

**IMPACT OF VERMIREMEDIATION ON AVAILABLE NITROGEN CONTENT IN
AGRICULTURAL SOILS OF PASHAMYLARAM, TELANGANA, USING
*PHERETIMA POSTHUMA***

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ABSTRACT; *The amount of nitrogen available to plants depends on the rate at which organic and inorganic nitrogen compounds undergo various transformations within the soil. Soil microorganisms play a significant role in regulating nitrogen availability through processes such as mineralization, ammonification, nitrification, and immobilization. Mineralization involves the breakdown of organic nitrogen compounds into inorganic forms by microbial activity. During ammonification, organic nitrogen is converted into ammonium, which may subsequently undergo nitrification under aerobic conditions, resulting in the formation of nitrate. These transformations continuously influence the quantity of nitrogen accessible to plants. Factors such as soil moisture, temperature, pH, organic matter content, microbial populations, and soil aeration also determine the rate of nitrogen transformation and availability. Loss of nitrogen from agricultural soils occurs through several interconnected physical, chemical, and biological processes, which can adversely affect soil fertility and crop productivity. Therefore, maintaining soil nitrogen reserves through appropriate nutrient management and biological remediation practices is essential for sustaining agricultural soil health. In the present research the role of indigenous species of earthworm i.e. Pheretima posthuma in restoring the nitrogen content of soil after remediation has been demonstrated. Available nitrogen was estimated using the alkaline permanganate method (Subbiah and Asija, 1956).*

INTRODUCTION

Available nitrogen in soil refers to the nitrogen that is present in soil in readily absorbable and usable forms by plants. Nitrogen is an essential macronutrient that plays a fundamental role in plant growth, development, and metabolism. It is involved in several important physiological activities, particularly the formation of amino acids, proteins, chlorophyll, enzymes, and nucleic acids. Since nitrogen is a major component of many cellular constituents, its adequate supply is necessary for healthy plant development, maintenance of soil productivity, and improved agricultural yield. Available nitrogen is considered an important chemical indicator for assessing the nutritional condition and fertility of agricultural soils. An insufficient supply of nitrogen can adversely affect plant growth, leading to leaf yellowing, reduced chlorophyll production, restricted vegetative development, and lower crop productivity. Maintaining an appropriate nitrogen status is therefore important for sustainable agricultural practices and long-term soil fertility management.

In soil, nitrogen is distributed as organic and inorganic nitrogen. Organic nitrogen is associated with decomposing plant materials, animal residues, soil organic matter, and microbial biomass. Inorganic nitrogen is mainly found in the form of ammonium (NH_4^+) and nitrate (NO_3^-), which are the major forms utilized by plants for their nutritional requirements. Nitrite (NO_2^-) may also occur in soil as a temporary intermediate during nitrogen transformations, but its concentration is generally comparatively low. In agricultural fields such as Pashamylaram, several of these mechanisms may influence the initial nitrogen status of soil. Continuous agricultural activities, removal of crop residues, inadequate organic matter replenishment, erosion, and inappropriate fertilizer management can contribute to nitrogen depletion.

Vermiremediation is a biological approach that may influence the nitrogen status of soil through the combined activities of earthworms and soil microorganisms. During this process, earthworms consume organic residues and soil materials, break them into smaller particles, and facilitate their decomposition through digestive activities. Their movement through the soil also improves aeration and creates favourable conditions for microbial growth and nutrient transformations. Furthermore, the organic materials passing through the earthworm digestive system undergo biochemical changes, resulting in the formation of nutrient-enriched casts. These casts can

contribute to the availability of essential nutrients, including nitrogen, depending on the characteristics of the soil and the nature of the organic substrate.

