



Impact of UTPANN Fermented Organic Manure (FOM) on Growth, Yield, and Quality of Groundnut (*Arachis hypogaea* L.)

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Abstract

A field experiment was conducted during the 2023–2024 kharif season at Himmatnagar to evaluate the effect of UTPANN FOM on growth, yield, and quality of groundnut (*Arachis hypogaea* L.). The experiment was laid out in a Randomized Block Design (RBD) with two treatments: T₁ (control) and T₂ UTPANN Fermented Organic Manure (FOM), each replicated three times. The soil was determined as sandy loam with a neutral pH 7.4, non-saline conditions, and moderate fertility. The application of UTPANN FOM resulted in substantial improvements in groundnut yield. The treated plots reported a pod yield of 1985 ± 85 kg/ha, kernel yield of 74.90 ± 2.35%, oil content of 48.75 ± 1.45%, and protein content of 26.85 ± 1.10. The treatment also improved plant height, number of branches, nodulation, and shelling percentage. This organic application enhanced soil health and nutrient availability, which supported better root development and overall crop vigor throughout the growing season. These results indicate that UTPANN FOM is an effective organic nutrient management system for groundnut cultivation. This application promotes both qualitative and quantitative traits, providing a sustainable approach to increasing regional agricultural farming.

Keywords: Growth Parameters; Kernel Quality; Organic Manure; Pod Yield; Peanut Crop; Semi-Arid Agriculture

Introduction

Groundnut (*Arachis hypogaea* L.), also known as the “King of Oilseeds,” is a major oilseed and leguminous crop with substantial agronomic, nutritional, and value to the economy [1]. Groundnut kernels contain 48–50% oil and 25–28% high-quality protein, making them a vital component of human nutrition and food security, particularly in semi-arid regions [2]. Groundnut cultivation spans over 32 million hectares worldwide, contributing to a global annual production of more than 5.75 million tons. In many agricultural regions, this crop acts as a primary income source for smallholder farmers and supplies protein-rich fodder for the poultry industry [3].

To sustain productivity in groundnut farming, better nutrient management methods are required due to decreased soil fertility, excessive cropping, and excessive dependence on chemical fertilizers, a number of which have detrimental effects on soil health and crop resilience [4,5]. Agricultural research focuses on high-yield, low-impact farming through sustainable organic practices. This approach maintains productivity while protecting the environment [6].

Organic sources for nutrients are critical in such sustainable systems because they improve soil structure, porosity, and water-holding capacity, resulting in increased crop growth and resilience [7]. They boost microbial diversity and enzymatic activity, speed up

nutrient cycling, and increase macro- and micronutrient availability [8]. Furthermore, organic fertilizer increase long-term soil fertility by replenishing organic carbon and preventing deterioration, salinity, and acidification [9]. The increasing number availability of poultry and animal waste provides an opportunity to recycle these materials into value-added fertilizers, reducing environmental pollution and improving resource efficiency. Organic fertilizers also boost crop tolerance to abiotic conditions such as drought and nutrient deprivation, promoting sustainable production [10,11].

Fermented Organic Manure (FOM) is a highly advanced organic input with rich nutritional profiles and high concentrations of beneficial microorganisms. Unlike raw manure, FOM facilitates faster nutrient mineralization, improves nutrient use efficiency, and supports soil enzymatic activity, ultimately promoting better plant growth [12]. In groundnut, these attributes are particularly critical during pegging and pod development stages, when nutrient demand peaks and conventional fertilizer application often fails to meet crop requirements [13]. The enhanced microbial activity in FOM also improves rhizosphere dynamics, increasing nodulation and supporting biological nitrogen fixation, which is vital for legume productivity [14].

