

Preliminary Studies on Revegetating the Mine Spoils of ACC Limited, Madukkarai Cement Works

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

During the last two decades, the number of cement factories has increased hugely due to expanding requirement of cement materials for construction. A study was taken in ACC cement works, Madukkarai, Coimbatore to assess the floristic composition of shrubs, herbs and tree species that are available in both mine out soils and soils nearby the factory vicinity. A pot experiment was conducted to find the effect of different biofertilizers on the growth of tree seedlings with potting mixture of minespoil, garden soil and vermicompost in the ratio 1:1:1 on volume basis. The results revealed that the application of phosphobacteria @ 10 g/seedlings enhanced the growth of seedlings to about 20 percent over the control. Therefore, it was concluded that utilizing biofertilizer with proper potting mixture can help to revegetate the mined out spoils of cement industry.

Keywords: Rehabilitation; revegetation; biofertilizers; minespoil; urbanization; industrialization.

1. INTRODUCTION

The global production of cement in 2030 is projected to grow to a level roughly five times

higher than its level in 1990, with close to 5 billion tonnes worldwide (WWF International, [1]). In recent times there has been significant development activity in terms of industrialization

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and urbanization in almost all cities in India. Significant growth is also observed in the cement industry sector and second largest market after china accounting for about 7-8% of the total global production. Most of the areas in India and other countries, the environment have reached its maximum carrying capacity in terms of air pollutants, noise pollution, water pollution and soil pollution and there is an urgent need to look for alternatives to reduce the pollutants in various sectors.

Re-vegetation on these mine spoils to restore the pre-mining ecological equilibrium or to return such areas to an ecologically acceptable post-mining land use is a challenging problem. The present ecological technology for the rehabilitation of such drastically disturbed systems particularly in the developing countries is still in its infancy. The area currently reported to be disturbed for mining, the world over, is about 3,86,000 ha y1 (Dhar, [2]).

Soil microbial activity is important for the nutrient biogeochemical cycling and it is negatively affected by the cement dust pollution (Nowak et al., 2003). Impact on the plant community has also been studied worldwide in terms of plant – environment interactions, since the plants are much more sensitive in comparison to other organisms. The symptoms or effects in plant anatomy, physiology or biochemistry indicates the state of the environment. Since the major system and organs of plants are exposed to the atmosphere and the leaves continuously exchange gases in and out of the systems, any change in the atmosphere is reflected in the plant physiology Abbasi et al., [3]. In this context, the study was framed with the objective of finding options for selecting better soil mixture and for identifying easily available materials which helps in improving the vegetation growth in minespoils.

2. MATERIALS AND METHODS

Madukkarai cement factory of the ACC limited (Associated Cement Companies Limited) is located in 10° 54' 46"N Latitude & 76° 57' 10'E Longitude and 14 km distance from the Coimbatore City. Madukkarai is the administrative centre for Madukkarai Taluk. ACC Limited is India's foremost manufacturer of cement and ready mixed concrete with a countrywide network of factories and sales offices. Established in 1936, ACC is acknowledged as a pioneer and trendsetter in cement and concrete technology. Minespoil was

collected from the cement factory site and pot culture experiment was carried out in the Compost yard, Department of Environmental Sciences, Tamil Nadu Agricultural University, Coimbatore.

2.1 Mine Spoil Analysis for Initial Characteristics

Mine spoil samples were collected from ACC cement industry site and were analysed for major nutrient contents by following standard procedures.

2.1.1 Pot culture experiment

A pot culture experiment was conducted with two tree crops *Azadirachta indica* and *Casuarina equisetifolia* at Compost yard, Department of Environmental Sciences, TNAU, Coimbatore. A total of 300 gms of pot mixture was filled up in each pot with garden soil, vermicompost (prepared in the compost yard, Dept. of Environmental Sciences) and ACC mine spoil in the ratio 1:1:1 on volume basis. The study was mainly carried out to study the impact of various inputs viz, Recommended dose of NPK, 3% Panchakavya, Azospirillum, Phosphobacteria and VAM on the growth of Neem & Casuarina seedlings. Seedlings were planted and treatments were imposed at regular intervals as given below.

2.1.2 Treatments

T1- Recommended dose of fertilizers
T2 –3% Panchagavya
T3 –VAM (10 gms/seedling)
T4 –Phosphobacteria (10 gms/seedling)
T5 – Azospirillum (10 gms/seedling)
Design –Factorial Completely Randomized Block Design
Treatment- Five
Replications-Four

2.1.3 Biometric observation recorded:

Shoot length –the length was measured from the root collar region to the tip of the stem and the mean length was expressed in centimeter. The experimental results were statistically scrutinized as suggested by Panse and Sukhatme [4]. The critical difference was worked out at 5 per cent (0.05) probability.

