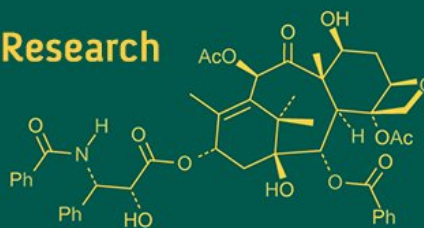


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(5): 945-948
www.biochemjournal.com
Received: 01-03-2026
Accepted: 04-04-2026

T Suresh

Department of Soil Science, Sri Venkateswara Agricultural College, Tirupati, ANGRAU, Andhra Pradesh, India

KV Naga Madhuri

Principal scientist, Institute of Frontier Technology (IFT), Regional Agricultural Research Station (RARS), Tirupati, Andhra Pradesh, India

MVS Naidu

Department of Soil Science, Sri Venkateswara Agricultural College, Tirupati, ANGRAU, Andhra Pradesh, India

Ch. Sreenivas

Regional Agricultural Research Station (RARS), Maruteru, West Godavari, Andhra Pradesh, India

V Sailaja

Regional Agricultural Research Station (RARS), Lam, Guntur, Andhra Pradesh, India

V Chandrika

Department of Agronomy, Sri Venkateswara Agricultural College, Tirupati, ANGRAU, Andhra Pradesh, India

Sk. Nafees Umar

Department of Statistics and Application, Sri Venkateswara Agricultural College, Tirupati, ANGRAU, Andhra Pradesh, India

Ch. Bhargava Rami Reddy

Institute of Frontier Technology (IFT), Regional Agricultural Research Station (RARS), Tirupati, Andhra Pradesh, India

Corresponding Author:**T Suresh**

Department of Soil Science, Sri Venkateswara Agricultural College, Tirupati, ANGRAU, Andhra Pradesh, India

Assessment of soil enzyme activity under long-term fertilizer experiment in groundnut monocropping system

T Suresh, KV Naga Madhuri, MVS Naidu, Ch. Sreenivas, V Sailaja, V Chandrika, Sk. Nafees Umar and Ch. Bhargava Rami Reddy

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i5Sk.8497>

Abstract

The present study is based on a long-term experiment initiated in 1981 (*kharif* season) at the Regional Agricultural Research Station, ANGRAU, Tirupati, Andhra Pradesh, India, to assess the influence of continuous application of fertilizers and organic manure on groundnut productivity grown in Alfisol. The same experiment was used for present investigation to study the influence of continuous application of fertilizers and manure on various soil enzyme activity during *kharif*, 2023. The experiment consisted of eleven treatments, however, only seven treatments were selected for the present research study, each replicated four times in a randomized block design. The treatments included control, (T₁) FYM @ 5 t ha⁻¹ once in 3 years (T₂), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ (T₃), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ (T₄), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) (T₅), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + lime @ 100 kg ha⁻¹ (top dressing) (T₆), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) + ZnSO₄ @ 25 kg ha⁻¹ once in 3 years (T₇). The soil enzyme activity was estimated in soil at pre-sowing, flowering and post-harvest of groundnut crop. The results revealed that long-term application of fertilizers and manure showed significant influence on soil enzyme activity at pre-sowing, flowering and post-harvest of groundnut crop. The soil urease activity was significantly increased in the application of 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) + ZnSO₄ @ 25 kg ha⁻¹ once in 3 years (T₇), (49, 61 and 53 × μg NH⁻¹g⁻¹ soil hr⁻¹ at pre-sowing, flowering and post-harvest, respectively), followed by 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) (T₅) (37, 49 and 42 × μg NH⁻¹g⁻¹ soil hr⁻¹) and the lowest urease activity (24, 35, 26 × μg NH⁻¹g⁻¹ soil hr⁻¹ at pre-sowing, flowering and post-harvest, respectively) was recorded in control (T₁). Similarly, the treatments revealed the highest dehydrogenase activity in FYM @ 5 t ha⁻¹ once in 3 years (T₂), (187, 199 and 191 × μg TPFg⁻¹ dry soil 24 h⁻¹ pre-sowing, flowering and post-harvest, respectively) followed 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + lime @ 100 kg ha⁻¹ (top dressing) (T₆) (167, 179 and 172) and the lowest dehydrogenase activity (121, 134 and 126 μg TPFg⁻¹ dry soil 24 h⁻¹ at pre-sowing, flowering and post-harvest, respectively) was recorded in control (T₁). However, the acid phosphatase activity was significantly the highest in 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) + ZnSO₄ @ 25 kg ha⁻¹ once in 3 years (T₇) (17, 26 and 18 × μg of PNP g⁻¹ dry soil hr⁻¹ at pre-sowing, flowering and post-harvest, respectively) followed by (10, 20 and 13) and the lowest (3, 12 and 6 × μg of PNP g⁻¹ dry soil hr⁻¹ at the pre-sowing, flowering and post-harvest, respectively) was recorded in control (T₁). Similarly the highest alkaline phosphatase activity (35, 46 and 41 × μg of PNP g⁻¹ dry soil hr⁻¹) was recorded in 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) + ZnSO₄ @ 25 kg ha⁻¹ once in 3 years (T₇), followed by (34, 44 and 37 × μg of PNP g⁻¹ dry soil hr⁻¹) and the lowest (28, 38 and 33 × μg of PNP g⁻¹ dry soil hr⁻¹) was recorded in control (T₁). However, the enzyme activity was increased from pre-sowing to flowering and later on decreased at harvest.