Soil is not just a layer of earth's crust but a living system that supports life on earth. But unfortunately this life supporting system is itself in extreme pathetic condition due to increased pollution from various sources. In recent years, Bioremediation using earthworms (Vermi-remediation) has emerged as a sustainable and cheap process to reduce soil pollution. Earthworms are an important indicator for ecosystem health and numerous studies have been conducted on the response of earthworms to pollutants. The earthworms which are commonly used in bioremediation process are *Eisenia foetida* and *Eudrilus eugineae*. These are not native to India. *Eisenia* is a native of Europe, and *Eudrilus* is a native of West Africa. These are invasive species. Earthworms are canonical ecosystem engineers: organisms that play such an important role in creating and maintaining their habitats that their activity can decide which other species benefit or lose out in that environment. For example Earthworms species from northern latitudes (e.g., European lumbricoids and some Asian megascoleids) are poor colonizers in tropical or subtropical climates (except in localized temperate situations), and vice versa. Worms of different species can influence natural processes in soils. Native earthworms probably shape different kinds of soils differently from each other and from non-native worms. In many regions, invasive earthworms have been found to affect nitrogen levels in stream water by directly excreting ammonium waste into the soil, possibly contributing to nitrogen pollution

Vermiremediation using indigenous earthworm, *Pheretima posthuma*, may help improve nitrogen cycling by promoting organic matter decomposition, stimulating microbial activity, and facilitating nutrient mineralization. However, earthworm activity does not eliminate all nitrogen losses. Depending on soil moisture, aeration, pH, and substrate composition, nitrogen may also be lost through leaching or gaseous emissions.

KEYWORDS; earthworm, field, Kjeldahl distillation flask, Nitrogen, Pashamylaram, Pheretima, pollution, soil.

MATERIALS AND METHODS

Study Area

Agricultural soils were collected from Pashamylaram, Telangana, India. Pashamylaram is characterized by intensive agricultural activities. Many industries are also located in this area.

Soil Collection and Experimental Design

Approximately 40 kg of composite soil was collected from rice field from a depth of 15–30 cm. Soil samples were homogenized thoroughly and divided into experimental units. Each treatment container received 10 kg of soil and was inoculated with 50 healthy adult individuals of *Pheretima posthuma*. Three replicate treatment units and one control unit were maintained. Moisture content was monitored regularly and maintained near field capacity throughout the experiment.

Sample Collection and Preparation

Soil samples were collected at 0, 30, 60, 90, 120, 150, and 180 days after the initiation of vermiremediation. Samples were air-dried under shade for 3 days, ground, homogenized, and passed through a 2-mm sieve prior to analysis.

ASSESSMENT OF AVAILABLE NITROGEN BY KJELDAHL DISTILLATION FLASK METHOD

Principle

In the alkaline permanganate method, soil nitrogen is oxidized using alkaline potassium permanganate (KMnO_4), which liberates ammonia (NH_3). The released ammonia is distilled, absorbed in boric acid, and quantified by titration with a standard sulphuric acid solution. The amount of nitrogen present in the soil is calculated from the volume of acid used.

Materials

- Kjeldahl distillation apparatus
- Conical flasks
- Measuring cylinders
- Pipettes

- Burette
- Electronic weighing balance
- Heating mantle

Reagents

- 0.32% potassium permanganate (KMnO_4) solution
- 2.5% sodium hydroxide (NaOH) solution
- 2% boric acid solution
- Mixed indicator (bromocresol green and methyl red)
- Standard 0.02 N sulphuric acid (H_2SO_4)
- Distilled water

Procedure

About 5 g of soil sample was taken in a Kjeldahl distillation flask and about 20 mL of distilled water and 100 ml of 0.32% potassium permanganate solution were added to the flask, followed by 100 ml of 2.5% sodium hydroxide solution. The flask was immediately connected to the distillation unit. A conical flask containing 20 ml of 2% boric acid solution mixed with a few drops of mixed indicator was placed at the receiving end of the apparatus so that the tip of the condenser dipped into the solution.

The contents were heated gently, and the liberated ammonia was distilled and absorbed in the boric acid solution. Distillation was continued until approximately 30–40 mL of distillate was collected. The distillate containing absorbed ammonia was titrated against standard 0.02 N sulphuric acid until the color changed from green to pink, indicating the endpoint. A reagent blank was prepared simultaneously and analyzed under similar conditions.

