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Influence of Combined Termite Mound Materials and Inorganic Fertilizers on Growth Parameters of Maize under Non Sterilized Pot Culture Study

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ABSTRACT

Soil microinvertebrates are important agents of soil functioning through their bioturbation effects. Termites are found to be distributed with high species diversity in tropical ecosystem. They perform several activities that qualify them as soil engineers. Termite involves in mound building, subterranean tunneling and soil feeding thereby improving soil quality and nutrient fluxes. Subterranean termites *Odontotermes obesus* and *Trinervieus trinervoides* modify their environment, increasing the clay and organic matter content ensuring the soil fertility. Free living N_2 fixers are found to be associated in termite mound materials. The TMM can be used as biofertilizers and it can improve maize production and economic yield.

Introduction

Termites are major components of detritivore microfauna feeding on a whole range of living, recently dead plant material in various stages of decomposition. Subterranean termites of Termitidae family make epigeous or hypogeous nests, construct galleries to separate food sources from the nest. Epigeal mounds have a high percentage of soil fractions, variable portions of minerals with saliva and faeces rich in organic material. Free living N_2 fixing bacteria belonging to the genera *Azotobacter*, *Beijerinckia*, *Bacillus*, *Derxia*, *Enterobacter*, *Erwinia* and *Azospirillum* are found to be associated in termite mound materials. These soil dwelling organisms modify soil properties by displacing soil organic and mineral compounds from one side to another by producing organic aggregates with specific properties (Jouquet *et al.*, 2000). Biological nitrogen fixation offers a non polluting source with increased crop production and decrease the global use of synthetic fertilizers. The potential of using termite mound debris for fertilizing arid soils and their biofertilizing activity would act as an organic amendment for maize growth.

Materials and methods

A field survey was conducted at various sampling blocks of Dindigul district. Subterranean termite mound of *Odontotermes obesus* and *Trinervieus trinervoides* in different transect was documented. The termite mound material of the two species *O.obesus* and *T.trinervoides* which were positive for the bacterial strains *Azotobacter* sp., *Bacillus* sp. and fungal isolate *Aspergillus niger* were selected and used in eight different combinations with inorganic fertilizers along with a control (uninoculated) to assess their effect on maize growth. Pot culture studies were conducted in Department of Biology, Gandhigram Rural Institute with three replicates and monitored.

The garden soil was processed and filled in the pots after making the soil free from stones, fibrous materials which may interfere with the growth of plants. The pots were filled with red soil, sand and farmyard manure and sterilized well for few hours before seedling. Healthy and viable maize seeds were procured from the seed center, TamilNadu Agriculture University (TNAU), Madurai. *Z.mays* L.seeds of hybrid CoH (M) were surface sterilized and soaked for two hours in water.

For the experiment each pot was seeded with four healthy seeds and the pots were watered well. The germinated seeds were allowed to grow in each pot and the effect of the selected mound materials along with microbes *Azotobacter* sp., *Bacillus* sp. and *Aspergillus niger* were selected and used in eight different combinations with inorganic fertilizers along with a control (uninoculated) to assess their effect on maize growth. The effect of TMM and inorganic fertilizers on the growth of seedlings were monitored carefully and growth parameters on the 30th day were recorded.

Results

Application of TMM and inorganic fertilizers and influence on growth parameters of *Z. mays* L.

Influence of plant growth parameters of *Z. mays* L. *a*pplied with TMM of *O.Obesus* and T. *trinervoides* with inorganic fertilizers were studied under pot culture studies. Eight different treatments with termite mound materials and inorganic fertilizers were used along with a control and the results on 30 DAS are presented in Table no.1.

The plant growth parameters and soil characterization recorded a significant variation in treated than in control. The pH of treated soil exhibited slight acidic pH and electrical conductivity of below 0.5dSm^{-1}. The total number of colony forming units of *Azotobacter* sp. was recorded as 3.12 x10^{3}CFU/g and the amount of dehydrogenase registered a maximum of 6.44 µg TPF g^{-1}d^{-1} in treatment T8. Likewise the application of OOMM and TTMM applied in conjunction with inorganic fertilizers registered higher growth rate than in single application.

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Table 1. Influence of combined termite mound materials and inorganic fertilizers application on growth parameters of maize under non sterilized pot culture condition on 30 DAS.

Treatments	pH	EC (dSm^{-1})	*Azotobacter* ($x10^3$CFU/g)	Dehydrogenase (µg TPF $g^{-1}d^{-1}$)	Plant height (cm)	No. of leaves	Leaf area (cm^2)	Leaf area index	Dry matter production (g/plant)	Chlorophyll content (mg/g)
To	7.10	0.214	2.42	5.32	61.25	4.5	140.1	0.761	118.47	0.95
T1	6.06	0.211	2.45	6.44	65.32	4.7	143.3	0.785	119.00	1.14
T2	6.02	0.232	2.68	5.60	66.12	4.8	147.2	0.792	118.74	1.21
T3	6.08	0.313	2.71	5.87	70.12	5.0	144.5	0.810	118.95	1.27
T4	6.24	0.343	2.67	5.86	71.48	5.4	152.0	0.815	119.50	1.43
T5	5.97	0.383	2.75	5.93	73.43	5.6	155.0	0.823	119.85	1.72
T6	6.07	0.391	2.81	6.18	75.9	5.7	158.0	0.859	120.67	2.07
T7	6.12	0.427	2.96	6.25	76.46	5.9	158.4	0.878	122.82	2.10
T8	6.10	0.416	3.12	6.44	78.32	5.9	159.2	0.917	123.67	2.10
One way ANOVA										
F-value	18.42***	30.256***	39.87***	19.751***	945.02***	32.82***	80.05**	375.35**	245.86***	193.24***