Keywords: Long-term fertilizer experiment, rainfed groundnut, soil enzyme activity

Introduction

Indian soils are generally characterized by low fertility due to the continuous depletion of their finite nutrient reserves caused by centuries of intensive cultivation. The adoption of modern agricultural technologies, coupled with the imbalanced use of fertilizers and their poor use efficiency, has further aggravated this problem (Malewar, 2005) [6]. Although inorganic fertilizers play a crucial role in sustaining crop productivity, their prolonged and

indiscriminate use can significantly alter the chemical, physical and biological properties of soil, ultimately affecting overall soil quality and long-term agricultural sustainability. In contrast, the application of organic inputs such as farmyard manure (FYM), crop residues and compost has been widely recognized for improving soil health. These organic amendments enhance soil physical, chemical and biological properties by increasing soil organic matter (SOM) and stimulating enzymatic activity such as urease and acid phosphatase. Additionally, root-derived organic substances act as substrates for microbial growth, thereby increasing microbial populations (Kent and Triplett, 2002)^[5] and influencing both the diversity and functional dynamics of soil microbial communities (Patra *et al.*, 2006)^[7].

Soil biochemical processes are predominantly governed by enzyme-mediated catalytic reactions, which utilize various substrates that also serve as energy sources for soil microorganisms. Soil enzymes such as dehydrogenases, phosphatases and ureases originate from plant roots, animal residues, organic matter and soil microorganisms. These enzymes play a fundamental role in nutrient cycling and are considered sensitive indicators of soil health due to their responsiveness to changes in soil management practices. Dehydrogenases are intracellular enzyme that play a vital role in the biological oxidation of soil organic matter by facilitating the transfer of hydrogen from organic substrates to inorganic electron acceptors. As such, dehydrogenase activity is widely regarded as a reliable indicator of microbial oxidative metabolism in soils. Phosphatases, on the other hand, catalyse the hydrolysis of organic phosphorus compounds into inorganic phosphate through dephosphorylation, thereby playing a central role in phosphorus cycling (Amador *et al.*, 1997)^[1].

Similarly, urease is a key enzyme involved in nitrogen cycling, catalysing the hydrolysis of urea into ammonia (NH₃) and carbon dioxide (CO₂), making nitrogen available for plant uptake. Given their integral role in nutrient transformations, soil enzyme serves as valuable indicators of soil quality, closely associated with soil organic matter content, physical structure, and microbial activity. Notably, enzymatic activity respond rapidly to changes in soil management practices and can reflect soil health variations within a short period (Burns, 1982)^[3]. In this contest the present study was under taken in a long-term fertilizer experiment to assess soil enzyme activity.

