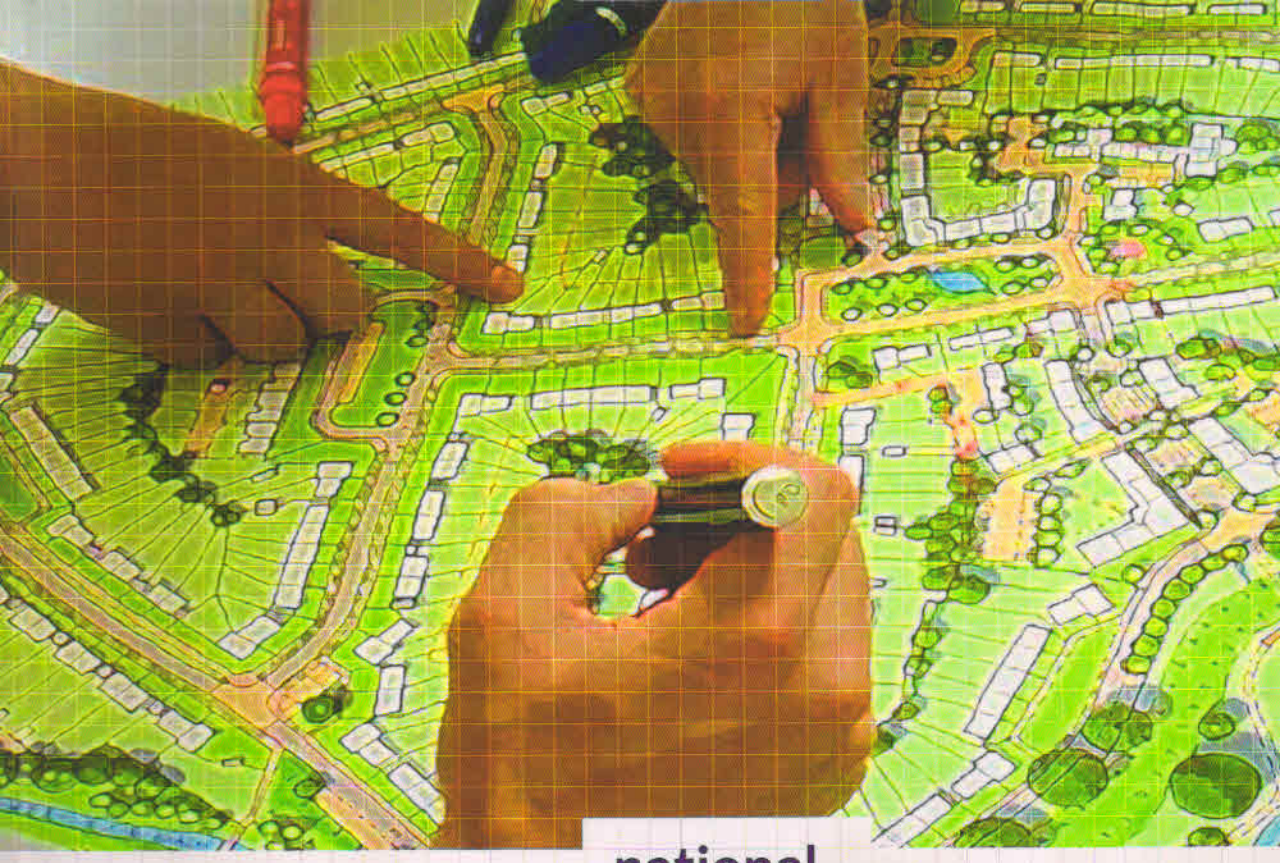

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AFFORESTATION IN LATERITE LANDS AT KASARGODE, KERALA WITH SWIETENIA MACROPHYLLA AND BENEFICIAL MICROBES

