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Short Communication

Herbaceous biomass yield on an age series of naturally revegetated mine spoils in a dry tropical environment

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Abstract

The influence of mine spoils age on herbaceous biomass yield was studied in a dry tropical environment. Naturally revegetated mine spoils selected were 1-, 5-, 10-, 15- and 20-year-old. The biomass yield increased with increasing age of the spoils. The root, shoot and total biomass were significantly greater on 5-, 10-, 15- and 20-year-old spoils compared to 1-year-old young spoil. A stabilizing trend in biomass yield started after 10 years, reaching almost a stage of saturation on 20-year-old spoil. Spoil age had affected root/shoot ratio also. However, the root/shoot ratio exhibited a decreasing trend with advance in the age of the spoil.

Keywords: Mine spoils, root biomass, root/shoot ratio, shoot biomass, total biomass.

1. Introduction

Nutritionally and microbiologically poor mine spoils create inhospitable condition for plant growth [1], and hence, the natural revegetation of mine spoil is a slow process. Initially, the mine spoils are colonized only by a few herbaceous species especially the hardy grasses and nitrogen-fixing legumes. The growth of grasses and legumes ameliorates the spoil fertility by the addition of organic matter and nutrients to it, subsequently paving way for other herbaceous species to colonize. Thus, with advancing age, the yield capacity of the biomass of the spoils also increases owing to increased habitat fertility and species composition. Several field studies have reported greater biomass and productivity on older mine spoil sites than the younger ones [2–4]. The main objective of the present investigation is to evaluate the biomass yield of naturally colonized herbaceous species on an age series of mine spoils in a dry tropical environment.

2. Site description

The study was conducted at Singrauli coalfields. The coalfields extend over 2200 km^2 (lat. 23°47'–24°12'N; long. 81°48'–82°52'E and elevation of 280–519 m above the mean sea level), of which 80 km^2 lie in Sonabhadra district of Uttar Pradesh and the rest in Sidhi district of Madhya Pradesh. The climate is dry tropical with temperature reaching up to 48°C

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during June and lowering down to 5°C in January. Rainfall varies from 90–100 cm during monsoon months of June–September. Winter rains are negligible. The potential natural vegetation is a tropical dry deciduous forest.

3. Sampling

The naturally colonized herbaceous crop at its peak was harvested from three 1×1 m quadrats in September 1996 of 1-, 5-, 10-, 15- and 20-year-old coal mine spoils. The sampling was done randomly. The shoot biomass in each quadrat was harvested at ground level, and root biomass was sampled using $25 \times 25 \times 30$ cm monoliths. The monoliths were washed with a fine jet of water on 2.0- and 0.5-mm mesh screen. The root and shoot biomass was oven-dried at 80°C to constant weight. Differences between mine spoil age means were tested for significance through a two-tailed Student's *t*-test.

4. Results and discussion

The major grass species which colonized the age series of mine spoils were *Apluda mutica*, *Aristida cyanatha*, *Aristida adscensionis*, *Bothriochloa pertusa*, *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Dichanthium annulatum*, *Digitaria cruciata*, *Eleusine indica*, *Eragrostis tenella*, *Eragrostis viscosa*, *Eragrostis unioloides*, *Heteropogon contortus* and *Sporobolus diander*. The dominant grass species of 1- and 5-year-old spoils were *B. pertusa*, *D. annulatum* and *E. tenella*, whereas those of 10-, 15- and 20-year-old spoils were *A. mutica*, *A. adscensionis*, *A. cyanatha* and *H. contortus*.

The major legume species which colonized mine spoils of various age series were *Alysicarpus monilifer*, *Alysicarpus longifolius*, *Clitoria ternatea*, *Desmodium gangeticum*, *Desmodium triflorum*, *Tephrosia purpurea* and *Zornia gibbosa*. The dominant legume species of 1- and 5-year-old spoils were *A. monilifer*, *A. longifolius* and *D. triflorum*, while those of 10-, 15- and 20-year-old spoils were *C. ternatea*, *D. gangeticum*, *T. purpurea* and *Z. gibbosa*. The 1- and 5-year-old spoils have fewer number of species than 10-, 15- and 20-year-old spoils.

