KY 31- 100% Compost	3 lb/1000ft^2 KY 31- 100% Compost	5 lb/1000ft^2 KY 31- 100% Compost	1 lb/1000ft^2 KY 31-70% Compost & 30% Soil	3 lb/1000ft^2 KY 31-70% Compost & 30% Soil	5 lb/1000ft^2 KY 31-70% Compost & 30% Soil
1	16%	36%	48%	4%	16%	80%
	20%	28%	24%	28%	24%	84%
	24%	20%	32%	28%	12%	88%
2	8%	44%	60%	32%	56%	64%
	12%	28%	24%	36%	32%	48%
	16%	52%	36%	20%	68%	56%
3	12%	56%	16%	28%	36%	40%
	12%	16%	20%	12%	12%	20%
	12%	20%	32%	24%	16%	32%
4	4%	12%	20%	24%	60%	32%
	4%	40%	16%	4%	44%	28%
	4%	44%	8%	4%	56%	36%
Mean	0.12	0.33	0.28	0.20	0.36	0.51
Median	0.12	0.32	0.24	0.24	0.34	0.44
Std Dev	0.06	0.14	0.15	0.11	0.20	0.23

Table 3 Ground Coverage - evaluated 4/21/2008

Percentage ground covered by grass						
Replication	1 lb/1000ft^2 KY 31- 100% Compost	3 lb/1000ft^2 KY 31- 100% Compost	5 lb/1000ft^2 KY 31- 100% Compost	1 lb/1000ft^2 KY 31-70% Compost & 30% Soil	3 lb/1000ft^2 KY 31-70% Compost & 30% Soil	5 lb/1000ft^2 KY 31-70% Compost & 30% Soil
1	20% 20% 36%	16% 36% 36%	76% 32% 88%	20% 24% 40%	64% 88% 64%	80% 96% 100%
2	16% 36% 36%	64% 80% 96%	20% 68% 80%	36% 44% 20%	80% 68% 76%	40% 60% 92%
3	0% 12% 48%	72% 84% 88%	60% 60% 88%	8% 56% 12%	76% 60% 56%	28% 80% 84%
4	4% 16% 40%	28% 36% 52%	64% 72% 76%	4% 20% 44%	64% 96% 100%	68% 80% 84%
Mean	24%	57%	65%	27%	74%	74%
Median	20%	58%	70%	22%	72%	80%
Std Dev	15%	27%	21%	16%	14%	22%