Enriched organic amendments have been thoroughly identified for their capacity to improve growth performance, nodulation, pod development, kernel mass, and shelling percentage in groundnut. These improvements are predominantly attributed to synchronous nutrient release, improved photosynthesis utilization, and progressive enhancement of soil physicochemical and biological properties, which promote long-term agroecosystem sustainability [15]. In addition, the incorporation of organic nutrients reduces the environmental issues associated with excessive dependence on artificial fertilizers, while concurrently preserving soil structural stability and maintaining a balanced and functionally productive soil microbial ecosystem [16].

Groundnut (*Arachis hypogaea L.*) productivity primarily determined the fertilizers availability and soil health. Organic nutrients, such as UTPANN FOM, a fermented manure, can improve soil biological activity and nutritional balance. As a result of this, research aims to evaluate the effect of UTPANN FOM on groundnut growth and yield.

Materials and Methods

Experimental design

The research project was conducted at the experimental farm in Himmatnagar during the 2023–2024 kharif season. The experimental place is located in a semi-arid agricultural environment, which is characterized by high temperatures, comparatively low humidity, and moderate rainfall during the monsoon season. These weather conditions are thought to have been favourable for growing groundnuts, particularly in the kharif season, since these conditions promote optimal vegetative and reproductive growth.

Soil characteristics

Composite soil samples were conducted from a depth of 0-15 cm after sowing and analyzed using standard laboratory techniques. The experimental soil was characterized as sandy loam in texture, which makes it suitable for drainage and aeration.

Parameter	Value
Soil type	Sandy loam
pH	7.4
Electrical conductivity (dS/m)	0.28
Organic carbon (%)	0.50
Available Nitrogen (kg/ha)	238
Available Phosphorus (kg/ha)	32.80
Available Potassium (kg/ha)	265

Table 1: Soil characteristics before sowing.

Experimental design and treatment details

The experiment used a Randomized Block Design (RBD) to account for regional variation in the field and improve the precision of treatment analyses. Two treatments were included in the study, each replicated three times. Treatments included T₁ (Control) with no nutrient input and T₂ (Treated) with UTPANN FOM applied at 10 kg/acre. Treatments were randomly assigned within each replication, and uniform plot size and layout were maintained to minimize variability and ensure experimental precision.

Crop establishment and sowing

For the study, a widely used and regionally adapted groundnut variety appropriate for Gujarat present environmental conditions

was selected. Sowing was done at the commencement of the monsoon season (June-July) to ensure appropriate soil moisture for uniform germination and crop establishment.

Seeds spread manually at 30 cm between rows and 10 cm between plants, which is considered to be optimal for maintaining an optimal plant population and making maximum use of available resources. All specified agronomic measures were carried out to provide a similar crop establishment across the experimental plots.

Measurement of observations

Growth parameter

Plant height was measured from the soil surface to the top of the main stem with a measuring scale, and the average of selected plants was recorded. The number of branches per plant was calculated by manually counting the primary branches. Plants were removed during the flowering stage to conduct nodule measurements, and the roots were manually washed to remove all remaining soil. The number of nodules per plant was determined manually. The collected nodules were dried in the oven at 65-70°C and then weighed equivalent. Plant biomass was determined by removing sample plants, drying them to a standardized weight, and estimating total dry matter [17].

Yield attribute

During harvest, the number of pods per plant was manually counted for selected plants. An electronic balance was used to determine the pod weight per plant after suitable drying. The weight of 100 kernels was measured by weighing randomly selected, well-dried kernels. The shelling % was derived using the following equation:

$$\text{Shelling (\%)} = \text{kernel weight} / \text{pod weight} \times 100 \text{ [18].}$$

Yield and economics

A pod and haulm yields were recorded from each plot during harvest, dried to a consistent weight, and reported as kg/ha. Economic parameters such as net profits and benefit-cost ratios were calculated using current market prices and total cultivation expenses, as required with standard procedures used in groundnut economic analysis [19].

