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NATURAL COLONIZATION OF WOODY SPECIES ON REVEGETATED COAL MINE SPOILS IN A DRY TROPICAL ENVIRONMENT

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ABSTRACT

A study was undertaken to report the natural colonization of woody species on 53 months (4 years and 5 months old) revegetated coal mine spoils at Jayant and Bina coal mines of Singrauli coalfields, India. The revegetated Jayant site seeded with two tropical grass species *Pennisetum pedicellatum* and *Heteropogon contortus* has greater number of naturally colonizing woody species than the Bina site. The leguminous species dominate over all the natural woody invaders on coal mine spoils at both the sites.

Key Words: Coal Mine Spoil, Keystone Species, Singrauli Coalfields

INTRODUCTION

Mining activity results in huge dumps of overburden material as mine spoil. These dumps are severely disturbed and physically, chemically and biologically poor habitats (Singh and Jha, 1993). Nitrogen and phosphorus are the limiting nutrients in mine spoil (Singh and Singh, 2001). Mine spoil needs to be stabilized and restored to a natural self-sustaining ecosystem. Natural restoration is a slow process (Jha and Singh, 1991). However, it can be accelerated by planting tree species with ground seeding of herbaceous flora (Singh *et al.*, 1997). This initial two tier vegetation increases the biological fertility and diversity of mine spoil subsequently paving way for the invasion of locally adapted species. The objective of the present study is to analyze the natural colonization of woody flora on 53 months old revegetated coal mine spoils in a dry tropical environment.

MATERIALS AND METHODS

The study was conducted at Jayant and Bina coal mines of Singrauli coalfields, India. The coalfields of Singrauli spreads over more than 2200 km² (latitude 23°47' -24°12' N; longitude 81°48' - 82° 52' E and elevation 280-519 m above mean sea level), of which 80 km² lie in state of Uttar Pradesh and rest in the state of Madhya Pradesh.

The climate is dry tropical with temperature reaching up to 42°C during June and lowering down to 5°C in January. Rainfall varies from 90-100 cm during monsoon months from June to September. Winter rains are negligible. The potential natural vegetation is a tropical dry deciduous forest (Champion and Seth, 1968).

Geological formation is susceptible to erosion overlying sand stone with coal seams of various depths varying from 8 to 135 m in thickness.

A revegetation experiment was set on coal mine spoils at Jayant and Bina coal mines of Singrauli coalfields, India. In July 1993, woody species plantations were raised on fresh coal mine spoils at both the sites. The revegetated mine spoil area at Jayant site was about 8 hectares while the same at Bina site was about 4 hectares. At Jayant site the woody species used for revegetation of coal mine spoils included *Acacia catechu*, *Albizia lebbek*, *Azadirachta indica*, *Dalbergia sissoo*, *Dendrocalamus strictus*, *Gmelina arborea*, *Phyllanthus emblica*, *Leucaena leucocephala*, *Pongamia pinnata*, *Tectona grandis* and *Terminalia bellerica*. Whereas at Bina site woody species raised for revegetation of coal mine spoil included *Albizia lebbek*, *Albizia procera*, *Azadirachta indica*, *Dalbergia sissoo*, *Dendrocalamus strictus*, *Holoptelea integrifolia*, *Leucaena leucocephala*, *Madhuca indica*, *Phyllanthus emblica*, *Pongamia pinnata*, *Tamarindus indica* and *Terminalia arjuna*. The woody species at both the sites were planted in 20 m x 20 m plots size with spacing distance of 2 m x 2 m, in monoculture and mixed culture

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plantations with ground seeding of herbaceous flora at the rate of 7 kg ha⁻¹. At the Jayant site two species of grasses namely *Pennisetum pedicellatum* and *Heteropogon contortus*, and two species of leguminous forbs namely *Stylosanthes hamata* and *Stylosanthes humilis* were seeded. However, the revegetated plots at Bina site were seeded only with leguminous forb *Stylosanthes humilis*.

A field study was conducted in December 1997 (53 months after revegetation) to report the various naturally colonizing woody species revegetated coal mine spoils at Jayant and the Bina sites of Singrauli coalfields. The Sorensen's Similarity Index (Sorensen, 1948) was used to compare the naturally colonizing woody species between both the sites.

RESULTS AND DISCUSSION

The total number of naturally colonizing woody species at Jayant site is given in the Table 1

Table 1: Naturally colonizing woody species on a 53 months old revegetated coal mine spoil at Jayant coal mine of Singrauli coalfields, India

