

# WARM-SEASON GRASS ESTABLISHMENT ON MINE SPOIL IN KENTUCKY

**William F. Kuenstler**  
Plant Materials Center  
U.S. Department of Agriculture  
Soil Conservation Service  
Quicksand, Kentucky 41363

**Donald S. Henry**  
U.S. Department of Agriculture  
Soil Conservation Service  
333 Waller Avenue  
Lexington, Kentucky 40504

**Samuel A. Sanders**  
Plant Materials Center  
U.S. Department of Agriculture  
Soil Conservation Service  
Quicksand, Kentucky 41363

With the increasing dependence on coal to fill this country's energy needs in the future, thousands of acres are being stripped every year to recover coal. Coupled with this operation is the pressure to protect the remaining natural resources in the coal-producing areas. Strip-mining creates large areas denuded of vegetation, which, if left unstabilized, will generate large quantities of silt; thus, streams and rivers downstream from the mining area are being polluted. Plants that provide cover quickly and maintain an adequate stand indefinitely need to be established on these strip-mined soils.

In addition to newly created, mined land, thousands of acres of abandoned mined land exist that also need reclamation. Revegetation on these areas is usually difficult because the topsoil or other soil material suitable for plant growth was not retained. The remaining material is very rocky and clayey, making seeding and establishment almost impossible.

Mined land should be planted with species that not only stabilize the soil but also have economic value. Since the passage of the Surface Mining and Reclamation Act of 1971, much of the approximately 117,450 ha (280,000 acres) on which permits for mining were issued in Kentucky has been returned to a condition that could support hayland or pasture (Ky. Dept. Nat. Resources and Environ. Protection, Div. of Reclamation, personal communication). However, the species generally used to reclaim this land were either not suited for or had limited value for hay and pasture during the summer months. Plant species are needed that (1) provide sufficient cover on mine spoil to meet state specifications, (2) are suitable for hay or pasture, and (3) provide forage through the summer months.

In response to these needs, the Environmental Protection Agency funded a study by the Soil Conservation Service that would (1) compare the performance of several warm-season grasses, seeded alone or with legumes, with the species commonly used for mine spoil revegetation, (2) evaluate several different methods of establishing these grasses, and (3) determine the forage yield and quality of the warm-season grasses and grass-legume mixtures. The first two objectives are reported on in this paper.

## METHODS

Study sites of identical size were established in the eastern and western Kentucky coal fields in April 1976. The differences in soils, climate, and types of mining were the reasons for establishing two study sites. The western Kentucky site is located near Central City, Muhlenberg County, on the Vogue mine of Peabody Coal Company. The soils in this area are formed from sandstone and shales, with a thin loess cap. The growing season averages 180-185 days and annual rainfall distribution is divided equally between the first and last six months. The summers tend to be hotter and dryer than eastern Kentucky. The pH of the mine spoil was 5.6, but lime was applied to raise

it to 6.5. The eastern Kentucky site is about 24 km (15 miles) from Jackson, Breathitt County, on the Press Howard Fork mine operated by Falcon Coal Company. Soils in this area are shallow, residual ones formed in acid sandstone and calcareous shale. About 45 percent of the annual rainfall accumulates in the first six months. Summers are hot, but generally moisture is available. The pH of the spoil was 6.6; therefore, no lime was applied.

Mining methods vary between the two areas. In western Kentucky, area strip-mining is the predominate type of surface mining. During reclamation the spoil is placed so that the land could be used for pasture or hayland. In eastern Kentucky, the trend is toward mountaintop removal mining. In this method, the entire coal seam is exposed by removing the peak of the mountain. This procedure creates large, relatively flat areas that could be suitable for pasture or hayland.

The study sites at each location were chosen so that both had approximately the same aspect, drainage pattern, and amount of relief. The study uses a split plot design, with three replications. Each replication is 24.2 m x 106.7 m (80 ft x 352 ft). The five establishment methods are each 4.8 m (16 ft) wide and run the length of the replication. The eight seeding mixtures are each 13.3 m (44 ft) long and run with the width of the replication. This divides the replication into 40, 4.8 m x 13.3 m (16 ft x 44 ft) plots, each containing a different seeding mixture-establishment method combination.