Materials and Methods

The present study was carried in an undergoing long-term fertilizer experiment on Alfisol (Typic Rhodustalf) at Regional Agricultural Research Station, Tirupati, Tirupati district of Andhra Pradesh during *kharif*, 2023 which was initiated in 1981. The experiment consisted of eleven treatments, however, only seven treatments were selected for the present research study, each replicated four times in a randomized black design. The treatments include control (T₁), Farm yard manure @ 5 t ha⁻¹(once in 3 years) (T₂), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ (T₃), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ (T₄), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + 250 kg gypsum ha⁻¹(top dressing) (T₅), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + lime 100 kg ha⁻¹ (top dressing) (T₆), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + 250 kg gypsum ha⁻¹(top dressing) + ZnSO₄ 25 kg ha⁻¹ once in 3 years (as basal, once in 3 years) (T₇). The nutrients N, P and K applied through the inorganic fertilizers like urea, single

superphosphate (SSP) and muriate of phosphate (MOP). The farmyard manure and ZnSO₄ were applied once in the three years as per treatment. The groundnut variety TCGS-1694 crop was sown on 16-07-2023 and harvested on 19-11-2023. The soil samples were collected at pre-sowing, flowering and post-harvest at 0-15cm as per treatments and analysed for soil enzyme activity. The urease activity (μgNH₄⁺ g⁻¹ 2 hr⁻¹) was determined by tris (hydroxymethyl)amino methane (THAM) buffer method (Bremner and Douglas (1971)^[2], Dehydrogenase activity (μgTPFg⁻¹soil day⁻¹) by 2, 3, 5-Triphenyl tetrazolium chloride (TTC) reduced to triphenyl formazone (TPF) method Casida *et al.* (1964)^[9], Acid phosphatase activity (μg p-nitrophenol g⁻¹ soil h⁻¹) by Modified universal buffer (pH 6.5) (Tabatabai and Bremner, 1969)^[8] and Alkaline phosphatase activity (μg p-nitrophenol g⁻¹ soil h⁻¹) by modified universal buffer (pH 6.5) (Evazi and Tabatabai, 1969)^[8]. The collected data were subjected to statistical analysis using the analysis of variance (ANOVA) technique appropriate for a randomized block design (RBD), recommended by gomez and gomez (1984)^[14].

Results and Discussion

Urease activity

The data on urease activity in the soil under the long-term application of fertilizers and manure in groundnut during *kharif*, 2023 at pre-sowing, flowering and post-harvest of crop is presented in Table (1) and among the treatments, significantly the highest urease activity (49, 61 and 53 × μg NH₄⁺g⁻¹ soil hr⁻¹ at the pre-sowing, flowering and post-harvest, respectively) was recorded with the application of 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) + ZnSO₄ @ 25 kg ha⁻¹ once in 3 years (T₇), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) (T₅), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + lime @ 100 kg ha⁻¹ (top dressing) (T₆), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ (T₃), 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ (T₄) and FYM @ 5 t ha⁻¹(T₂).The lower urease activity (24, 35 and 26 × μg NH₄⁺g⁻¹ soil hr⁻¹ soil at pre-sowing, flowering and post-harvest, respectively) was recorded in control (T₁).

The application of 20 kg N ha⁻¹ + 10 kg P ha⁻¹ + 25 kg K ha⁻¹ + gypsum @ 250 kg ha⁻¹ (top dressing) + ZnSO₄ @ 25 kg ha⁻¹ once in 3 years (T₇), might be attributed to the combined and synergistic effects of nitrogen availability, improved soil chemical environment and enhanced microbial activity. Urease is a key soil enzyme responsible for the hydrolysis of urea into ammonium and carbon dioxide and is predominantly produced by soil microorganisms and plant roots. The direct addition of nitrogen stimulated microbial proliferation and activity, as nitrogen acts as both a nutrient and an energy source for urease producing microorganisms. Higher nitrogen availability induces the synthesis of urease enzyme, thereby increasing its activity in the soil. Wenbo mi *et al.* (2024)^[13] reported that N input significantly affected soil nutrients potential of hydrogen, total nitrogen and organic matter. In addition, soil enzyme activity like urease, catalase and nitrate reductase significantly increased in response to varying N concentrations, inducing changes in soil nutrient contents.