Quality parameters

The Soxhlet extraction method was used to determine oil content, and the Kjeldahl method was used to estimate protein

content, which was shown as a percentage. Kernel yield was calculated as the percentage of kernels collected from the overall pod yield. These analytical methods have been reported in groundnut quality research study [20].

Statistical analysis

The data collected was examined using an appropriate RBD-based ANOVA. Treatment differences were considered substantial at $P < 0.05$. CD values were determined to compare treatment means.

Result and Discussion

Effect of treatment on growth parameters of groundnut

Plant height

The data show that treatment with UTPANN FOM resulted in a considerable increase in plant height 36.95 cm compared to the control group 24.80 cm. Plant growth increases nutrient availability and soil biological activity, both of these improved root development and plant health. Similar results were reported in earlier study, where the applying phosphate-rich organic manure improves groundnut growth, where using 75% RDP with PROM resulted in a plant height of 26.7 cm, which is a 53.44% increase over the 17.4 cm recorded in the control. This organic manure fertilizer application increases soil parameters for plant development throughout the growing season [21].

Number of branch per plant

The results in Table 2 show that treated plants reported a higher number of branches 8.10 than the control 5.20. The higher number of branches is attributed to enhanced nutrient availability, particularly nitrogen, which promotes vegetative growth and branch formation. Another study recorded better groundnut growth using integrated nutrient management, the combination of 46:46kg N:p2o5/ha and 2.5 t/ha vermicompost resulted in 6.1 branches per plant in Ba-ha Gudo, 5.7 in Ba-ha Jidu, and 5.5 in Roba, compared to the control. This change occurs due to better growth management inside the plant, which allows side buds to develop into more branches [22].

Number of nodules per plant

Table 2 shows that treatment with UTPANN FOM result in higher nodulation 72.85 as compared to the control 48.60. This improvement indicates that the treatment promoted a more suitable rhizosphere environment, increasing rhizobial

colonization and symbiotic nitrogen fixation. The improved nodulation is important for maintaining a constant nitrogen supply, which supports crop development. A similar trend was observed in another study under vermicompost treatments, which consistently showed higher nodulation than FYM treatments, indicating that vermicompost has a beneficial impact on nodule formation. The highest nodulation 92.00 was recorded under 35 × 10 cm + 2.5 t/ha VC, followed by 30 × 10 cm + 2.5 t/ha VC 89.44, while the lowest 80.11 was observed under 40 × 10 cm + 2 t/ha FYM [23].

Dry weight of nodule (mg/plant)

As shown in Table 2, the dry weight of nodules in the UTPANN FOM treatment was 108.60 mg per plant, and the control was 72.40 mg per plant. The growth results in higher nodule development and functional efficiency. The higher dry weight of nodules improves metabolic activity, which helps with biological nitrogen fixation and the plant nutrient supply. Another study found that

chicken manure treatment (T_2 -3220 mg) increased nodule weight compared to the untreated control (T_1 -20 mg). The application of nitrogen and organic nutrients, better soil physical properties, and higher microbial activity all help with nodule development and nutrient intake [24].

Plant biomass (g/plant)

UTPANN FOM substantially improved groundnut plant biomass to 58.75 ± 2.40 g/plant, compared to 38.60 ± 1.85 g/plant in the control. The higher biomass in treated plants indicates better plant growth and greater accumulation of dry matter. The treatment effect on biomass production demonstrated by the statistical CD = 5.60 g at $P < 0.05$, yield to increased productivity and crop yield. Similarly observed where application of 75% RDF + 25% N with FYM and biofertilizers produced a plant biomass of 38.90g/plant, higher than the 33.45 g/plant observed in the 100% RDF control. This is due to a steady supply of nutrients and improved soil conditions, which help the plant to maintain its weight during the season.