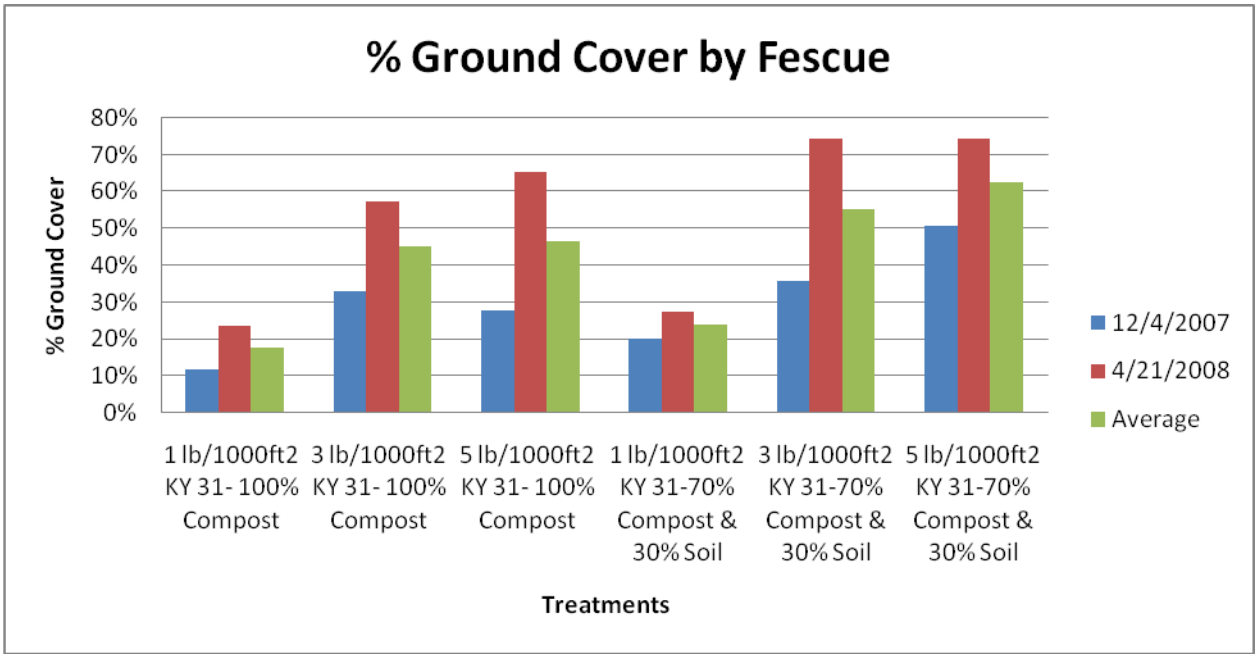

Figure 1 Percent Ground Coverage

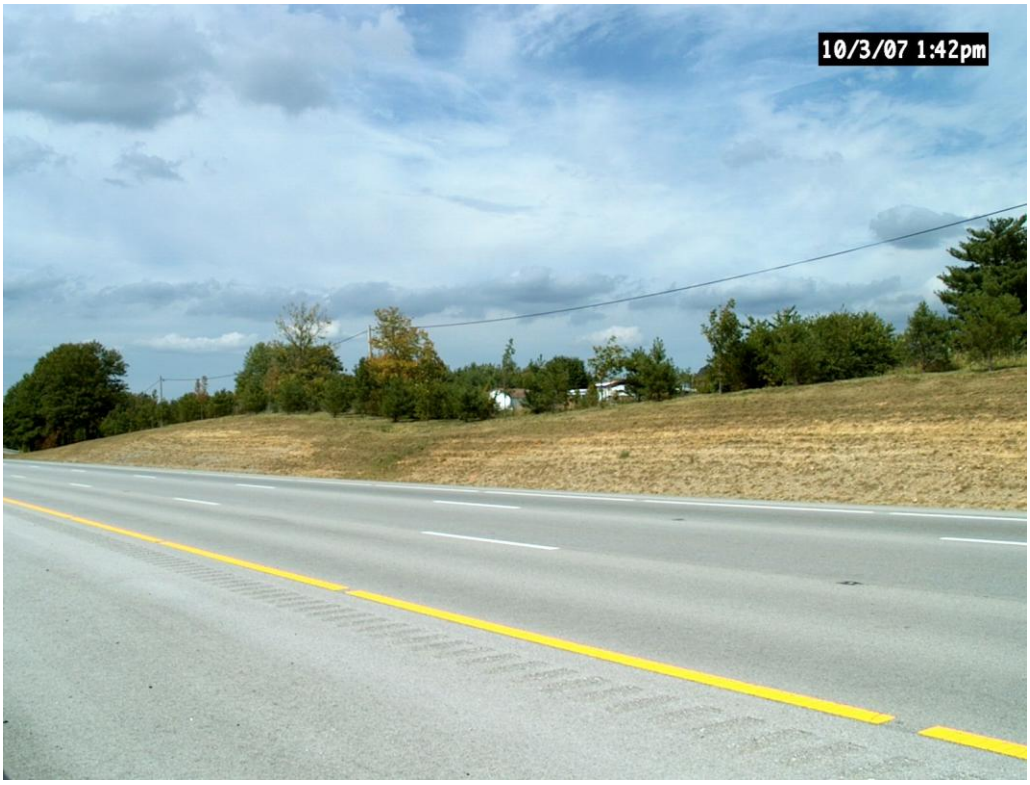

Figure 2 Pilot Program Site at mile marker 92 on I 64 Westbound near Lexington, KY