Dehydrogenase activity

The data on dehydrogenase activity under the long-term application of fertilizers and manure in groundnut during *kharif*, 2023 at pre-sowing, flowering and post-harvest of

crop is presented in Table (1) and among the different treatments, significantly the highest dehydrogenase activity ($175, 187$ and $182 \times \mu\text{g TPF dry soil } 24 \text{ hr}^{-1}$ at the pre-sowing, flowering and post-harvest, respectively) was recorded with the application of $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing) + $\text{ZnSO}_4 @ 25 \text{ kg ha}^{-1}$ once in 3 years (T_7), $\text{FYM @ } 5 \text{ t ha}^{-1}$ (T_2), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{lime @ } 100 \text{ kg ha}^{-1}$ (top dressing) (T_6), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1}$ (T_4), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1}$ (T_3) and $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing) (T_5). The lower dehydrogenase ($121, 135$ and $126 \times \mu\text{g TPFg}^{-1} \text{ dry soil } 24 \text{ hr}^{-1}$ soil at pre-sowing, flowering and post-harvest, respectively) was recorded in control (T_1).

The results indicated that long-term application of fertilizers and manure had significant effect on soil dehydrogenase activity at pre-sowing, flowering and after harvest of the groundnut during *kharif*, 2023. The significantly higher dehydrogenase was recorded with the application of $\text{FYM @ } 5 \text{ t ha}^{-1}$ might be due to continuous application of farmyard manure, residual effect of organic manure was superior in improving dehydrogenase as it stimulated microbial population. Being chief carbon source, it provides energy for soil microorganisms and increased number of pores, which were considered important in soil-water-plant relationships and maintained good soil structure accompanied by better dehydrogenase activity (Marinari *et al.*, 2000) [11].

Acid phosphatase activity

The long-term application of fertilizers and manure showed a significant influence on acid phosphatase activity at pre-sowing, flowering and after harvest of groundnut crop during *kharif*, 2023 and data is presented in Table (2) and among the different treatments, significantly the higher acid phosphatase activity ($17, 26$ and $18 \times \mu\text{g PNP g}^{-1} \text{ dry soil hr}^{-1}$ at the pre-sowing, flowering and after harvest, respectively) was recorded with the application of $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing) + $\text{ZnSO}_4 @ 25 \text{ kg ha}^{-1}$ once in 3 years (T_7), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{lime @ } 100 \text{ kg ha}^{-1}$ (top dressing) (T_6), $\text{FYM @ } 5 \text{ t ha}^{-1}$ (T_2), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing) (T_5), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1}$

(T_4) and $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1}$ (T_3). The lower acid phosphates activity ($3, 12$ and $6 \times \mu\text{g PNP g}^{-1} \text{ dry soil hr}^{-1}$ soil at pre-sowing, flowering and post-harvest, respectively) was recorded in control (T_1).

The results indicated that long-term application of fertilizers and manures had significant effect on acid phosphate activity at pre-sowing, flowering and after harvest of the crop during *kharif*, 2023. The significantly higher acid phosphates activity was recorded with the application of $\text{FYM @ } 5 \text{ t ha}^{-1}$, might be due to application of FYM which stimulates the growth and activity of soil microorganisms like bacteria, fungi that produce enzyme such as acid phosphatase a key enzyme involved in making phosphorus available to plants by hydrolyzing organic phosphorus compounds (Joanna Lemanowicz *et al.*, 2024) [10].

