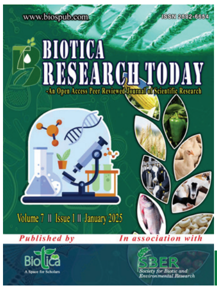

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Properties of Termite Mounds and Its Impact on Crop Growth: A Review

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Abstract

Termite mounds, though more often than not neglected, are one of the most ideal naturally occurring biofertilizers, found throughout the tropics. Although termites are damaging in nature, their termitaria is a storehouse of packed nutrients and beneficial microorganisms. Its physico-chemical and biological characteristics surpass those of the surrounding soil. Additionally, they are also helpful in soil nutrient cycling and are excellent ecosystem engineers. This article emphasizes on various studies conducted by workers to analyze its properties and its impact on crop growth. Due to its eco-friendly and sustainable nature, it will assist in reducing production costs and hence is a viable option to be used in farming practices.

Keywords: Biological, Crop growth, Enzyme, Physico-chemical, Termite mound soil

Introduction

Termites are eusocial and eurytopic insects (Ugbomeh and Diboyesuku, 2019) and are one of the dominant detritivores on Earth (Bignell and Eggleton, 2000). Termites are less prevalent in temperate regions while in tropical regions they are very much dominant (Bignell and Eggleton, 2000). Two factors mainly determine their population growth: soil type and favourable climate (Bhattacharyya *et al*., 2014). There are numerous species of termites, around 3,106 (living and fossil) distributed across the globe in a wide area. Out of these, 261 species of termites are included under the category of Indian termite fauna (ICAR, 2017). There are three different types of termite categories on the basis of their habitat. They are: subterranean, dry-wood and damp-wood (Paul and Rueben, 2005). The subterranean species are mound building termites and they dwell in soil and also in wood which is in proximity with the soil (Khan and Ahmad, 2018). The subterranean termite, *Odontotermes obesus* (Rambur), known for its mound-building properties are found predominantly in tropical and sub-tropical zones of the world (Ashraf *et al*., 2020). Termites are important "ecosystem engineers" affecting the soil properties. They are key species in bioturbation of the soil in tropical regions (Cheik *et al*., 2022). They build mounds which are solid yet porous creating tunnels throughout, increasing the soil porosity (Kavyashree *et al*., 2022). These mounds are constructed in such a way so as to shield their colonies from adverse biological and harsh weather conditions (Eze *et al*., 2020). The mound abundance varies based on the species and external factors and their number are less likely to be found in high rainfall areas (Shanbhag *et al*., 2017).

O. obesus mounds are conical and at its base the royal chamber is present which is below the fungus garden. They are built by agglomeration of organic components and clay with the help of termite's saliva, faeces and other secretions (Sujada *et al*., 2014). Despite the damaging nature of the termites, their structured mounds are very advantageous having abundant nutrient content and accommodates numerous microorganisms which are beneficial *viz., Citrobacter freundii*, *Pseudomonas* sp., *etc*. They have the ability to solubilize potassium and phosphate (Adebajo *et al*., 2021). Hence, by constructing them, they contribute significantly to carbon cycling, disintegration and mineralisation of cellulose (Ahmed *et al*., 2019).

Due to the activity of termites, the mounds own some distinctive biochemical and physico-chemical features in comparison to the adjoining soils. Various researchers have studied the impact of termite soil on crop growth.

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Experiments in crops include paddy (Miyagawa *et al.*, 2011), tomato (Garba *et al.*, 2011), sorghum (Mokossesse *et al.*, 2012), marigold (Kathbaruah *et al.*, 2024) *etc*. Such studies displayed outstanding growth effect of termite soil on these crops. In Africa, smallholder farmers use them for crop production instead of commercial fertilizers (Chisanga *et al*., 2020). This shows the potential of termite soil which would be helpful in controlling the injudicious use of chemical fertilizers.