S. No.	Plant Species	Family	Habit
1.	<i>Acacia catechu</i> Willd.	Fabaceae	Tree
2.	<i>Boswellia serrata</i> Roxb.	Burseraceae	Tree
3.	<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	Tree
4.	<i>Calotropis gigantea</i> (L.) R. Br.	Asclepiadaceae	Shrub
5.	<i>Cassia fistula</i> L.	Fabaceae	Tree
6.	<i>Ficus benghalensis</i> L.	Moraceae	Tree
7.	<i>Ficus glomerata</i> Roxb.	Moraceae	Tree
8.	<i>Ficus religiosa</i> L.	Moraceae	Tree
9.	<i>Grewia rothii</i> DC	Malvaceae	Shrub
10.	<i>Haldina cordifolia</i> (Roxb.) Ridsd.	Rubiaceae	Tree
11.	<i>Holarrhena pubescens</i> Benth.	Apocynaceae	Tree
12.	<i>Holoptelea integrifolia</i> (Roxb.) Planch	Ulmaceae	Tree
13.	<i>Melia azadarach</i> L.	Meliaceae	Tree
14.	<i>Nyctanthes arbor-tristis</i> L.	Oleaceae	Shrub
15.	<i>Ougeinia ougeinensis</i> Roxb.	Fabaceae	Tree
16.	<i>Phyllanthus emblica</i> L.	Euphorbiaceae	Shrub
17.	<i>Woodfordia fruticosa</i> (L.) Kurz	Lythraceae	Shrub
18.	<i>Ziziphus nummularia</i> (Burm. f.) Wt. & Arn.	Rhamnaceae	Shrub
19.	<i>Ziziphus oenoplia</i> Mill	Rhamnaceae	Shrub
20.	<i>Ziziphus xylopyrus</i> Willd.	Rhamnaceae	Shrub

While the same for Bina site is depicted in Table 2.

The study reveals that the revegetated mine spoil at Jayant has greater number of naturally colonized woody species than the same aged revegetated coal mine spoils at the Bina site. In fact at Jayant site the two tropical hardy grass species namely *P. pedicellatum* and *H. contortus* were seeded in plantation plots. However, there was no such seeding of grasses in plantation plots at the Bina site. The C₄ pathway of photosynthesis enables the grasses to grow successfully on mine spoil. The grass covers not only ameliorate the fertility status of the spoil by addition of organic matter to it, but also serve as trap for wind-blown seeds. Hence the natural invasion of woody species was greater at the Jayant site than the Bina site.

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Table 2: Naturally colonizing woody species on a 53 months old revegetated coal mine spoil at Bina coal mine of Singrauli coalfields, India

S.No.	Plant species	Family	Habit
1.	<i>Acacia catechu</i> Willd.	Fabaceae	Tree
2.	<i>Anogeissus latifolia</i> Wall.	Combretaceae	Tree
3.	<i>Boswellia serrata</i> Roxb.	Burseraceae	Tree
4.	<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	Tree
5.	<i>Grewia rothii</i> DC	Malvaceae	Shrub
6.	<i>Haldina cordifolia</i> (Roxb.) Ridsd.	Rubiaceae	Tree
7.	<i>Holarrhena pubescens</i> Benth.	Apocynaceae	Tree
8.	<i>Holoptelea integrifolia</i> (Roxb.) Planch	Ulmaceae	Tree
9.	<i>Lannea coromandelica</i> (Hout.) Merr.	Anacardiaceae	Tree
10.	<i>Melia azadarach</i> L.	Meliaceae	Tree
11.	<i>Nyctanthes arbor-tristis</i> L.	Oleaceae	Shrub
13.	<i>Woodfordia fruticosa</i> (L.) Kurz	Lythraceae	Shrub
14.	<i>Ziziphus nummularia</i> (Burm. f.) Wt. & Arn	Rhamnaceae	Shrub

Eleven species were common to both the sites. Hence, the Sorensen's Similarity Index value reported was 0.646. A higher Similarity Index value reveals that most of the naturally invading species are similar to both the sites.

Three keystone species namely *Ficus benghalensis*, *Ficus glomerata* and *Ficus religiosa* were reported at the Jayant site while no any keystone species was reported at the Bina site. Keystone species are those which maintain the structure and organization of the community (Terborgh, 1986).

Of the total woody species reported at both the sites, maximum number of species was represented by those belonging to the Fabaceae family. Thus the study clearly suggests that naturally colonizing species at both the sites were dominated by the Fabaceae family. Singh (2011) reported greater abundance for naturally colonizing woody leguminous species than non-leguminous woody species on the coal mine spoils of Singrauli coalfields. Since mine spoils are deficient in nitrogen hence leguminous species appear as a pioneer community on mine spoils.

At Jayant site, of the total 20 woody species reported, 8 were represented by shrubs while 12 were represented by trees. However, at Bina site of the total 14 species reported, 4 were represented by shrubs, while 10 were represented by trees. Thus the study reveals that naturally colonizing woody species at both the sites were dominated by trees. It was noticed that the *Nyctanthes arbor-tristis*, *Woodfordia fruticosa* and *Ziziphus nummularia* were the most commonly occurring shrubs on revegetated coal mine spoils at both the sites of Singrauli coalfields.

It was also observed that *Acacia catechu*, *Adina cordifolia*, *Boswellia serrata*, *Butea monosperma* and *Holarrhena antidysenterica* were the most frequent naturally colonizing tree species on mine spoils at both the sites of Singrauli coalfields. The result conforms to the previous finding on coal mine spoils of Singrauli coalfields (Singh, 2011).

All the naturally colonizing woody species on revegetated coal mine spoils at both sites are the component plant species of the tropical dry deciduous forest of the locality.

The *Anogeissus latifolia* and *Lannea coromandelica* were the two important tree species reported from revegetated mine spoils of Bina site. However, they were not reported at the Jayant site. Since revegetated Bina site was located adjacent to the forest cover, hence these two species which are the component tree species of the deciduous forest of the region were reported at the Bina site.

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CONCLUSIONS

It can be concluded from the study that seeding of grasses is essential during revegetation of mine spoils for the enhancement of the natural colonization of woody species which would ultimately lead to quick establishment of a self-sustaining ecosystem.

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