Eight species or cultivars were used at both study sites; they are listed below with references:

<i>Festuca arundinacea</i> Schreb	Hitchcock, 1950
'Ky-31' tall fescue	
<i>Panicum virgatum</i> L.	Hitchcock, 1950
'Blackwell' switchgrass	
<i>Andropogon gerardii</i> Vitman	Hitchcock, 1950
'Kaw' big bluestem	
<i>Andropogon caucasicus</i> Trin.	Hitchcock, 1936
Caucasian bluestem	
<i>Sorghastrum nutans</i> (L.) Nash	Hitchcock, 1950
'Cheyenne' Indiangrass	
<i>Coronilla varia</i> L.	Gleason and Cronquist, 1963
'Chemung' crownvetch	
<i>Lespedeza cuneata</i>	Gleason and Conquist, 1963
(Dumont) G. Don	
'Interstate' sericea	
lespedeza	
<i>Lespedeza cuneata</i>	Gleason and Cronquist, 1963
'Appalow' sericea lespedeza,	
a prostrate cultivar	

Eight different seeding mixtures were used at both study areas with varying seeding rates for Pure Live Seed (PLS): 'Kaw' big bluestem (16.9 kg PLS/ha), 'Cheyenne' Indiangrass (16.9 kg PLS/ha),

'Blackwell' switchgrass (11.1 kg PLS/ha), 'Chemung' crownvetch (22.5 kg PLS/ha), Caucasian bluestem (22.5 kg PLS/ha), 'Blackwell' switchgrass (11.1 kg PLS/ha) and 'Interstate' sericea lespedeza (33.75 kg PLS/ha), 'KY-31' tall fescue (33.75 kg PLS/ha) and 'Interstate' sericea lespedeza (33.75 kg PLS/ha), and Caucasian bluestem (22.5 kg PLS/ha) and 'Appalow' sericea lespedeza (33.75 kg PLS/ha).

Five different establishment methods were evaluated for each species or species mixture. Seed was broadcasted with straw (4500 kg/ha), woodbark (255 m<sup>3</sup>/ha), or without mulch. Seed was drilled with straw (4500 kg/ha) or no mulch. Stand counts at the sixtieth day, and the one hundred and twentieth day for each seeding mixture and establishment methods in both studies were taken in 1976. Two observers each made counts in three randomly selected 25 cm x 25 cm (10 in x 10 in) plots within every seeding mixture and establishment method subplot. In the autumn of 1977, when stands were at their peak, two observers estimated the percentage of plant cover in each plot.

## RESULTS

Data from the 120-day stand count (Table 1) show that some species sown alone can become established as well as a standard reclamation mixture of tall fescue-sericea lespedeza, and others cannot. Caucasian bluestem, whether seeded alone or in a mixture with 'Appalow' sericea lespedeza, produced good stands. The presence or absence of mulch was not critical in stand establishment for any species. Many unmulched plots had better stands than the mulched plots.

The data on percent cover (Tables 2 and 3) are in four columns. The column headed "all" gives the percent ground cover due to seeded species plus unseeded species or "weeds." The columns headed "unseeded," "grass," and "legume" show the percent of total ground cover that is provided by "weeds," seeded grass, and seeded legume, respectively.

The data show that some of the warm-season grasses produce stands as good or better than the standard tall fescue-sericea lespedeza mixture, and some do not. Caucasian bluestem gave the best results in stand establishment. Whether seeded alone or in a mixture with 'Appalow' sericea lespedeza, this grass species was the most consistent in establishing stands that met the reclamation standard of 70 percent cover for permanent vegetation. In 1976 in Eastern Kentucky (Table 2), Caucasian bluestem seeded alone and the Caucasian bluestem-'Appalow' sericea lespedeza mixture both had adequate cover under three different establishment methods. Tall fescue-'Interstate' sericea lespedeza met the reclamation standard under all five establishment methods. In 1977 at the same location (Table 3), three different treatments of Caucasian bluestem gave adequate

cover, as did four different treatments of the Caucasian bluestem-'Appalow' sericea lespedeza mixture. Again, all five treatments of tall fescue-'Interstate' sericea lespedeza met the reclamation standard. No plots of big bluestem, Indiangrass, or switchgrass met the standard.

Establishment methods also affected the amount of cover produced. More successful plots were established with broadcast seeding and woodbark mulch than with any other establishment method. Fifteen plots met the reclamation standard for percent cover in both 1976 and 1977. In both years, five of these plots were established by the above method. The next most successful establishment methods were seed drilled without mulch and seed broadcast without mulch. Both of these methods produced three plots that met the standard in both 1976 and 1977. The plots mulched with woodbark have a better stand of the seeded species, and fewer "weeds" or unseeded species, than the plots mulched with straw. The fewest successful plots were produced when seed was broadcast with straw mulch or seed was drilled with straw mulch.

