'Interstate' Sericea Lespedeza: A Long-Term Nitrogen Source for Loblolly Pine Growing on Coal Mine Spoil

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*The effects of several combinations of nitrogen (N) and phosphorus (P) fertilizers with different cover crops on the growth of loblolly pine (*Pinus taeda *L.) seedlings in Appalachian coal mine spoils were compared from 1970 through 1979. For the first 5 years, two or three N applications during this period resulted in greater tree growth than a single N application in combination with an understory of sericea lespedeza (*Lespedeza cuneata *Dum.) G. Don var. 'Interstate.' However, from the sixth through the ninth years N supplied by the lespedeza resulted in significantly better growth than occurred on plots that had received multiple N applications. Beneficial effects of sericea lespedeza could still be seen after 14 years.*

Experiments have shown that most coal spoils in Appalachia supply inadequate amounts of N and P for good growth of tree seedlings and herbaceous vegetation (1,3,4). Nutrient deficiencies could be corrected, at least for the short term, by conventional fertilizer applications providing at least 50 kg/ha each of N and P. However, maintaining long-term productivity of nonleguminous plants without supplemental N applications has been difficult.

Bengtson and Mays (2) reported on a study conducted from 1970 through 1976 that evaluated the effects of combinations of fertilizer treatments and cover crops on the growth of young loblolly pines (*Pinus taeda* L.). Their work showed the benefits of an initial application of NP fertilizer and repeated applications of N in increasing growth of pines and improving stands of tall fescue (*Festuca arundinacea* Schreb.) and common bermudagrass (*Cynodon dactylon* (L.) Pers.) understory plantings. The beneficial N-supplying effects of an understory of sericea lespedeza (*Lespedeza cuneata* (Dum.) G. Don) var. 'Interstate' was suggested but not fully realized during the period covered by that publication. Data collected from the same series of plots following the 1979 growing season clearly showed the favorable effects of this variety of lespedeza on the long-term growth of loblolly pine.

Methods

The experiment was established in September 1970 at the Arch Coal Company's Fabius mine on Sand Mountain, near Stevenson, AL. Spoil at this mine is derived from sandstone, conglomerate, and shale; its pyrite content is minimal. The site was a graded roadside spoil bank planted about 9 months previously with 1+0 loblolly pine seedlings at 2-meter spacing in rows 2.5 meters apart. At the time of treatment, about 70 percent of the planted trees had survived. Few pines died subsequently.

Analysis of the < 2 millimeter fraction of spoil showed the following mean values: pH (in water), 4.8; organic matter, 12 percent; double-acid-extractable P, 0.5 parts per million; cation exchange capacity, 3.32 milliequivalents per 100 grams; exchangeable bases, 0.06, 0.86, and 0.42 milliequivalents per 100 grams from potassium (K), calcium (Ca), and magnesium (Mg), respectively.

Herbaceous species selected for interseeding were 'Kentucky 31' tall fescue, common bermudagrass, and 'Interstate' sericea lespedeza, a dwarf mutant variety. The lespedeza seeds were treated immediately before sowing with commercially prepared lespedeza inoculum. Fescue was seeded in the fall of 1970; the bermudagrass and lespedeza were seeded in 1971. The NP fertilizer treatment was applied just before planting (table 1).

To minimize extension of pine roots across plot boundaries, in the winter of 1974 we severed

Table 1—*Fertilizer broadcast over experimental plot of graded roadside coal mine spoil planted with loblolly pine (values are in kilograms per hectare).*

Fertilizer treatment	First application[1]			Additional application[2]				Cover crop[3]	
	N	P	Date	N	Date	P	Date	Species	Date
0	0	0	—	0	—	0	—	None	—
NP+N	84	150	9/70	112	9/71	0	—	None	—
NP+N+N	84	150	4/71	112	9/71	112	4/75	None	—
NP+N	84	150	9/70	112	9/71	0	—	K31	9/70
NP+N	84	150	4/71	112	4/72	0	—	CBG	4/71
NP	84	150	4/71	0	—	0	—	ISL	4/71

[1]N and P were applied as ammonium polyphosphate.
[2]N was applied as ammonium nitrate.
[3]K31 = 'Kentucky 31' tall fescue, CBG = common bermudagrass, ISL = 'Interstate' sericea lespedeza.

lateral roots along plot boundaries with mattocks. The temporary trenches were about 10 centimeters wide and 20 centimeters deep. Herbicides were used as necessary to stop the spread of lespedeza seedlings into adjoining plots.