Calculation

Available nitrogen in soil was calculated using the formula:

$$\text{Available Nitrogen (mg/kg)} = (V_s - V_b) \times N \times 14 \times 1000 / \text{weight of soil (g)}$$

Where:

- (V_s) = Volume of standard acid used for sample (ml)
- (V_b) = Volume of standard acid used for blank (ml)
- (N) = Normality of standard acid
- 14 = Atomic weight of nitrogen
- 1000 = Conversion factor to mg

RESULT AND DISCUSSION

Vermiremediation Stage	Available Nitrogen mg/kg
	Pashamylaram
0 days	37.61 ± 0.15
30 days	38.30 ± 0.17
60 days	40.70 ± 0.17
90 days	42.63 ± 0.12
120 days	43.17 ± 0.67
150 days	48.03 ± 0.87
180 days	49.10 ± 0.87

Values are expressed as Mean ± Standard Deviation (n = 3)

Table 1. Available Nitrogen in Pashamylaram Soil during Vermiremediation

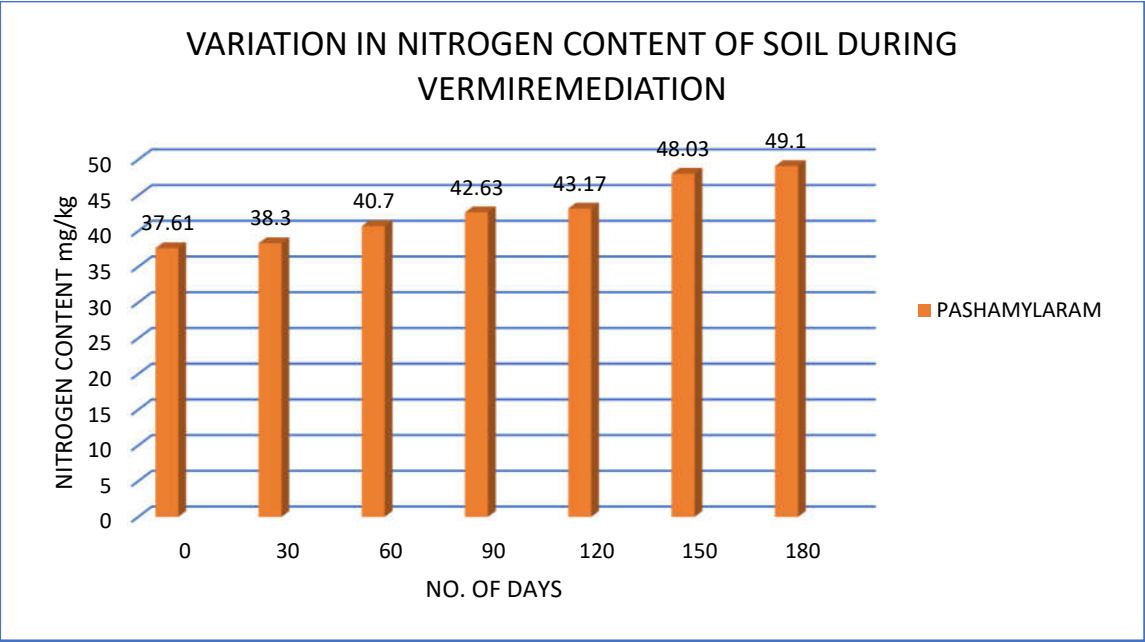


Fig. 1. Changes in Nitrogen content in soils of Pashamylaram during vermiremediation by *Pheretima posthuman*

STATISTICAL ANALYSIS

All measurements were performed in triplicate and expressed as mean ± standard deviation (SD). One-way ANOVA was used to evaluate temporal changes in Available Nitrogen concentration.

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	356.6106	6	59.4351	202.6980	p < 0.001	2.847726
Within Groups	4.105067	14	0.293219			
Total	360.7157	20				

p < 0.001= highly significant

The results indicate that vermiremediation duration significantly influenced nitrogen reduction in Pashamylaram.

The Available Nitrogen was found to be 37.61 ± 0.15 mg/kg in Pashamylaram soil initially and gradually it increased to 49.10 ± 0.87 mg/kg at the end of experimentation period. i.e. 180days.