The data for root, shoot and total biomass and root/shoot ratio are summarized in Table I. Results reveal marked influence of spoils age on herbaceous biomass yield. The biomass yield for root and shoot was reported least on 1-year-old young spoil while the same was

Table I
Root, shoot and total biomass and root/shoot ratio of herbaceous species on an age series of naturally revegetated mine spoil (Mean ± SE)

Spoil age (years)	Biomass (g m^{-2})			Root/shoot ratio
	Root	Shoot	Total	
1	26 ± 1^{a}	60 ± 3^{a}	86 ± 2^{a}	0.42 ± 0.02^{a}
5	106 ± 5^{b}	279 ± 13^{b}	385 ± 19^{b}	0.37 ± 0.01^{ab}
10	172 ± 6^{c}	501 ± 10^{c}	673 ± 5^{c}	0.34 ± 0.01^{bc}
15	181 ± 8^{c}	528 ± 12^{c}	709 ± 13^{c}	0.34 ± 0.02^{bc}
20	183 ± 10^{c}	535 ± 13^{c}	718 ± 22^{c}	0.33 ± 0.01^{c}

Values in a column suffixed with different letters are significantly different from each other at $P < 0.05$.

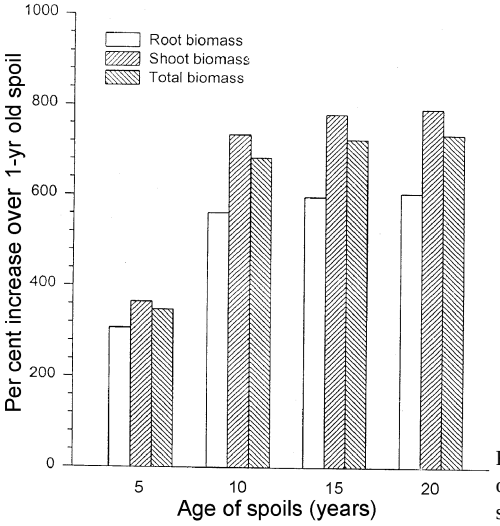

FIG. 1. Per cent increase in root, shoot and total biomass of herbaceous species on 5-, 10-, 15- and 20-year-old spoil over 1-year-old young spoil.

the greatest on 20-year-old spoil. This suggests that biomass-producing capacity increased with increasing age of the spoil. A direct relationship between increasing spoil age and increased productivity has been reported [4]. Compared to 1-year-old spoil, the root, shoot and total biomass were 604, 792 and 735% greater, respectively on 20-year-old spoil (Fig. 1). The result of the study also suggests that the response to spoil age was greater for shoot biomass than for root biomass. The root, shoot and total biomass yield on 5-, 10-, 15- and 20-year-old spoils significantly differed from 1-year-old spoil. However, the root, shoot and total biomass yield did not differ significantly among 10-, 15- and 20-year-old spoils. This indicates a stabilizing trend in biomass production after 10 years. Many naturally colonized plant communities on mine spoil show high productivity in 2–5 years, but productivity and vigour decline due to large build-up of litter which ties up substantial amount of C and N later on [5]. Compared to 15-year-old spoil, the root, shoot and total biomass yield was only 1.10, 1.32 and 1.26% greater, respectively, on 20-year-old spoil. This clearly indicates a stage of saturation in biomass yield on 20-year-old spoil.

Spoil age had marked effect on root/shoot ratio also. The root/shoot ratio on 10-, 15- and 20-year-old spoils significantly differed from 1-year-old spoil. The root/shoot ratio had shown a decreasing trend with advancing age of the spoil suggesting lesser allocation to root part with increasing spoil age. This may be due to increase in fertility with advancing age of the spoil. On nutrient-poor sites the greater proportion of assimilate allocations to roots is owing to limitation of nutrient supply [6, 7]. In nutrient-poor habitats, plants are adapted by an increase in biomass allocation to structure that enhances nutrient absorption [8].

5. Conclusion

The study suggests that the herbaceous biomass production on naturally revegetated mine spoil increases vigorously with advancing age of the mine spoil, but after 10 years, the biomass production drops considerably reaching almost a stage of saturation on 20-year-old spoil.

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