Treatment	Plant height	Number of branch per plant	Number of nodules per plant	Dry weight of nodule (mg/plant)	Plant Biomass (g/plant)
Control	24.80 ± 1.15	5.20 ± 0.18	48.60 ± 2.10	72.40 ± 3.25	38.60 ± 1.85
Treatment	6.95 ± 1.45	8.10 ± 0.25	72.85 ± 2.80	108.60 ± 4.10	58.75 ± 2.40
CD ($P \leq 0.05$)	3.40	0.75	6.20	9.80	5.60

Table 2: Vegetative Growth and Nodule Formation of Groundnut under Different Treatments.

Effect of treatment on yield attributes of groundnut

Number of pod/plant

Table 3 shows that the number of pods per plant was higher under treated conditions 16.75 ± 0.65 compared to the control 9.85 ± 0.45, indicating an increase of about 70%. The increased pod number illustrates that the treatment resulted in enhanced flowering and pod conditions, which contributed to higher fertility and reproduction. Similar trends were also observed in previous research, application of recommended doses of NPK fertilizers combined with farmyard manure (FYM) or compost significantly increased the number of pods per plant 24.33 compared to the control 19.13. Nutrients and increased soil biological activity promote robust rhizobial colonization and effective nodule development [26].

Pod weigh per pant

An increase in pod weight was observed under treated conditions 168.90 ± 4.85 g relative to the control 102.40 ± 3.20 g, with the difference surpassing the critical difference CD = 12.50 at $P \leq 0.05$. This increased pod weight was a result of better photosynthetic productivity and efficient nutrient allocation to growing pods. A comparable result was observed in the previous study on groundnut under integrated nutrient management, where the difference in number of pods per plant compared with 75% RDF + Vermicompost 2 t/ha 18.15 and 100% RDF 16.88 treatments was attributed to differences in nutrient availability, improved soil conditions, and enhanced microbial activity, a combination of which promoted effective pod development [27].

100 kernel weight

Groundnut plants treated with UTPANN FOM reported higher 100-kernel weight in groundnuts. In treated conditions, the 100-kernel weight was 52.40 ± 1.60 g, up from 38.60 ± 1.25 g in the control, result in a 35.9% increase (Table 3). In a similar research on groundnut under organic manure-based nutrient control, the difference in 100-kernel weight compared with organic manure 66.3 g and inorganic 60.7 g treatments was attributed to differences in nutrient supply, the treated organic fertilizer application improved soil conditions, and higher microbial activity, all of which promoted effective kernel development [28].

Shelling %

The application of UTPANN FOM, 10.8% increase in shelling percentage $73.95 \pm 2.10\%$ compared to $66.80 \pm 1.85\%$ in the control. The increase in shelling percentage was attributed to improved pod size, optimized nutrient availability, and favourable soil physical conditions under the applied treatment. Comparable observations have been reported in earlier study, the application of RDF + FYM 10 t/ha (T2) showed a maximum shelling percentage of 67.25%, indicating a 13.97% increase higher than the control 53.28%. This improvement was attributed to increased pod formation, beneficial soil physical conditions, higher nutrient release, and of growth-promoting compounds [29].

Treatment	Number of pod/plant	Pod weigh per/pant	100 kernel weight	Shelling %
Control	9.85 ± 0.45	102.40 ± 3.20	38.60 ± 1.25	66.80 ± 1.85
Treatment	16.75 ± 0.65	168.90 ± 4.85	52.40 ± 1.60	73.95 ± 2.10
CD (P ≤0.05)	2.10	12.50	4.20	5.10

Table 3: Yield Components and Kernel Characteristics of Groundnut with UTPANN FOM Application.

Effect of treatment on yield and economics of groundnut

Pod yield (kg/plant)

The observation show in table 4. increase in pod yield under UTPANN FOM treatment (1985 ± 85 kg/ha) compared to the control (1180 ± 65 kg/ha) result from improved nutrient uptake, which enhanced the availability of essential nutrients, and higher photosynthetic efficiency, which higher production and translocation of assimilates to developing pods. The application of RDF125 + FYM (5 t/ha) in combination with *Rhizobium*, PSB, and VAM resulted in a higher yield 2453 kg/ha than the control 1471 kg/ha. The increase in pod yield was due to higher nutrient availability and microbial activity, which improved nutrient uptake efficiency and promoted better pod development [30].