Figure 3 Application of media treatments

Figure 4 Site after the application of media treatments

Figure 5 Germination rates being measured

Figure 6 Compost- 1 lb Seed Replication-1

Figure 7 Compost- 1lb Seed Replication - 2

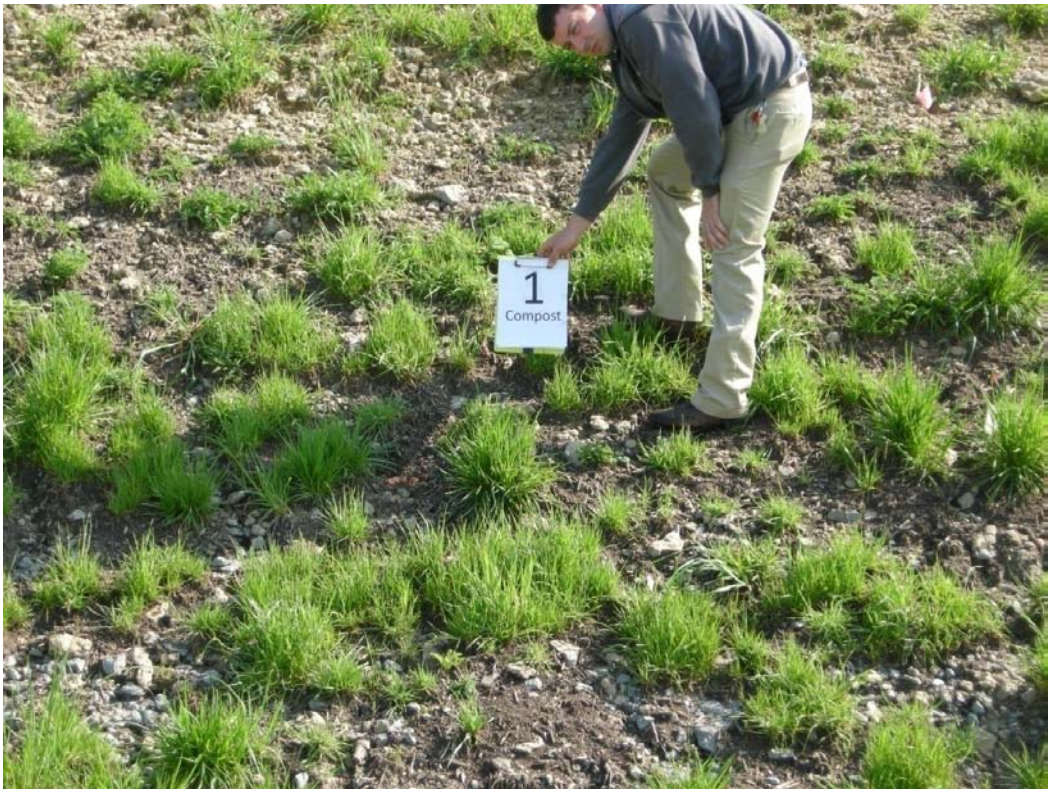

Figure 8 Compost – 1 lb Seed Replication - 3

Figure 9 Compost – 1 lb Seed Replication - 4

Figure 10 Compost /Soil– 1 lb Seed Replication - 1

Figure 11 Compost/Soil – 1 lb Seed Replication - 2

Figure 12 Compost/Soil – 1 lb Seed Replication - 3

Figure 13 Compost/Soil – 1 lb Seed Replication - 4

Figure 2 Compost – 3 lb Seed Replication - 1

Figure 3 Compost – 3 lb Seed Replication - 2

Figure 4 Compost – 3 lb Seed Replication - 3

Figure 5 Compost – 3 lb Seed Replication - 4

Figure 6 Compost/Soil – 3 lb Seed Replication - 1

Figure 7 Compost/Soil – 3 lb Seed Replication - 2

Figure 20 Compost/Soil – 3 lb Seed Replication - 3

Figure 21 Compost/Soil – 3 lb Seed Replication - 4

Figure 22 Compost – 5 lb Seed Replication - 1

Figure 23 Compost – 5 lb Seed Replication - 2

Figure 8 Compost – 5 lb Seed Replication - 3

Figure 9 Compost – 5 lb Seed Replication - 4

Figure 10 Compost/Soil – 5 lb Seed Replication - 1

Figure 11 Compost/Soil – 5 lb Seed Replication - 2

Figure 12 Compost/Soil – 5 lb Seed Replication - 3

Figure 13 Compost/Soil – 5 lb Seed Replication - 4

1 lbs /1000 ft^2 Compost – Replications 1-4

Compost/Soil – Replications 1-4

Figure 30. 1 lbs Seed/1000 ft^2.

3 lbs /1000 ft^2 Compost – Replications 1-4 Compost/Soil – Replications 1-4

Figure 31. 3 lbs Seed/1000 ft^2.

5 lbs /1000 ft^2 Compost – Replications 1-4

Compost/Soil – Replications 1-4

Figure 32. 5 lbs Seed/1000 ft^2.

For more information or a complete publication list, contact us at:

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