3. RESULTS AND DISCUSSION

The results confirmed that the major nutrient status of the mine spoils was very poor and the

organic carbon level was 0.3% and the microbial status in the mine spoils was in normal (Table 1).

3.1 Pot Culture Experiment

3.1.1 Effect of different biofertilizers on the growth of tree seedlings

The seedlings height was observed once in a month for 3 months for Neem and Casuarina. *Casuarina equisetifolia* registered maximum growth increment (49.6 cm) in application of phosphobacteria @ 10 g/seedling. The growth increment was the least (35.7 cm) in panchagavya applied treatment. The same trend was followed in *Azadirachta indica* which registered maximum growth increment (26.2 cm) in phosphobacteria @ 10 g/seedling application and the growth increment was the least (17.2 cm) in recommended dose of fertilizer application

(Tables 2 & 3). Nitrogen and phosphorous are usually deficient in mine spoils, which limits vegetation establishment and sustained productivity but the addition of biofertilizers in this study supplemented the nutrients and enhanced the growth of seedlings [5,6]. But Phosphobacteria is immensely important, as it have been reported to increase uptake of P by converting insoluble from soluble ones. Similar to this study in field conditions, in bauxite mine spoils AM fungi, Phosphobacterium and Frankia inoculated seedlings of *C. equisetifolia* showed 90 to 100% survival over the control seedlings. Their growth was also significantly higher than the control seedlings Karthikeya et al., [7]. In another study by Dupponnois et al. [8] indicated that mycorrhizal inoculation significantly improves the growth of *Acacia holosericea* seedlings in degraded soils.

Table 1. Initial characteristics of ACC cements mine out soil

Particulars	Value
pH	8.04
EC	0.14
Organic carbon (%)	0.32
Nitrogen kg/ha	67.2
Phosphorous kg/ha	10.2
Potassium kg/ha	78.4
Bacteria x 10 ⁶ CFU	16
Actinomycetes X10 ² CFU	30
Fungi X 10 ⁴ CFU	4



Fig. 1. Effect of different amendments on the growth of tree seedlings

Table 2. Effect of different treatments on the growth of neem seedlings

Treatments	Initial (cm)	30 days after planting (cm)	60 days after planting (cm)	90 days after planting (cm)	Incremental growth (cm)
T ₁	14.1	23.9	28.9	31.3	17.2
T ₂	16.0	27.5	30.5	34.5	18.5
T ₃	15.8	30.5	37.9	41.3	25.5
T ₄	12.8	28.2	32.1	39.0	26.2
T ₅	17.4	30.1	38.1	42.3	24.9
SEd	0.6	0.5	1.1	0.6	0.7
CD(0.05)	1.0	0.9	1.3	1.2	1.4

T₁-Rec. doses of NPK, T₂- 3% Panchagavya, T₃- VAM @ 10g/seedling, T₄- Phosphobacteria @ 10 g/seedling, T₅- Azospirillum @ 10 g/seedling

Table 3. Effect of different treatments on the growth of Casuarina sp

Treatments	Initial (cm)	30 days after planting (cm)	60 days after planting (cm)	90 days after planting (cm)	Incremental growth (cm)
T ₁	33.1	53.3	62.3	78.3	45.2
T ₂	31.0	50.6	61.1	66.7	35.7
T ₃	30.5	56.2	67.2	79.2	48.7
T ₄	29.2	54.1	62.7	78.8	49.6
T ₅	32.4	63.8	72.4	78.0	45.6
SEd	1.2	0.8	0.7	1.0	1.1
CD(0.05)	1.5	1.2	1.4	1.2	1.3

T₁-Rec. doses of NPK, T₂- 3% Panchagavya, T₃- VAM @ 10g/seedling, T₄- Phosphobacteria @ 10 g/seedling, T₅- Azospirillum @ 10 g/seedling

4. CONCLUSIONS

Stored mine spoils the microbial populations are reduced when compared to undisturbed sites. Carbon content of stored mine spoils is also significantly lower due to lack of microbes. All these characters lead to reduced soil quality, nutrient cycling and lower availability of nutrients in mine spoils. However, suitable trees with beneficial microbial inoculants are always successful for reforestation in mine spoils. So, this study helps in finding suitable method/possibilities of revegetating the mined out spoils present in ACC cement factory site in Coimbatore. The results from this study supports the general conclusion that introduction of plants to mine spoils with microbial inoculants is a beneficial biotechnological tool to aid the recovery of degraded eco systems.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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