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ABSTRACT

Laterite lands are rich in Kasargode District Kerala that used mainly for making bricks in building construction. These lands are found barren in Kasargode (District) Kerala due to lack of vegetation. To develop vegetation in these laterite lands the soil properties of laterite was examined. It was found that the soils have lack of beneficial microbes and poor in major nutrients (N, P, K). Therefore the beneficial microbes Arbuscular mycorrhizal fungi, Azospirillum (N fixing bacteria) and Phosphobacterium were selected for afforestation in laterite lands along with Swietenia macrophylla. The laterite soils were collected and used as potting media for seedlings of S. macrophylla in nursery. Thereafter the cultured beneficial microbes were inoculated in to the seedlings of S. macrophylla and maintained for 6 months under nursery conditions. The beneficial microbes inoculated seedlings showed improved growth and biomass Later the seedlings were transplanted at laterite lands at Karmanthodi, Bovikanam, Kasargode and monitored their growth for 6 months. The seedlings inoculated with beneficial microbes showed 97% survival rate and improved growth. This study will help to convert the degraded laterite lands and barren laterite lands into productive lands

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INTRODUCTION

Laterites or lateritic soils are rich in iron and aluminum, formed in hot and wet tropical areas and appeared as rusty-red because of iron oxides. They develop by intensive and long lasting weathering of the underlying parent rock. These lands are abundant in Kasargode District, Kerala and massively used in building constructions as bricks. The unused laterite lands are found barren and un productive in Kasargode due to lack of vegetation. Developing vegetation in barren or wastelands are very essential to conserve the environment and to mitigate the climate change. However developing vegetation is difficult in the barren laterite lands as they are rocky in nature less amount of top soil, absence of organic matter and soil microbial populations. Soil microbes plays important role in soil fertilization, land reclamation and organic deposition. Some of the beneficial microbes are took an important role in reclamation and rehabilitation of degraded lands like mined out areas (Karthikeyan and Krishnakumar 2012). Arbuscular mycorrhizal (AM) fungi, Nitrogen fixing bacteria and Phosphate solubiizing bacteria are some of the beneficial microbes which convert the lands in productive as well as improve the plant growth. These microbes can enhance plant growth by a wide variety of mechanisms like phosphate

solubilization, biological nitrogen ûxation, rhizo- sphere engineering, exhibiting antifungal activity, production of volatile organic compounds induction of systemic resistance, promoting beneûcial plant -microbe symbioses and interference with pathogen toxin production.

In this study the beneficial microbes AM fungi, *Azospirillum* (N fixing bacteria) and *Bacillus megatherium* (phosphate solubilizing bacteria) were used for afforestation in laterite lands along with *Swietenia macrophylla* a commercially important tree in Kerala. The main objective of the study is to develop vegetation with *S. macrophylla* and beneficial microbes as an eco friendly approach so as to convert the barren laterite lands into productive lands.

MATERIALS AND METHODS

Study site

1 ha latrite land was selected at Karmanthodi, Bovikanam (taluk) Kasargode

(12°31'48.93'N; 75°09'28.93'E) for this study (Fig1).

Soil analysis

The physico chemical properties of laterite soils were analysed according to Jackson (1973).

ISOLATION AND CULTURE OF AM FUNGI

The AM fungi, *Glomus geosporum* and *G. fasciculatum* were isolated from the rhizosphere of *Acacia auriculiformis* found grown in laterite areas and multiplied with *Crotalaria juncea* seedlings in the sterile soil media (alfisol: sand) for 4 months

ISOLATION OF PHOSPHOBACTERIUM

Three o.1 ml aliquots of laterite soil diluted in sterile water were spread on the standard medium for Phosphobacterium (Pikovaskya medium) culture. The PSB medium composition per litre of distilled water is follows to obtain the culture. 10g sucrose, 5.0g Ca3 (Po4), 0.27 NH4 No3, 0.2g KCl, 0.1g MgSo4.7H2O, 0.1 g yeast extract, 1.0 mg MnSo4.6 H2O, 1.00 mg FeSO4.7 H2O, 0.1g Yeast extract and 15 g agar. The plates were incubated at 27°C for 3to 5 days. The colonies in PSB medium that formed clear zone on the medium were observed. The PSB was identified as *Bacillus megaterium* as shown whitish colonies.

ISOLATION OF AZOSPIRILLUM

A congo red medium was used for *Azospirllum* as follows. The medium had the following composition of g/litre of distilled water: KH2 Po4 5g; MgSo4.7H2O. 0.2 g; Nacl, 0.1g; Yeast extract, 0.5g; FeCl3.6H20, 0.2g; Nacl;0.1, DL. Malic Acid, 5.0 g; KOH 4.8 g, Agar 12 g; and 15 ml of 1:4000 solution of congo red added to the medium prior to plating. In this medium *Azospirillum* was appeared as scarlet colonies. These plates were incubated fro 7 hr at 37æ%C for 3 – 5 days.