At the time that plots were established, 12 trees in the central portion of each plot were marked for observation. Their heights were measured before treatment (September 1970) and during the winters of 1971,1972,1974, and 1976. These trees were also measured for d.b.h. After the 1979 growing season, $7^1/_2$ years after the final fertilizer application, height and d.b.h. were again measured for 10 trees from each main plot.

Results and Discussion

As Bengtson and Mays (2) reported earlier, 'Interstate' sericea lespedeza appeared to supply little or no N for loblolly pine growth for several years after seeding (fig. 1). Initial stand establishment was poor and resulted in only about 10 percent ground cover during the first year. All varieties of sericea typically exhibit low seedling vigor and grow sparsely during the first 12 months after seeding. This creates a favorable situation for early development of fertilized pine seedlings because competition for water and light by the seeded cover is minimal during the time that young pines are becoming established. In contrast, grass species such as tall fescue, bermudagrass, and annual ryegrass (*Lolium multiflorum* Lam.) offer severe competition to young pine seedlings, particularly when the area is well fertilized with N.

Dwarf varieties of sericea, such as Interstate, are superior to standard size varieties for seeding with trees because they are 25 to 50 centimeters shorter at maturity and do not cause as much damage by overtopping the pine seedlings as the tall varieties do. The primary disadvantage of the lespedeza for ground cover is its ineffectiveness in controlling erosion during the year required for it to develop a thick, vigorous stand.

Data in figure 1 show that during the first four growing seasons, pines fertilized once with NP and growing with sericea lespedeza did not grow as tall as pines receiving a second or third application of N. During the fifth and sixth growing seasons, N from the lespedeza resulted in slightly more pine growth than the NP+N treatment, but the trees did not completely overcome their earlier growth disadvantage. From the seventh through the ninth years, trees growing with sericea lespedeza not only grew more than trees that had received the NP+N and NP+N+N treatments, but they made up for the earlier poor performance and became slightly taller than trees that had received this additional N fertilizer.

Comparisons of tree height and d.b.h. (table 2) among treatments show that after 6 years, pines growing with sericea lespedeza were significantly smaller than those that had received NP+N+N

and slightly smaller than those fertilized with NP+N. However, after 9 years, trees growing in association with the lespedeza were slightly but not significantly larger than those that had been subjected to any of the supplemental fertilizer applications and much larger than unfertilized trees. This indicates that sericea has the potential for meeting the long-term N needs of pines grown on coal spoil.

The analysis of soil and pine needles for N concentration (table 2) shows that sericea was ultimately at least as effective in supplying N to the ecosystem as the other fertilizer-cover crop combinations were. Tall fescue and common bermudagrass were gradually shaded out as pine trees increased in size and had mostly disappeared after 4 or 5 years. In contrast, the lespedeza was still in a vigorous condition after 9 years. Sericea lespedeza produces several tons per acre of high N biomass in roots and tops each year and could be expected to contribute a significant amount of N to the system even after the plants died.

During the ninth year only pines growing with sericea lespedeza exhibited the bright