Alkaline phosphatase activity

The long-term application of fertilizers and manures revealed a significant effect on alkaline phosphatase activity at pre-sowing, flowering and after harvest of groundnut crop during *kharif*, 2023 and data is presented in Table (2) and among the treatments, significantly the highest alkaline phosphatase activity ($35, 45$ and $41 \times \mu\text{g PNP g}^{-1} \text{ dry soil hr}^{-1}$ at the pre-sowing, flowering and after harvest, respectively) was recorded with the application of $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing) + $\text{ZnSO}_4 @ 25 \text{ kg ha}^{-1}$ once in 3 years (T_7), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing) (T_5), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1}$ (T_3), $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{lime @ } 100 \text{ kg ha}^{-1}$ (top dressing) (T_6), $\text{FYM @ } 5 \text{ t ha}^{-1}$ (T_2) and $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1}$ (T_4). The lower alkaline activity ($32, 42$ and $37 \times \mu\text{g PNP g}^{-1} \text{ dry soil hr}^{-1}$ soil at pre-sowing, flowering and after harvest, respectively) was recorded in control (T_1).

From the above said results, it was clear that alkaline phosphate activity in the soil decreased in all the treatments including control. Application of $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing) + $\text{ZnSO}_4 @ 25 \text{ kg ha}^{-1}$ once in 3 years might be due to the increased population of microorganisms due to availability of substrate which in turn released these alkaline phosphatase enzymes, as these enzymes are of extracellular origin. These findings are in agreement with the studies of Ramakrishnaiah and Vijaya (2013) [12].

Table 1: Effect of long-term application of fertilizers and manure on urease and dehydrogenase activity at pre-sowing, flowering and harvest of groundnut during *kharif*, 2023.

Treatments	Urease activity ($\mu\text{g NH}_4\text{-}^1\text{g}^{-1} \text{ soil hr}^{-1}$)			Dehydrogenase ($\mu\text{g TPFg}^{-1} \text{ dry soil } 24 \text{ h}^{-1}$)		
	Pre sowing	Flowering	Post-harvest	Pre sowing	Flowering	Post-harvest
(T_1) Control	24	35	26	121	134	126
(T_2) $\text{FYM @ } 5 \text{ t ha}^{-1}$ once in 3 years	32	44	36	187	199	191
(T_3) $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1}$	36	49	41	167	166	163
(T_4) $20 \text{ kg ha}^{-1}\text{N} + 10 \text{ kg P ha}^{-1} + 25 \text{ K kg ha}^{-1}$	35	48	39	163	177	170
(T_5) $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing),	37	49	42	152	164	157
(T_6) $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{lime @ } 100 \text{ kg ha}^{-1}$ (top dressing),	36	48	41	167	179	172
(T_7) $20 \text{ kg N ha}^{-1} + 10 \text{ kg P ha}^{-1} + 25 \text{ kg K ha}^{-1} + \text{gypsum @ } 250 \text{ kg ha}^{-1}$ (top dressing) + $\text{ZnSO}_4 @ 25 \text{ kg ha}^{-1}$ once in 3 years	49	61	53	175	187	182
Mean	36	48	40	162	172	166
CD @ 0.05	3.24	4.52	3.78	15.8	17.45	15.42
SE $\pm$	1.12	1.23	1.26	5.23	5.52	5.12
CV (%)	11.02	11.84	10.35	9.65	10.02	11.15

Table 2: Effect of long-term application of fertilizers and manure on acid and alkaline phosphatase activity at pre-sowing, flowering and harvest of groundnut during kharif, 2023