## SUMMARY

Some warm-season grasses will establish stands on mine spoil that are equal to stands obtained with plants commonly used for mine spoil reclamation, and some will not. Caucasian bluestem seeded alone, the Caucasian bluestem-'Appalow' sericea lespedeza mixture, and the switchgrass-'Interstate' sericea lespedeza mixture produced stands as good as the tall fescue-'Interstate' sericea lespedeza standard; however, the warm-season grass seedings were not successful under as many different establishment methods as were the standard mixture seedings. Neither big bluestem, Indiangrass, nor switchgrass seeded alone produced adequate stands. Stands of the warm-season grasses improved in the second year. Establishment methods can affect the stand of seeded species. Woodbark mulch on a broadcast seeding was the most effective. The plots mulched with straw had a greater percent of total cover from "weeds" and unseeded species than did the plots with woodbark mulch or without mulch.

If the forage quality of the warm-season grasses grown on these sites is found to be acceptable, we will have more plant species which can both stabilize and provide an economic return from the growing acreage of strip-mined land.

**Table 1.** Eastern (E) and western (W) Kentucky 120-day stand count given in plants/m<sup>2</sup> for species seeded alone and in mixture. Values are the average of three replications.

	Seed Broadcasted						Seed Drilled			
	Woodbark Mulch		Straw Mulch		No Mulch		Straw Mulch		No Mulch	
	E	W	E	W	E	W	E	W	E	W
<b>Seeded Alone</b>										
Big bluestem	81	105	27	110	31	71	25	135	49	95
Indian grass	92	150	52	76	97	59	76	100	64	105
Switch grass	53	32	56	44	86	37	57	33	63	60
Crownvetch	107	75	69	129	70	47	49	79	57	95
Caucasian bluestem	252	257	175	260	342	254	132	241	281	422
<b>Seeded in Mixture</b>										
'Interstate' sericea lespedeza & switch grass	77/163	40/169	46/44	44/36	27/27	52/60	29/44	60/40	51/18	76/15
'Interstate' sericea lespedeza & 'KY-31' tall fescue	236/84	221/49	172/73	181/24	134/55	129/25	132/173	220/41	158/56	155/52
'Appalow' sericea lespedeza & Caucasian bluestem	186/92	260/98	256/110	196/60	292/63	319/30	191/45	203/42	298/48	160/15



**Table 3.** Percent cover and stand composition, eastern (E) and western (W) Kentucky, in October 1977.

	Woodbark Mulch Percent Cover						Seed Broadcasted Straw Mulch Percent Cover						No Mulch Percent Cover											
	All		Unseeded		Grass		Legume		All		Unseeded		Grass		Legume		All		Unseeded		Grass		Legume	
	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W
<b>Seeded Alone</b>																								
Big bluestem	91	64	60	12	40	88			87	76	86	14	14	86			87	59	80	23	20	77		
Indian grass	86	68	39	15	61	86			77	62	71	41	29	59			80	50	68	48	32	52		
Switch grass	92	64	49	8	51	92			83	59	73	22	27	78			90	55	58	22	42	78		
Crownvetch	92	55	38	29			62	71	96	63	35	29			65	71	79	22	50	71			50	29
Caucasian bluestem	93	83	12	6	88	94			80	82	37	11	63	89			99	56	9	15	91	85		
<b>Seeded in Mixture</b>																								
'Interstate' sericea lespedeza & switch grass	97	65	15	6	25	53	60	41	83	63	37	13	22	71	41	16	87	59	50	10	22	87	28	3
'Interstate' sericea lespedeza & 'KY- 31' tall fescue	96	59	4	4	58	58	38	38	96	59	4	4	58	58	38	38								
96	64	5	8	80	85	15	7	98								44								
7	12	83	86	10	2																			
'Appalow' sericea lespedeza & Cau- casian bluestem	98	69	10	6	51	64	39	30	85	71	30	11	39	66	31	23	96	67	13	12	58	78	29	10
<b>Seed Drilled</b>																								
	Straw Mulch Percent Cover						No Mulch Percent Cover																	
	All		Unseeded		Grass		Legume		All		Unseeded		Grass		Legume									
	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W								
<b>Seeded Alone</b>																								
Big bluestem	88	74	92	22	8	78			89	43	91	40	9	60										
Indian grass	84	68	73	24	27	76			87	58	85	36	15	64										
Switch grass	82	65	59	24	41	76			93	67	58	12	42	88										
Crownvetch	87	65	56	35					44	65	88	52	70	44									30	56
Caucasian bluestem	78	72	22	11	78	89			92	58	15	15	85	85										
<b>Seeded in Mixture</b>																								
'Interstate' sericea lespedeza & switch grass	86	68	44	9	22	66	34	25	92	66	38	12	29	85	33	3								
'Interstate' sericea lespedeza & 'KY- 31' tall fescue	94	67	4	7	73	73	23	20	93	50	5	12	80	81	15	7								
'Appalow' sericea lespedeza & Cau- casian bluestem	87	73	21	21	48	65	31	19	93	59	15	23	60	68	25	9								

**LITERATURE CITED**

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