NURSERY EXPERIMENTS

The seeds of *S. macrophylla* was procured from Kerala Forest Research Institute, Peechi, Kerala. The seeds were directly sown with required prior treatment (soaked in cold water for 24 hrs) in the nursery beds containing pure sand. The seeds were found germinated between 7 to 10 days. There after the germinated seedlings were transplanted to polythene bags (14 X 27 cm) containing sieved laterite soil collected from the latertie out areas at Kannur.

The AM fungal inoculums *G. geosporum* and G. *fasciculatum* along with soil from pot cultures of *C. juncea* comprising mycorrhizal roots, soil hyphae and spores were used for inoculation. 20 g of inoculums was placed 5 cm below the laterite soil surface of each polythene bag containing *S. macrophylla* seedlings.

Thereafter the seedlings were maintained in the nursery for 3 months and watered regularly. Similarly 15 ml of inoculums of *Azospirllum* and PSB culture in broth cultures were applied to the seedlings individually and in combination with AM fungi.

MEASUREMENTS

The seedlings of *S. macrophylla* were measured in terms of height, stem girth and number of leaves after 90 days to assess the performance of seedlings in laterite soils along with microbes. The seedlings showed good performance in nursery grown in laterite soils as potting media.

TRANSPLANTATION OF SEEDLINGS

The seedlings of *S. macrophylla* along with beneficial microbes and laterite soils were transplanted at laterite lands. The seedlings were transplanted at randomized block design according to the treatments with 5 replicates. The initial measurements of seedlings were taken in terms of height, collar diameter and number of leaves.

STATISTICAL ANALYSES

The data on physico - chemical properties of laterite soils were statically analysed by SE and the nursery and field data were analyzed according to DMRT.

RESULTS & DISCUSSION

The physic chemical properties of the laterite soils showed that the soil is acidic and very poor in major nutrients (Table.1). However the soils were used a potting media for *S. macrophylla* seedlings in the nursery experiments with beneficial microbes of AM fungi, Phosphobacterium and Azospirillum. The seedlings inoculated with these beneficial microbes showed good performance than the un inoculated control seedlings (Table. 2). These microbes mobilized the Phosphorus (P) and fix the atmospheric nitrogen in the seedlings with that helped to improve the growth of seedlings than control (Karthikeyan et al. 2009). Phosphobacterium plays an important role solublilizing un available form of soil P and the facilitate to up take by *S. macrophylla* seedlings which is on part at earlier studies (Sperber, 1998; Singh et al. 1989). Combined inoculation of beneficial microbes gives better results than single and dual inoculation of beneficial microbes in the study. It showed the fact that combined inoculation always promotes the plant growth in multiple ways particularly P and N uptake.

In the field experiments at laterite lands the growth and survival performance of beneficial microbes inoculated *S. macrophylla* seedlings were higher than uninocualted controls (Table 3. Fig.2). The seedlings were well established in the laterite lands due to beneficial microbes (Fig.3). Similar results found in *Casuarina equisetifolia* and *Eucalyptus terticorns* planted at bauxite mine spoils (Karthikeyan et al. 2009; Karthikeyan and Krishnakumar, 2012). The improved survival rate at laterite land is due to nutrient uptake of N and P through beneficial microbes. Further the significant growth enhancement of *S. macrophylla* seedlings with beneficial microbes may be due to increased microbial population in soil.

CONCLUSION

The results from this study draw a conclusion that introducing plants to laterite land with beneficial microbial inoculation is an afforestation technology to establish the vegetation. This study will be also helpful to convert the degraded lands of laterite mined out in to productive lands with USEFUL TREES/ PLANTS

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Table.1. Physico chemical properties of laterite soils (mean of 5 replicates)

	pH	E.C (ds/m)	Bulk density (gm/cc)	Organic carbon (%)	Available Nitrogen (kg/ha)	Available Phosphours (kg/ha)	Available Potassium (kg/ha)	Calcium (mq/100g)	Magensium mq/100g)
Laterite soils	6.3 (±0.02)	0.12 (±0.012)	1.4 (±0.22)	0.87 (±0.04)	135.9 (±2.3)	19.7 (±1.8)	0.0	0.8 (±0.001)	1.20 (±0.15)