Haulm yield (Kg/ha)

Treated plants produced a higher haulm yield 3480 ± 140 kg/ha compared to the control 2350 ± 110 kg/ha, as reported in Table 4. The increased haulm yield in treated plants is attributed to enhanced vegetative growth, which increased leaf area and stem development, improved nutrient uptake, which supply essential nutrient for metabolic and structural functions. Similarly, the organic manure application of poultry manure at 2 t/ha resulted in increased haulm yield (430 kg/ha) compared to the control (350 kg/ha) and other treatments. This increase reported due to increased nutrient availability, including nitrogen, which promoted vegetative growth and biomass growth [31].

Treatment	Pod yield(kg/plant)	Haulm yield (Kg/ha)
Control	1180 ± 65	2350 ± 110
Treatment	1985 ± 85	3480 ± 140
CD (P ≤0.05)	210	320

Table 4: Total Pod and Haulm Yield along with Economic Performance of Groundnut.

Effect of treatment on quality parameters of groundnut

Oil content (%)

Groundnut oil content increased to $48.75 \pm 1.45\%$ under UTPANN FOM treatment, compared with $44.20 \pm 1.25\%$ in the control (Table 5). This resulted in increased lipid synthesis and more efficient nutrient absorption, facilitating greater oil accumulation in the seeds. Results from other studies have shown that, where 100% RDN to castor cake and FYM yielded 46.38% and 46.54% oil, which were higher than the control results. The observed increase in oil content using oilseed-based nutrition sources, such as castor cake, is due to the sustained and controlled release of nitrogen and micronutrients during vital growth phases [32].

Protein content (%)

Table 5 observed that treated plants had higher protein levels $26.85 \pm 1.10\%$ than the control group $23.10 \pm 0.85\%$. The improvement resulted from increased nitrogen uptake and enhanced metabolic activity during seed development, leading to promote synthesis of

proteins. A comparable experiment was conducted on groundnut reported that application of 100% N FYM resulted in a protein value of 24.85%, which was higher than the 20.35% reported in the control. This 4.50% increase results from higher nitrogen availability, which is required for amino acid and protein synthesis. Increased nitrogen availability and soil activity allows the plant to yield more amino acids for protein synthesis in the kernels [33].

Kernel yield (%)

Table 5 shows that kernel yield increased to $74.90 \pm 2.35\%$ in treated plants, compared to $68.40 \pm 2.10\%$ in the control. The increase in yield due to more efficient nutrient partition and enhanced pod and seed development during treatment, which yields a greater quantity of edible seeds. Another study demonstrated that, the groundnut kernel percentage recorded from 19.29% to 22.20%, with the highest values observed under nutritional treatments compared to 75% RDF + vermicompost (2 t/ha), which were due to increased nutrient availability and metabolic activity promoting better kernel production [34].

Treatment	Oil content (%)	Protein content (%)	Kernel yield (%)
Control	44.20 ± 1.25	23.10 ± 0.85	68.40 ± 2.10
Treatment	48.75 ± 1.45	26.85 ± 1.10	74.90 ± 2.35
CD ($P \leq 0.05$)	3.20	2.10	5.80

Table 5: Nutritional and Seed Quality Parameters of Groundnut under Treatment Conditions.

Conclusion

The present study demonstrated that the application of UTPANN Fermented Organic Manure (FOM) improved growth, yield, and quality parameters of groundnut under semi-arid conditions compared to the control. Treated plants increased vegetative growth, higher pod and kernel yield, improved nodulation, and increased biomass production. Quality parameters such as oil and protein content, as well as shelling percentage, were also improved. The results indicate that UTPANN FOM acts as an effective organic input by enhancing nutrient availability, supporting nitrogen fixation, and improving overall crop performance. Its application contributes to higher productivity and better quality produce, offering potential economic advantages for farmers.