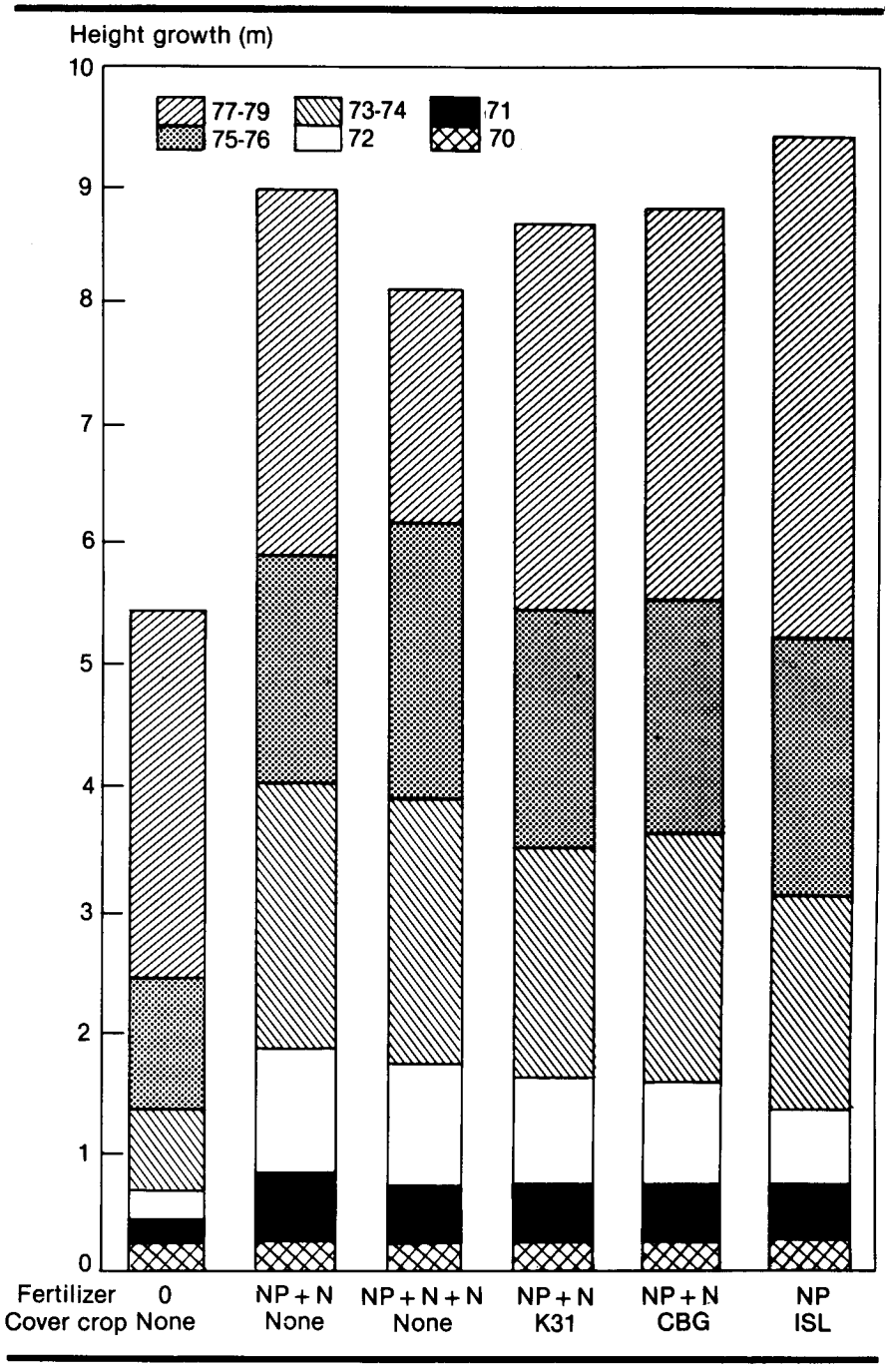

Figure 1—*Periodic and cumulative height growth of loblolly pine planted in graded roadside coal mine spoil as affected by nitrogen fertilization and cover crops (see table 1). K31 = 'Kentucky 31' tall fescue, CBG = common bermudagrass, ISL = 'Interstate' sericea lespedeza.*

Table 2—*Effects of fertilizer treatments and cover crops on growth of loblolly pines and on the nitrogen content of soil and pine needles*[1]

				After 9 yr			
		Pines after 6 yr		Pines		Percent N	
Fertilizer treatment	Cover crop[2]	Height (m)	d.b.h. (cm)	Height (m)	d.b.h. (cm)	Soil	Pine needles
0	None	2.4c	1.8d	5.5b	7.8b	0.029c	0.93ab
NP+N	None	5.9ab	8.1b	9.0a	13.1a	.033bc	.83b
NP+N+N	None	6.1a	9.3a	8.2a	12.1a	.030c	.85b
NP+N	K31	5.5b	7.8b	8.7a	12.5a	.039a	.94ab
NP+N	CBG	5.5b	7.7b	8.8a	11.7a	.033bc	.95ab
NP	ISL	5.2b	7.1c	9.4a	13.3a	.037ab	1.04a

[1]Fertilizer treatments and cover crops are described in table 1. Values in columns followed by the same letter do not differ significantly at the 5% level of probability.

[2]K31 = 'Kentucky 31' tall fescue, CBG = common bermudagrass, ISL = 'Interstate' sericea lespedeza.

green color that indicated an adequate N supply; trees in other treatments exhibited the characteristic yellowing of N deficiency.

The experimental plot was examined again in 1984. Trees growing on sericea lespedeza plots were noticeably larger, greener, and more vigorous than other trees in the planting. Some sericea still persisted even though the pine canopy had completely closed.

Conclusions

1. Growth of young loblolly pines was increased by application of NP fertilizers.
2. One or two N applications in subsequent years resulted in greater tree growth than a single NP treatment.
3. Interstate sericea seeded at the same time as the NP fertilizer application was ineffective in supplying N to pines for about 2 years after seeding.
4. Interstate sericea persisted and grew vigorously under pines for 9 years. From the sixth year onward trees growing in association with sericea grew more vigorously than pines receiving 112 kg/ha of N during the second and third years of growth.
5. Beneficial effects of sericea could still be seen after 14 years.

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