Physico-Chemical Characteristics of Termite Mound Soil

Numerous studies have been conducted regarding the nutrient composition and physical features of termite mounds. According to the studies, termite mounds contain more clay and less sand as compared to surrounding soils (Dhembare, 2013; de Lima *et al.*, 2018) which help in agglomeration. Mounds contain different textural particles like clay, sand and silt having values (in g kg^{-1}) 354, 429 and 217, respectively (Fageria and Baligar, 2004). Bulk density was recorded high while porosity and dispersion ratio was noticed to be less in termitaria soil as compared to adjacent soil (Bera *et al*., 2020). Also, termite soil has good water absorption coefficient (Seetapong *et al*., 2021) and high capacity to hold water (Kathbaruah *et al*., 2024). Due to the foraging nature of the termites, the infiltration rate of mound soil is high (Adugna *et al*., 2016). Termite soils are found to have an acidic pH (Ibrahim *et al*., 2022) while others found that the pH rises in mound soil due to accumulation of organic substances (Dhembare, 2013; Santoshkumar, 2024). There are some researchers who noticed no difference in the pH of termite soils with the soil of nearby adjacent areas (Brossard *et al*., 2007). It is most likely that the parent soil type influences the physical nature as well as the chemical properties of the mound soil (Jouquet *et al*., 2015).

Researchers have often sought to compare the properties of mounds with that of the neighbouring soil. Macronutrients like potassium (48.18 mg g^{-1}) and phosphorus (20.13 mg g^{-1}) were observed to be in higher quantity while nitrogen (22.09 mg g^{-1}) was in lesser quantity. Whereas micronutrients like iron (6.17 mg g^{-1}), magnesium (46.65 mg g^{-1}), copper (0.98 mg g^{-1}), and zinc (0.97 mg g^{-1}) were in higher amount while calcium (14.28 mg g^{-1}), manganese (4.02 mg g^{-1}) and sulphur (13.01 mg g^{-1}) were in lesser amount than adjoining soil areas (Dhembare, 2013). This has contradicts the findings of another study that shows high manganese in termite mounds while available phosphorus was reported in lesser amounts (Baig *et al*., 2018). Another contradiction was found where high nitrogen was observed in termite mounds (Jose and Maya, 2020). Dhembare (2014) reported 10.08% increment in available potassium in termite soil. Similarly, Bachha *et al.* (2022) reported 0.37% increment in potassium availability in mounds in comparison to the potassium availability in the soil adjacent to the mounds. The EC of termite mounds was observed to be higher in comparison to neighbouring soil (Ibrahim *et al*., 2022; Bekele *et al*., 2024). Clarke *et al.* (2023) reported high organic carbon as well as high inorganic carbon in termite mound soil. Some workers also found that the ageing of organic matter in mound soil increases with increase in depth upto 1 metre and then decreases further (Francis *et al*., 2024). Momah *et al.* (2018) also found the OC and TOC to be in higher quantity. They found less nitrogen and phosphorus in comparison to the adjacent top soil.

