Plant Nutrient Availability Following Chemical Site Preparation for Conservation Land Use Development

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The harvest of marketable timber from sloping, eroded soils in the Piedmont and upper Coastal Plain has increased the need for systems to revegetate these areas with economically important species while conserving the soil. Conservation of the soil, on sloping land, is probably best achieved through reforestation or conversion to perennial forage species for grazing. Mechanical site preparation for reforestation or conversion to grazing land is expensive and generally promotes soil erosion from the hillsides. Chemical site preparation could allow for safe, effective, and efficient systems for land-use conversion. Results have indicated that up to 95% of the trees found in the woodland sites can be killed by aerial application of herbicides. The standing-dead trees conserve soil during reforestation and/or aerial seeding with forage species. Tebuthiuron was found to be an effective herbicides for site preparation].

Significant plant nutrient losses can occur during ecosystem conversions. The efficiency of establishing pastures or improved forest land following the application of tebuthiuron will be increased by conserving the plant nutrients already present. This study was conducted to determine the plant nutrient status of a site near Williamson, Georgia, treated with tebuthi uron, burned, and seeded with tall fescue.

Materials and Methods

The site is described in detail elsewhere in the proceedingsl. To determine the nutrient content and availability of various components of the ecosystem, we sampled soils and surface litter and established experimental plots to determine the effects of added phosphorus (P) on tall fescue growth and survival.

We established transects in three areas in the treated site to sample surface litter and soils. This allows us to sample similar areas to reduce variation between samplings. In each transect, we sampled surface litter (1 m^2) and soils (0 to 15 cm) from ten areas in Sept. 1983. The site was burned in November 1983 and the soils and ash sampled to determine nutrient release due to burning.

Replicated plots were established near the sampling transects to determine the effect of added P on tall fescue growth. Phosphorus treatments were 0, 10, 20 and 40 kg P/ha as concentrated superphosphate.

Available nutrients in the soil were determined by double acid extraction (0.05 N HC1 in0.025 N H_2SO_4). Plant and litter samples were digested in a mixture of nitric and perchloric acids for P, K, Ca and Mg analysis and in sulfuric acid for N analysis. Carbon was determined using a Leco combustion furnace. Soil pH was determined in 0.01 M $CaCl_2$.

Results and Discussion

Table 1 contains data on the nutrient status in the three transects of the Williamson site before and after burning (just prior to the aerial seeding of fescue). The soils of all three transects have low levels of available nutrients except for NO_3-N. Nitrate-N is expected to be mobile in these soils and would be leached from the rooting zone before significant plant uptake occurred. Phosphorus appears to be the most limiting plant nutrient. Burning generally improves plant nutrient availability (Table 1). Our visual observations were that there was better germination and growth of fescue in burned compared to unburned area which may be due to the slight increase in available nutrients.

Table 1. Effect of Chemical Site Preparation and Burning on Soil Plant Nutrient Status

	Pre-Burn			Post-Burn		
Site	1	2	3	1	2	3
Carbon (%)	1.48	0.92	0.86	1.87	1.32	1.42
NH_4 (ppm)	14	9	9	8	8	15
NO_3 (ppm)	24	24	7	32	34	8
P (ppm)	1	5	4	2	8	6
K (ppm)	87	49	17	101	53	30
Ca (ppm)	351	191	39	498	246	83
Mg (ppm)	63	24	5	110	28	12
pH	4.7	4.6	4.3	4.9	4.8	4.4

We further explored the release of plant nutrients from litter by sampling surface litter from 1 m^2 areas prior to burning. Litter weights and nutrient contents are presented in Table 2. The actual quantity of nutrients in the litter is low so the release of plant nutrients due to burning would be small. Chemical analysis of the ash (Table 2) showed that its composition is similar to the litter. The quantity of ash was not sufficient to obtain estimates of the amount on the surface.

The fescue plots were sampled for dry matter production and chemical composition (Table 3). The addition of P fertilizer significantly increased yield and P content of the fescue. From this data, it is evident that increasing P availability would benefit the establishment of vegetation at this site.

Table 2. Plant Nutrient Content of Litter and Ash

	Pre-Burn			Ash		
	1	2	3	1	2	3
Weight[1] ($kg\ m^{-2}$)	1.8	2.7	3.1	-	-	-
N (%)	-	-	-	0.75	0.89	0.87
P (%)	0.05	0.06	0.05	0.06	0.09	0.08
K (%)	0.10	0.08	0.05	0.1 1	0.11	0.10
Ca (%)	0.21	0.38	0.52	0.82	0.68	0.51
Mg (%)	0.09	0.07	0.04	0.1 1	0.11	0.10
Carbon (%)	30	43	41	29	44	46

[1]Estimates of nutrient content ($kg\ ha^{-1}$) in the litter can be made using the following equation: litter weight (kg/m^2) x nutrient content (%) x 10 = nutrient content ($kg\ ha^{-1}$).

Table 3. Effect of Phosphorus Fertilizer on Growth and P, K, Ca and Mg Content of Tall Fescue

Treatment	Yield	P	K	Ca	Mg
$kg\ P\ ha^{-1}$	$g\ m^{-2}$	%			
Check	126 b[1]	0.14 c	3.6 a	0.35 a	0.32 a
0	151 b	0.15 cb	3.5 a	0.32 ab	0.28 b
20	164 b	0.18 b	3.3 a	0.30 b	0.27 b
40	207 a	0.23 a	3.3 a	0.34 ab	0.27 b

'Values followed by different letters are significantly different (P = 0.05) according to the Duncan's Multiple Range Test.

The standing trees and stumps prevent economical fertilizer applications making the conservation of plant nutrients necessary. While P is likely the nutrient limiting plant growth, N losses as nitrate could be significant. The potential release of nutrients by burning the surface litter is small because of the limited quantities present. The role of the surface litter in reducing erosion may ultimately be more important. Chemical site preparation appears to be more economical than mechanical site preparation. Additional advantages may be gained by managing the surface litter and rapid revegetation of the sites.