Table.2. Response of *S. macrophylla* seedlings to beneficial microbes under nursery conditions (mean of 5 replicates)

Sl No	Treatment	Height (cm)	Stem girth (cm)	No. of leaves/plant
1	Azospirillum (AZ)	18.45c	0.96c	8.20a
2	Phosphbacterium (PSB)	13.00b	0.74ab	7.40a
3	AM fungi	13.05b	0.78ab	690a
4	AZ + PSB	11.55 ab	0.76ab	7.20a
5	PSB+ AM fungi	13.85b	0.72ab	8.10a
6	AZ+AM fungi	13.15b	0.68a	8.20a
7	PSB + AM fungi + AZ	10.75 ab	0.82b	9.40a
8	CONTROL	8.95a	0.74ab	9.20a

Means followed by same letters are significantly not different by DMRT ($p<0.05$)

Table.3. Growth performance of *S. macrophylla* seedlings inoculated with/without beneficial microbes in laterite lands (mean of 5 replicates)

Treatment	No of leaf	Height (cm)
Azospirillum (AZ)	20.00 bc	58.33 c
Phosphbacterium (PSB)	19.69 b	54.66 b
AM fungi	21.43 bc	52.33 b
AZ + PSB	23.28 c	54.41 b
PSB+ AM fungi	25.35 c	62.26 c
AZ+AM fungi	22.74 bc	61.73 c
PSB + AM fungi + AZ	28.86 d	80.44 d
CONTROL	12.66 a	41.32 a

Means followed by same letters are significantly not different by DMRT ($p<0.05$)

Fig.1. Study site at Karmamthody, Bovikanam, Kasargode.

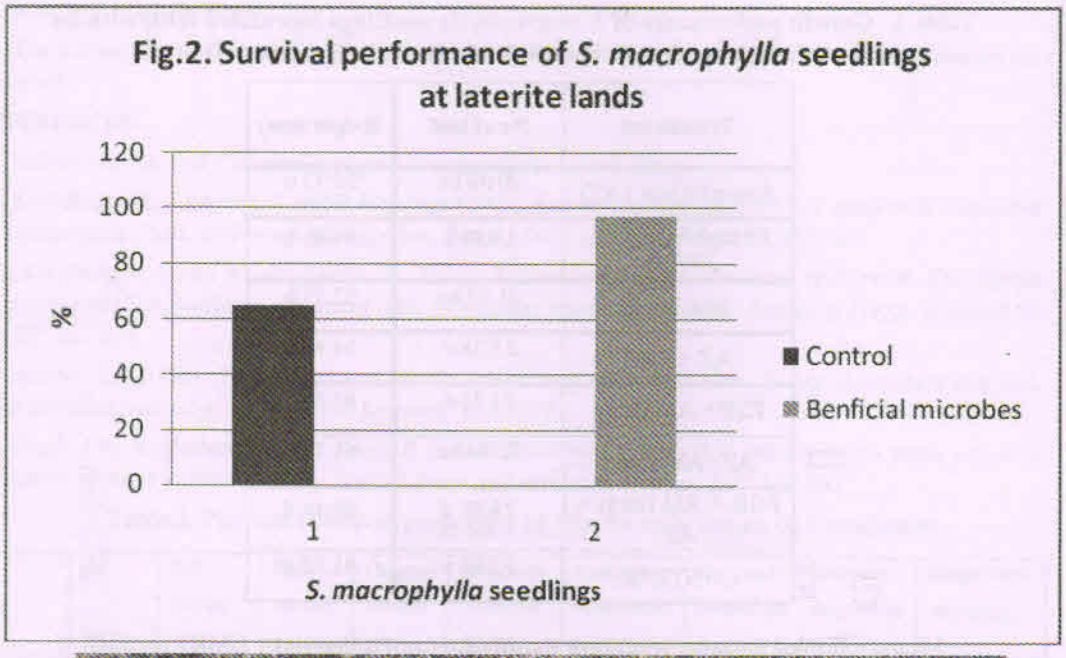

Fig.3. Planted *S. macrophylla* seedlings with beneficial microbes at latertie lands (6 months old)