NUTRIENT CONTENT OF AUSTRIAN PINE AS AFFECTED BY SOURCE AND LOCATION

Franklin C. Cech, David H.[1] Weingartner, and John P. Capp

Reclamation of any abandoned surface mine is mandatory. There has been considerable effort made to find plant species that can withstand the rigorous environment created as a direct result of surface mining. Stripped areas are often characterized by stony, sterile surfaces with extremely low pH. In West Virginia, this is as low as 2.5 on some strip mines. Since plant species that can thrive on such areas are rare, some methods of site amelioration is needed before successful revegetation can be accomplished.

Since fly ash is often alkaline and contains in many cases more macro and micro elements than some soils (table 1; Adams, et al., 1972) it was postulated that fly ash amendments might be used to raise the pH and improve the fertility of strip mined areas.

Coal burning power plants are producing enormous amounts of fly ash daily. According to Adams, et al., (1972) about 30 million tons of fly ash are produced yearly in the United States. About 15% of this is utilized constructively and the remainder is dumped as land fill where the terrain permits, or else dumped in huge piles. Large amounts of fly ash could be used profitably, (for the general public at least), making reclamation of the highly acidic strips possible. These are normally the most difficult to revegetate.

Investigation of the use of fly ash as a strip mine soil amendment was initiated in 1964 at the Morgantown Energy Research Center (West Virginia) by the United States Bureau of Mines. Small-plot studies were successful and in 1968 a five-acre area (Fort Martin site) was treated with fly ash at the rate of 150 tons per area. The fly ash was spread and incorporated into the strip soil using a farm tractor, plow and disc harrow.

[1] Professor of Forest Genetics; Research Assistant, West Virginia University, Division of Forestry; and Chemical Research Engineer, Bureau of Mines, respectively.

In 1970, a 65-acre area (Stewartstown site) was treated at the same rate. The latter site was covered with large boulders, consequently dumping and spreading was difficult. Because of the rough surface, incorporation of the fly ash was done using a 955-H high lift with a single ripper tooth. This treatment was not as satisfactory as that at the Fort Martin site.[2] The pH of the sites was raised from 3.1 - 4.7 and 2.5 - 3.3 to 6.0 - 7.0 and 7.0 - 8.0 respectively (Adams et al., 1972).

Table 1.--Typical composition of bituminous coal (Fort Martin) fly ash used at Stewartstown.

Constituent	
Major elements, wt pct	
SiO_2	46.8
Al_2O_3	23.3
Fe_2O_3	17.5
CaO	5.7
MgO	1.1
Na_2O	.8
K_2O	2.0
TiO_2	.7
P_2O_5	.5
C	1.5
S	.4
Loss on ignition	5.1
Trace elements, ppm	
B	450
Cu	40
Mn	200
Mo	20
Zn	90
Bulk density, g/cc	1.15
pH	11.9
Fineness, pct through 200 mesh	91
Average size, micron	19

From Adams *et al.*, 1972

[2]Part of this site adjacent to the tree planted area was later reworked with a heavy agricultural disc plow that provided much better mixing of fly ash, overcame the rough surface problem and resulted in better vegetative cover.

These sites were subsequently fertilized with granular 10 - 10 - 10 fertilizer at a rate of 1000 pounds per acre and sown with a mixture of grass seed.

A small area on the Stewartstown strip (approximately 1/2 acre) was covered with fly ash early in 1971 to smother a fire in the "gob" pile located there. The smothering was successful and in late spring the area was disced. Very little of the strip mine residue was incorporated into the fly ash in the discing process, because of the depth of the fly ash (up to approximately 10 - 12 inches).

These three areas provided us with sites which had been treated with fly ash 3 years, 2 years, and the current year before planting. Two additional areas were incorporated into the study, one on agricultural soil, which had been lying fallow for three years, and an untreated strip mine where the bench had been leveled, but not planted. Soil analyses of the sites is presented in Table 2.

Table 2.--Soil analyses of the five plantations.

Site	pH	P	K	Ca*	Mg	Zn	B	$N(NO_3)$
Reedsville	6.7	048	152	1201	108	05	1.20	21.0
Fort Martin	6.6	096	120	1201	084	17	3.94	21.0
Stewartstown 1-10	7.0	007	068	1201	361	07	1.70	16.8
Stewartstown 1-13	7.7	008	076	1201	128	09	85.00	20.3
Rt.119	4.7	020	100	1201	172	05	.90	19.6
		lbs./acre					lbs.B/A	

*Ca - Limit of test capacity

Seedlings for the study were grown at the Clements Nursery of the West Virginia Department of Natural Resources and seed was provided by W. Plass of the United States Forest Service, Princeton, West Virginia. Seedlings were planted in five-tree randomized rows, with 10 replications on all sites except the site with the current application (where there was sufficient plantable area for only 3 replications), and the untreated site, with 4 replications.

Needles were collected from each seedling alive at the end of the growing season and bulked to make a single sample for each source at each site. They were dried and ground to 60 mesh in a standard Wiley mill. Ground samples were sent to the soil Testing and Plant Analysis Laboratory at the University of Georgia in Athens, Georgia, where they were analyzed. Computer print-outs of the results were returned for statistical analysis.

The analysis of variance (Table 3) indicated that there were differences significant at the .01 or .05 levels in nutrient absorption among sources for all elements tested except copper and barium. There were also significant differences at the .01 or .05 level among seed sources for all elements tested except iron, copper, and boron.

Table 3.--Analysis of Variance - Leaf Analysis - 1972, Eight Sources - Austrian pine.

Element	Area Difference	Sources difference
P	**	**
K	**	*
Ca	**	**
Mg	*	**
Mn	**	**
Fe	**	NS
B	**	NS
Cu	NS	NS
Zn	**	*
Al	**	**
Mo	**	**
Sr	**	**
Ba	NS	**
Na	**	*

NS = Not significant
* = Significant at .05 level
** = Significant at .01 level

Correlation analyses were run for levels of each nutrient in the soil, and average level of each nutrient in the foliage. The same analyses were run for levels of nutrients in the soil and levels of nutrients in individual seed sources. In no case was there any correlation worth mentioning. There was also no correlation between the amount of nutrient absorbed and the survival or current growth of the individual sources.

Apparently nutrient level in the foliage for the first year after transplanting is independent of the amount of the particular nutrient present in the soil. In addition, several seed sources of the same species absorb nutrients differentially, not only when planted on the same soil, but when planted in several different soils. The results reported here agree generally with those reported previously by Gerhold (1959) who noted that there were differences in nutrient levels among sources as well as at different times of the year in Scotch pine. Steinbeck, (1965) noted significant differences in nutrient levels among seed lots and among plantations; also for Scotch pine. Lee (1970) noted with Austrian pine that there was a differential response among sources in the absorption of elements with fertilization. Steinbeck (1970) noted a strong relationship between growth rate, nitrogen, and magnesium, while Lee (1970) noted that the addition of nitrogen fertilizer increased the foliar content of nitrogen and manganese, but suppressed the absorption of potassium, phosphorus, magnesium, boron, zinc, and aluminum.

In our study, we were unable to find any clear correlations with amount of nutrient in the soil and in the foliage, possibly, because the seedlings were in the field for only one growing season. New evaluations of soil and foliage are planned at the end of either the second or third growing season. It will be interesting to observe whether the nutrient content of the soil will be reflected in the plant foliage as the seedlings mature.

LITERATURE CITED

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