Microbial mineralization converts organic nitrogen compounds into plant-available forms, including ammonium (NH_4^+) and nitrate (NO_3^-). Earthworm casts are particularly rich in mineral nitrogen and beneficial microorganisms, which contribute to the accumulation of available nitrogen in the soil. Thus these findings indicate that vermiremediation by *Pheretima posthuma* earthworms contributed significantly to the increase of available Nitrogen in soil.

REFERENCES

- Aira, M., Monroy, F., & Domínguez, J. (2007). Earthworms strongly modify microbial biomass and activity triggering enzymatic activities during vermicomposting independently of the application rates of pig slurry. *Science of the Total Environment*, 385(1–3), 252–261.
- Brady, N. C., & Weil, R. R. (2016). *The nature and properties of soils* (15th ed.). Pearson.
- Bohlen, P. J., Parmelee, R. W., McCartney, D. A., & Edwards, C. A. (1999). Differential effects of earthworms on nitrogen cycling from various nitrogen-15-labeled substrates. *Soil Science Society of America Journal*, 63(4), 882–890.
<https://doi.org/10.2136/sssaj1999.634882x>
- Cameron, K. C., Di, H. J., & Moir, J. L. (2013). Nitrogen losses from the soil/plant system: A review. *Annals of Applied Biology*, 162(2), 145–173.
<https://doi.org/10.1111/aab.12014>
- Edwards, C. A., & Bohlen, P. J. (1996). *Biology and ecology of earthworms* (3rd ed.). Chapman & Hall.
- *Effects of earthworm casts and compost on soil microbial activity and plant nutrient availability*. (2003). *Soil Biology and Biochemistry*, 35(2), 295–302.
[https://doi.org/10.1016/S0038-0717\(02\)00279-1](https://doi.org/10.1016/S0038-0717(02)00279-1)

- Earthworms and nitrogen mineralization in corn agroecosystems with different nutrient amendments. (1998). *Applied Soil Ecology*, 9(1–3), 295–301.
[https://doi.org/10.1016/S0929-1393\(97\)00056-5](https://doi.org/10.1016/S0929-1393(97)00056-5)
- Earthworm services for cropping systems: A review. (2015). *Agronomy for Sustainable Development*. <https://doi.org/10.1007/s13593-014-0269-7>
- Earthworms building up soil microbiota: A review. (2019). *Frontiers in Environmental Science*, 7, Article 81. <https://doi.org/10.3389/fenvs.2019.00081>
- Havlin, J. L., Tisdale, S. L., Nelson, W. L., & Beaton, J. D. (2014). *Soil fertility and fertilizers: An introduction to nutrient management* (8th ed.). Pearson.
- Lavelle, P., & Martin, A. (1992). Small-scale and large-scale effects of endogeic earthworms on soil organic matter dynamics in soils of the humid tropics. *Soil Biology and Biochemistry*, 24(12), 1491–1498. [https://doi.org/10.1016/0038-0717\(92\)90138-N](https://doi.org/10.1016/0038-0717(92)90138-N)
- Lavelle, P., & Spain, A. V. (2001). *Soil ecology*. Kluwer Academic Publishers.
- Marinissen, J. C. Y., & de Ruiter, P. C. (1993). Contribution of earthworms to carbon and nitrogen cycling in agro-ecosystems. *Agriculture, Ecosystems & Environment*, 47(1), 59–74. [https://doi.org/10.1016/0167-8809\(93\)90136-D](https://doi.org/10.1016/0167-8809(93)90136-D)
- Martin, A., & Marinissen, J. C. Y. (1993). Biological and physico-chemical processes in excrements of soil animals. *Geoderma*, 56, 331–347.
- Parmelee, R. W., & Crossley, D. A., Jr. (1988). Earthworm production and role in the nitrogen cycle of a no-tillage agroecosystem. *Ecology*, 69(6), 1806–1817.
- Stevenson, F. J., & Cole, M. A. (1999). *Cycles of soil: Carbon, nitrogen, phosphorus, sulfur, micronutrients* (2nd ed.). John Wiley & Sons.