Can Transpiration Rates Tell The Potentiality Of Mine Reclamation Ground Cover?

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Introduction

Minesoil in Appalachia is low infiltration rates and its hydraulic properties may result in droughty conditions of plant stress (Pedersen et al., 1980). Competitive interactions between woody and ground cover species was an important issue in ex-coal mining areas in Appalachia region. Plant selection is required to guarantee the reforestation success and transpiration rate may be used to predict the adaptability of the selected plant species. The study aimed to determine whether transpiration rates can be used to predict ground cover success on mine reclamation sites.

Materials and Methods

The experiment was carried out with fifteen herbs and grass different species (Table 2). Local available seeds were sowed in PVC pots (305 mm height and 100 mm diameter) on three different soil i.e. vermiculite and pure beach sand mixture at 1:1 (v:v) ratio, quarry soil, and coal spoil, on 8, October 2010. The quarry soil was collected from Oak Ridge, Tennessee and coal mined soil were collected from Zeb Mountain, Tennessee. Each treatment was repeated three times as blocks. The plants were grown in University of Tennessee - Knoxville green house under three 1000 watt mercury lamps from 6 am to 9 pm, and 23.9–27.7ºC/18.3–21.1ºC (day/night) temperature and 48.0/48.5% (day/night) average humidity during the study period. The plants were watered in the morning and afternoon daily during the study.

Transpiration measurement, using a LI-1600 chamber steady state porometer (LI-COR, USA), was measured at 10.00 – 14.00 at eleven weeks old in nine consecutive days. Leaves area were measured using a LI-3100 Area Meter (LI-COR, USA). Plant height and cover and transpiration rates were measured throughout the investigation period.

Data for this project were analyzed using SPSS © software version _____ (SPSS Inc., Chicago, USA).

Table 1 Physical properties of vermiculite and pure beach sand mixture at 1:1 (v:v) ratio, quarry soil, and coal mined spoil

	kg ha^{-1}									(%)
	P	K	Ca	Mg	Zn	Cu	Fe	Mn	Na	Organic Matter
Vermiculite / Sand (1:1)	**6.7**	**190.9**	**533.5**	**125.5**	**3.1**	**5.5**	**16.1**	**2.2**	**1556.9**	**0.1**
Quarry soil	**0.4**	**54.2**	**3626.0**	**1854.3**	**17.3**	**0.4**	**3.7**	**29.5**	**18.7**	**0.7**
Mined Soil	**263.0**	**180.5**	**3795.2**	**1311.4**	**21.8**	**8.0**	**32.5**	**229.8**	**72.9**	**2.2**

Table 2 Fifteen herbs and grass species used in transpiration observation

No.	Local name	Botany name	Family
1	Orchard grass	*Dactylis glomerata L.*	Poaceae
2	Ladino clover	*Trifolium repens* L.	Fabaceae
3	Birdsfoot trefoil	*Lotus corniculatus* L.	Fabaceae
4	Indian grass	*Sorghastrum nutans* (L.) Nash	Poaceae
5	Little bluestem	*Schizachyrium scoparium* (Michx.) Nash	Poaceae
6	Switch grass	*Panicum virgatum* L.	Poaceae
7	Perennial ryegrass	*Lolium perenne* L.	Poaceae
8	Annual ryegrass	*Lolium multiflorum* Lam.	Poaceae
9	Tendergreen mustard	*Brassica perviridis* (L.H. Bailey) L.H. Bailey	Brassicaceae
10	Cow pea Texas C40	*Vigna unguiculata* L.(Walp.)	Fabaceae
11	Okra red burgundy	*Hibiscus esculentus* L.	Malvaceae
12	Dwarf essex rape	*Brassica napus L.*	Brassicaceae
13	Buck wheat	*Polygonum fagopyrum* L.	Polygonaceae
14	Red clover	*Trifolium pratense* L.	Fabaceae
15	White clover	*Trifolium repens* L.	Fabaceae

Results and Discussion

Mean plant cover was significantly different between soil types, being greatest in quarry overburden and least in the vermiculite and pure beach sand mixture. Plant height did not differ between quarry and coal overburden, but was greater in these soils than in sand/vermiculite. Red clover (*Trifolium pratense* L.) and white clover (*Trifolium repens* L.) both Fabaceae performed consistently well across all three soil types. A relationship was found between transpiration rate and plant growth (R^2=0.45, p<0.05). Transpiration rate of white clover was the fourth smallest (1.04 µg cm^{-2} s^{-1}) and its red clover was the eighth one (1.76 µg cm^{-2} s^{-1}). Their transpiration rates were lower than the other four i.e. annual ryegrass (2.09 µg cm^{-2} s^{-1}), orchard grass (2.88 µg cm^{-2} s^{-1}). Perennial ryegrass (5.51 µg cm^{-2} s^{-1}), and indian grass (5.85 µg cm^{-2} s^{-1}) of five Poaceae readings. For water stress environment, the most drought-adapted species at the individual plant scale has the lowest daily transpirational water consumption (Tong et al., 2008).

More nutrients in coal spoil than in quarry soil and in vermiculite and pure beach sand mixture at 1:1 (v:v) ratio as the least (Table 1) and the soil texture may support the plant growth differences (Fig. 1). Except sodium and kalium, almost of analyzed minerals of vermiculite and pure beach sand mixture were the least. The sand texture was observed at this type of medium. The growth of ground cover is important as it support revegetation success (Holl and Cairns, Jr., 1994).

The results suggest that transpiration rate may be used to select plant adaptibility. Further study was needed to validate the finding that red clover and white clover may be potential as future selections to be used for reclamation after mining.

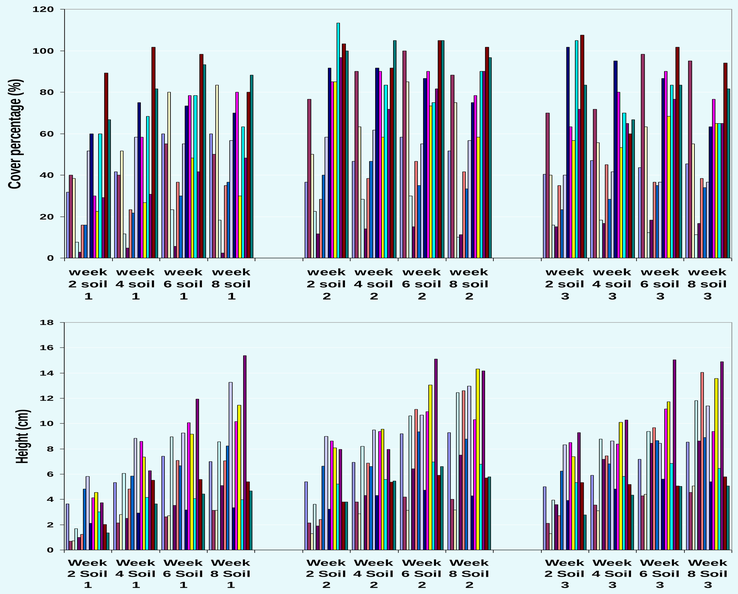

Fig. 1 Cover percentage (upper) and height (below) of fifteen ground cover species grown on vermiculite and pure beach sand mixture (1), quarry soil (2), and coal spoil (3) at week 2, 4, 6, and 8

Conclusions

Our results suggest that transpiration rate may be used to select plant adaptibility to mined soil. Two Fabaceae ground cover species i.e. red clover (*Trifolium pratense* L.) and white clover (*Trifolium repens* L.) may be potential as ground cover for mined soils.

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