Enzymatic and Biological Properties of Termite Mounds

High enzymatic activity termite mounds have been accredited to termite activity. Reports of a study conducted by Santoshkumar *et al*. (2020) confirm significant lignocellulose enzyme activity in the soil of termite mounds. Another study (Traore *et al*., 2022) has proved that termite sheetings are favourable for microbial activity which helps in organic matter mineralisation. Dehydrogenase enzymes play a very crucial role in decomposition of organic matter. Dehydrogenase activity in termite mounds was experimented by Subi and Sheela (2020) in two different mounds and its presence was detected which proved microbial activity in mounds. They also found some cellulose degrading organisms. Various bacteria which are plant growth promoting were observed in termite mounds *e.g*., *Enterobacter* sp., *Klebsiella* sp., *Citrobacter* sp., *Salmonella* sp., *etc.* (Adebajo *et al.*, 2021). The bacteria contained in termite guts are vital for nitrogen fixation (Mullins *et al*., 2021). Comparisons of epigeous, arboreal and subterranean species of termite gut enzymes were performed. It showed high composition of xylanase, cellulase and phosphatase enzymes in subterranean termite species (Hota and Sahoo, 2021). Various studies have reported significantly high levels of enzymes like xylanase, amylase, cellulase and phosphatase in termite mounds (Bachha *et al.*, 2022). High phosphatase activity was seen to be more in fresh termite mounds than mature mounds (Roose-Amsaleg *et al*., 2005). Enzyme activities have strong association with the physico-chemical properties (Bachha *et al.*, 2022; Kathbaruah *et al.*, 2024). Available nitrogen is strongly and positively correlated with urease activity. Similarly, available phosphorus has positive correlation with dehydrogenase and phosphomonoesterase activity. Available potassium has significant and positive correlation with dehydrogenase activity (Kathbaruah *et al*., 2024). Moreover, live mounds have an active microbial community as compared to abandoned ones (Chen *et al*., 2023).

Impact of Termite Mound Soil on Growth of Crops

A number of experiments have been conducted to study and analyse the impact of termitaria soil on crops, namely, arjun (*Terminalia arjuna*) (Kamaraj *et al.*, 2018), red amaranth (*Amaranthus cruentus*) (Jose and Maya, 2020), maize (*Zea mays*) (Beyene and Getu, 2021), sweet potato (*Ipomoea batatas*) (Chimdi *et al.*, 2021), eggplant, African marigold, *etc*. In case of *T. arjuna*, spraying termite soil mixed with cow dung solution led to an increase in nutritional concentration (Kamaraj *et al.*, 2018). Jose and Maya (2020) analysed the growth effects of *A. cruentus* in termite soil. They found higher amounts of phosphorus, potassium, nitrogen, copper, boron, zinc and iron in termite mound soil. In another experiment performed under greenhouse conditions, *Z. mays* grown in termite soil displayed significantly higher yield than those in normal soil (Beyene and Getu, 2021). They also observed significantly higher porosity, bulk density, moisture content, pH, organic matter and organic carbon. Some workers even found the efficacy of termite soil to be higher when paired with synthetic fertilizers, while analyzing the growth effects of *Ipomoea batatas* (Chimdi *et al.*, 2021). The dry biomass weight and total root yield of sweet potato was 1750 g plot^{-1} and 4066.7 g plot^{-1}, respectively, when cultivated in termite mound soil. This was significantly different from dry biomass weight (1533.3 g plot^{-1}) and root yield (3043.3 g plot^{-1}) of the crop obtained when cultivated in adjacent soil with application of NPK. When eggplant was grown by using soil amended with termite soil (Iroegbulam, 2021), the best yield was achieved with soil (80%) and termite soil (20%). Another study was conducted where a potting mixture was developed using four components: termitaria soil, fine sand, soil from garden and cow dung (FYM) in various proportions (Kathbaruah *et al*., 2024). Its effect was tested in African marigold and they found that the treatment composition of potting media *i.e.*, termite soil, sand and FYM @ 1:1:2 to be the most effective and high yield producing.

Conclusion

Termite mounds acts as a natural biofertilizer, in addition to being sustainable and eco-friendly. Research findings of various studies prove its high nutrient composition and beneficial effect on crops. Termite mounds are generally viewed to be damaging in nature but they are actually a hidden biowealth, even more beneficial than normal soil. Since chemical fertilizers have negative impact on human health, eco-friendly and sustainable approaches needs to be adopted. With the rising human population and to sustain the future generations, it is essential that we search for sustainable food practices. One such practice can be by using termite soil in farming. With numerous benefits of nutrients and enzymatic activities, it is a great example of biowaste conversion to biowealth. However, whether it can replace the use of synthetic fertilizers is still a question. Further studies and extensive research is required to discover ways to level up its efficacy and come up with alternative methods so that it becomes capable to replace the synthetic fertilizers.

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