**p $<$ .01 ***p $<$ 0.001, n .s – non significant TPF – Triphenyl formazon

T1	+ Urea	(2g /lt water) N:P- 100:50
T2	+ SP	SP -- super phosphate
T3	+ TTMM	
T4	+ OOMM	
T5	+ Urea +TTMM	
T6	+ Urea +OOMM	
T7	+ Urea +SP +TTMM	
OOMM- O.obesus mound material		
TTMM- T,trinervoides mound material		

Moreover, the tripartite application of inorganic fertilizers with OOMM and TTMM in treatment T8 registered higher plant growth response of 78.32 cm plant height 159.2 cm^2 leaf area, 123.67 g dry matter production and 2.1 mg/g chlorophyll content than control and all other treatments on 30 DAS. The lowest growth rate was recorded in the control (T0) with 61.25 cm plant height, 140.1 cm^2 leaf area and 118.47 g dry matter production and 0.95 mg/g chlorophyll content. On 30 DAS the growth parameters in T8 treatment was significantly ($P<0.01$ and $P<0.001$) higher than those observed in control and all other treatments.

Discussion

Subterranean termites, including mound building and arboreal species account for 80% of the economically important species. Termites are beneficial biological agents whose bioturbating and decomposing activities can be managed indirectly with organic matter to enhance primary production. Termites construct mounds that comprise clay, silt, sand and partially digested plant materials that are cemented together with excreta and saliva usually forming a hard exterior (Lee and Wood, 1971). Soil feeders play a major role in the dynamics of carbon and nitrogen in the soil (Eggleton and Tayasu, 2001). Termites utilize organic components at different stages of humification makes them one of the most ecologically important components of soil fauna (Donovan *et al.*, 2000). Additionally, the use of excreta and saliva in mound construction results in a relatively lower C: N ratio, which may favour plant growth (Laker *et al.*, 1982). Consequently, termite mounds may represent relatively "fertile islands" in a landscape that are attractive resources for plants (Gudeta *et al*., 2010).

In addition to the carbon mineralization, they have an ecological impact in terms of nitrogen. Many termite species utilize dead plant material rich in nitrogen and thus supplement their foods with nitrogen (Collins, 1983). Besides soil aggregation and bioturbation, termites are among the most important agents of nitrogen economy (Mettings, 1993). The dominance of termites in tropical ecosystem is mainly related to decomposition process, soil engineering, providing a possible input of nitrogen through symbiotic N fixation for soil fertility (Collins, 1984; Pascal Jouquet *et al*., 2011). In the present study, free living microbes were isolated from TMM of *T. trinervoides* and *O. obesus* and the isolated bacterial strains were found to be nitrogen fixers. Therefore it is evident that TMM harbors dense and varied symbionts which provide a favorable environment for soil biology (Brune, 1998).

Among cereals, maize (*Z. mays* L.) is an important food and feed crop which ranks third after wheat and rice in the world. It has an expanded use in the agro industries and is recognized as a leading commercial crop of great agro economic value. Balanced nutrition is an essential component of nutrient management and plays a significant role in increasing crop production and its quality. The efficient strains isolated from termite mound material was applied to study the combined effect of biofertilizers with inorganics in *Z. mays*. L The inorganic fertilizers added with the TMM of two different termite species in eight different combinations recorded a significant difference in the growth parameters of *Z. mays* L. on 30 DAS compared to the control plant. Various morphological characters play an important role in yield components and are of immense importance in understanding plant growth and development.

Combined application of inorganics along with biofertilizers has been known to influence morphological characters such as plant height, dry matter production and its distribution into different plant parts. When TMM was applied with N and P sources it influenced a better synergistic effect in growth parameters of maize than applied TMM as such. The effect of tripartite application on plant height, no of leaves, LAI, chlorophyll content were significantly different from those obtained with single application of *T. trinervoides*

and *O. obsesus* mound material. Therefore the study of TMM along with inorganics recorded a significant correlation with the higher nutrient status, better soil water storage capacity, increased plant growth parameters in maize compared to control.

Conclusion

Crop yield is mainly dependent on the interplay of various biochemical function of the plant in addition to the impact of growing environment. Our results signify that combined TMM and inorganic fertilization greatly influenced the growth and yield in maize. In agriculture, combined fertilization promotes the sustainability and agronomic efficiency of maize crop. Therefore, the use of TMM in agricultural practice would not only offset the high cost of chemical fertilizers but also mobilize insoluble form of nutrient into a soluble form for enriching soil fertility. Various environmental determinants and factors inherent to termite biology influence termite distribution and play a role in ecosystem processing influencing soil fertility by providing beneficial microbes for agriculture.

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