Bibliography

1. Asadi Muhammad Hassan., *et al.* "Advances in Breeding Strategies for Collar Rot Resistance in Peanut (*Arachis hypogaea L.*)". *Planta Animalia* 4.4 (2025): 411-420.
2. Kabir Sania., *et al.* "Evaluation and screening of peanut (*Arachis hypogaea L.*) germplasm for nutritional and biochemical enhancement with in-vitro assessment of anti-cancer properties". *PLoS One* 20.12 (2025): e0339289.
3. Zankat K M., *et al.* "Growth and instability in Indian groundnut: An analysis of area, production, yield and exports". *International Journal of Agriculture and Food Science* 7.10 (2025): 192-196.

4. Githumbi M., *et al.* "From Soil Degradation to Restoration: Integrated Soil Fertility Management Pathways for Sustainable Sugarcane Production in Kenya's Diverse Agroecological Zones". *Sugar Tech* (2026): 1-18.
5. Sahayaraj S., *et al.* "Toward Advanced Sensing and Data-Driven Approaches for Maturity Assessment of Indeterminate Peanut Cropping Systems: Review of Current State and Prospects". *Sensors* 26.7 (2026): 2208.
6. Jamil Uzair and Joshua M Pearce. "Regenerative agrivoltaics: integrating photovoltaics and regenerative agriculture for sustainable food and energy systems". *Sustainability* 17.11 (2025): 4799.
7. Liu Qi., *et al.* "Effects of organic fertilizers on soil properties in arid zones and their mechanism of action". *Frontiers in Environmental Science* 14 (2026): 1681958.
8. Kumar A., *et al.* "A Comprehensive Review on Plant-Soil Interactions: Microbial Dynamics, Nutrient Cycling and Sustainable Crop Production". *Asian Journal of Soil Science and Plant Nutrition* 11.2 (2025): 44-62.
9. Abbasi Naiyla Mobin. "Organic Farming and Soil Health: Strategies for Long Term Agricultural Sustainability". *Agricultural Innovation and Sustain Ability Journal* 1.01 (2025): 25-32.
10. Metachew K. "Integrated Waste Management Strategies for Sustainable Livestock Production Systems". *National Journal of Animal Health and Sustainable Livestock* 3.1 (2025): 42-49.
11. Garcia-Caparrros P., *et al.* "The Role of Organic Extracts and Inorganic Compounds as Alleviators of Drought Stress in Plants". *Horticulturae* 11.1 (2025): 91.
12. Holatko J., *et al.* "Cattle Manure Fermented with Biochar and Humic Substances Improve the Crop Biomass, Microbiological Properties and Nutrient Status of Soil". *Agronomy* 12.2 (2022): 368.
13. Sidhu Sudeep S., *et al.* "Peanut Production Guide: Management and Cultural Practices for Peanuts: SS-AGR-501/AG497, 1/2026". *EDIS* 2026.1 (2026).
14. Huang Q. "Enhancing Soil Health and Biodiversity through Nitrogen Fixation Symbiosis in Leguminous Plants". *Molecular Microbiology Research* 14 (2024): Feb 22.
15. Liu Yanqi., *et al.* "The Long-term effects of barren land afforestation on plant productivity, soil fertility, and soil moisture in China: a meta-analysis". *Plants* 13.12 (2024): 1614.
16. Xing Yingying., *et al.* "Enhancing soil health through balanced fertilization: a pathway to sustainable agriculture and food security". *Frontiers in Microbiology* 16 (2025): 1536524.
17. Oyewole Charles Iledun., *et al.* "Influence of seed size on seedling emergence, growth and yield of potted groundnut (*Arachis hypogaea* L.)". *Asian Journal of Agricultural and Horticultural Research* 6.2 (2020): 13-21.
18. Siddiqua Jannatul. "Growth and yield of groundnut varieties as influenced by seed size". (2021).
19. Kumar S. "Evaluation of Yield and Quality of Groundnut under High Density Plantations with Graded Levels of Phosphorus". *M. Sc. (Ag.) Thesis* (2020).
20. Pardeshi Shashikant. "Evaluation of percentage oil yield and physicochemical properties of extracted oils from different peanut species (*arachis hypogaea*) grown in India".
21. Somanaboina Ravi., *et al.* "Effect of Phosphate Rich Organic Manure (PROM) along with Pseudomonas on growth and yield of rabi groundnut". *International Journal of Research in Agronomy* 12 (2025) 417-420.
22. Bekele Getachew., *et al.* "Effect of inorganic and organic fertilizers on productivity of groundnut (*Arachis hypogaea* L.) varieties in East Hararghe, Eastern Ethiopia". *Oil Crop Science* 7.3 (2022): 112-121.
23. Raju Gorla Venkata., *et al.* "Effect of spacing and organic manures on growth and yield of groundnut (*Arachis hypogaea* L.)". *The Pharma Innovation Journal* 11.3 (2022): 291-294.
24. Arangote Violijim Ranay., *et al.* "Growth and yield response of peanut, (*Arachis hypogaea* L.) and soil characteristics with application of inorganic and organic fertilizer and dolomite addition". *International Journal of Biosciences* 15.6 (2019): 164-173.
25. Paramasivan M., *et al.* "Effect of Integrated Nutrient Management Practices on Growth and Yield of Groundnut (*Arachis hypogaea* L.) in an Alfisols of Tamiraparani Tract". *Legume Research-An International Journal* 1 (2025): 7.
26. Patil DB., *et al.* "Effect of integrated nutrient management on growth and yield of kharif groundnut (*Arachis hypogaea* L.)". *International Journal of Horticulture, Agriculture and Food Science* 1.1 (2017): 21-23.