Treatments	Acid Phosphatase (μg of PNP g^{-1} dry soil hr^{-1})			Alkaline phosphatase (μg of PNP g^{-1} dry soil hr^{-1})		
	Pre-sowing	Flowering	harvest	Pre-sowing	Flowering	Post-harvest
(T ₁) Control	3	12	6	28	38	33
(T ₂) FYM @ 5 t ha^{-1} once in 3 years	10	20	12	31	44	39
(T ₃) 20 kg N ha^{-1} + 10 kg P ha^{-1}	4	13	7	34	44	36
(T ₄) 20 kg ha^{-1} N + 10 kg P ha^{-1} + 25 K kg ha^{-1}	9	18	10	30	40	34
(T ₅) 20 kg N ha^{-1} + 10 kg P ha^{-1} + 25 kg K ha^{-1} + gypsum @ 250 kg ha^{-1} (top dressing),	9	19	12	34	44	37
(T ₆) 20 kg N ha^{-1} + 10 kg P ha^{-1} + 25 kg K ha^{-1} + lime @ 100 kg ha^{-1} (top dressing),	10	20	13	32	45	36
(T ₇) 20 kg N ha^{-1} + 10 kg P ha^{-1} + 25 kg K ha^{-1} + gypsum @ 250 kg ha^{-1} (top dressing) + ZnSO ₄ @ 25 kg ha^{-1} once in 3 years	17	26	18	35	46	41
Mean	9	18	11	32	43	37
CD @ 0.05	0.80	1.74	0.91	2.64	4.03	3.87
SEm $\pm$	0.27	0.58	0.30	0.87	1.33	1.29
CV (%)	9.12	9.84	10.19	10.27	11.77	11.34

Conclusion

The study revealed that long-term application of fertilizers and manures significantly enhanced soil enzyme activity in Alfisol under rainfed groundnut cultivation. The integrated application of NPK along with gypsum and ZnSO₄ (T₇) showed the highest urease and phosphatase activity, while FYM (T₂) improved dehydrogenase activity. Enzyme activity increased up to the flowering stage and declined at harvest. Overall, balanced fertilization micronutrient and organic inputs is essential for sustaining soil biological health and fertility.

References

- Amador JA, Glucksman AM, Lyons JB, Gorres JH. Spatial distribution of soil phosphatase activity within a riparian forest. *Soil Sci.* 1997;162:808-825.
- Bremner JM, Douglas LA. A rapid method of evaluating different compounds as inhibitors of urease activity in soils. *Soil Biol Biochem.* 1971;3:309-315.
- Burns RG. Enzyme activity in soil: location and possible role in microbial ecology. *Soil Biol Biochem.* 1982;14:423-427.
- Eivazi F, Bayan MR, Schmidt K. Selected soil enzyme activity in the historic Sanborn field as affected by long term cropping systems. *Commun Soil Sci Plant Anal.* 2003;34:2259-2275.
- Kent AD, Triplett EW. Microbial communities and their interactions in soil and rhizosphere ecosystem. *Soil Biol Biochem.* 1971;3:385-387.
- Malewar GU. Micronutrient stresses in soils and crops: serious sicknesses and clinical approaches for sustainable agriculture. *J Indian Soc Soil Sci.* 2005;53(4):484-499.
- Patra AK, Abbadie L, Clays-Josserand A, Degrange V, Grayston SJ, Guillaumaud N, *et al.* Effects of management regime and plant species on the enzyme activity and genetic structure of N-fixing, denitrifying and nitrifying bacterial communities in grassland soils. *Environ Microbiol.* 2006;8:1005-1016.
- Tabatabai MA, Bremner JM. Use of p-nitrophenyl phosphate for assay of soil phosphatase activity. *Soil Biol Biochem.* 1969;1:301-307.
- Casida L, Klein D, Santoro T. Soil dehydrogenase activity. *Soil Sci.* 1964;98:371-376.
- Lemanowicz J, Anuszkiewicz-Ziomek M, Koper E. Response of soil phosphatase activity to organic amendments and mineral fertilization in agricultural soils. *Appl Soil Ecol.* 2024;188:104902.
- Marinari S, Masciandaro G, Ceccanti B, Gregory PJ. Influence of organic and mineral fertilisers on soil biological and physical properties. *Bioresour Technol.* 2000;72(1):9-17.
- Ramakrishnaiah G, Vijaya T. Effect of integrated nutrient management on soil enzyme activity and microbial population in groundnut (*Arachis hypogaea* L.). *J Indian Soc Soil Sci.* 2013;61(4):310-315.
- Mi W, Luo F, Liu W, Qin Y, Zhang Y, Liu K, *et al.* Nitrogen addition enhances seed yield by improving soil enzyme activity and nutrients. 2024;19(12):16791.
- Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. New York: John Wiley & Sons; 1984.