27. Patel kk., *et al.* "Effect of integrated nutrient management on growth, yield and quality of groundnut (*arachis hypogaea* L.) under north gujarat condition". *international Journal of Research* 7.10s (2024): 706-709.
28. Kamble Mr Ajay Pralhad. "Effect of different varieties and nutrient managements on growth, yield and quality of summer groundnut (*Arachis Hypogaea* L.)": phd diss., mahatma phule krishi vidyapeeth, (2021): 100.
29. Sowmya S and M Ganapathy. "Effect of organic manures and biofertilizers on growth and yield of groundnut (*Arachis hypogaea*) in coastal soil". *Crop Research* 56.3and4 (2021): 118-121.
30. Rao MMV Srinivasa., *et al.* "Integrated Nutrient Management in Groundnut (*Arachis hypogaea* L.)-Maize (*Zea mays* L.) Cropping System". M. Sc. (Ag.) Thesis. Acharya NG Ranga Agricultural University, Guntur, Andhra Pradesh (2018).
31. Mukhtar Aishatu Abubakar., *et al.* "Comparative effects of organic manure sources and rates on performance of groundnut varieties". *Building Organic Bridges* 3 (2014): 843-846.
32. Patel JR., *et al.* "Effect of Organic Manures on Productivity in a Groundnut-Wheat Sequence under Organic Farming". *Journal of Scientific Research and Reports* 30.7 (2024): 464-475.
33. Kavadi M H., *et al.* "Effect of different organic sources and mulching on growth, yield and quality of groundnut (*Arachis hypogaea* L.)". *Journal of Agriculture and Ecology* 16 (2023): 11-15.
34. Patel DK., *et al.* "Effect of integrated nutrient management on yield and quality of groundnut (*Arachis hypogaea* L.)". *International Journal of Plant and Soil Science* 36 (2024): 1-10.