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# Nutrient Content and Nutrient Uptake of Rice by The Impact of Inorganic, Organic, and Biological Sources of Nutrients in An Inceptisol Soil of Tamil Nadu

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***Abstract***

*Using the rice variety ADT-37, a field experiment was conducted in the rabi season of 2023 in Tamil Nadu. The scope of the study is to find out the impact of different sources of nutrients on nutrient content and uptake of rice. Most of the previous research work has combined inorganic and organic sources, or inorganic alone or organic alone or anyone with biological. Here we have included inorganic, organic and biological sources of nutrients. The experiment included of nine treatments viz., $T_1$ – Control, $T_2$ - 100% RDF, $T_3$ - 125% RDF , $T_4$ - 100% RDF + Press mud @ 10 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria, $T_5$ – 100% RDF + Vermicompost @ 6 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria, $T_6$ – 100% RDF + Coirpith Compost @ 6 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria, $T_7$ – 125% RDF + Press mud @ 10 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria, $T_8$ – 125% RDF + Vermicompost @ 6 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria, $T_9$ – 125% RDF + Coirpith Compost @ 6 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria. The result concluded that 125% RDF + Vermicompost @ 6 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria ($T_8$) resulted maximum values in nutrient content and significantly higher in nutrient uptake values.*

**Keywords:** *Rice, Vermicompost, Zinc solubilizing bacteria, and NPK*

## 1. Introduction

Among the Indian states, Tamil Nadu grows the most rice, with a production of 5.79 million tonnes and a productivity of 3.04 t $ha^{-1}$ over an area of 1.90 million hectares. So it is important is to find the best combination of nutrient sources in rice nutrient content and uptake. The purpose of the study is to find out the impact of different source of nutrients. In this research we are combining inorganic, organic and biological sources of nutrients in different combination with different doses because of their value in maintaining good soil health, providing nearly all required plant nutrients for crop plant growth and development, and improving the physical, chemical, and biological aspects of soil, organic manures are increasingly used in modern agriculture. (Olivares *et al.*, 2020 and Montenegro *et al.*, 2021).

## 2. Materials And Methods

The current study was conducted in 2023 on the rice variety ADT-37 in a field that represented the tropical climate of Tamil Nadu. It was clay loam in texture and had a pH of 8.0 and an EC of 0.6 $dSm^{-1}$. To determine how rice (*Oryza sativa*) will react to various nutrient sources, the experiment was conducted using a randomized block design (RBD) with three replications.

### Experimental design

Three replications of a randomized block design were employed for the experiment. Different concentrations of inorganic, organic, and biological nutrients were given to the soil as the treatments. Below are the specifics of the treatments:

**$T_1$** - Control

**$T_2$** - 100 % RDF

**$T_3$** - 125% RDF

**$T_4$** - 100% RDF + Press mud @ 10 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria

**$T_5$** - 100% RDF + Vermicompost @ 6 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria

**$T_6$** - 100% RDF + Coir pith compost @ 6 t $ha^{-1}$+ 2% Zinc Solubilizing Bacteria

**$T_7$** - 125% RDF + Press mud @ 10 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria

**$T_8$** - 125% RDF + Vermicompost @ 6 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria

**$T_9$** - 125% RDF + Coir pith compost @ 6 t $ha^{-1}$+ 2% Zinc Solubilizing Bacteria

Plot size : 5 x 4 m

Design : Randomized Block Design

Replications : Three

Recommended dose of fertilizer : 120:40:40 kg N, $P_2O_5$, $K_2O$ $ha^{-1}$

**Nutrient Analysis**

The plant samples five in number was collected during harvest stage (grain and straw) in the case of rice. The plant samples were washed with 0.1N HCl and then with distilled water, air dried and oven dried at 60 to 70°C. The plant samples were powdered in the Wiley mill and analysed for available nitrogen, available phosphorus, available potassium and available micronutrients content in rice.

**Nitrogen content & uptake**

The nitrogen content of plant samples were estimated by the microkjeldahl method suggested by Yoshida *et al.*, (1976) and recorded in percentage. The total N uptake was estimated by multiplying N content per cent with DMP then divided by 100 and expressed in kg $ha^{-1}$.

**Phosphorus content & uptake**

Phosphorus content in plant samples were determined by calometrically using triple acid digestion method suggested by Jackson (1973) with photo-electric colorimeter. From the standard curve drawn, the $P_2O_5$ content of the crop was calculated and P content per cent multiplying with DMP then divided by 100 to find uptake, that was computed in kg $ha^{-1}$.

**Potassium content & uptake**

The potassium in plant samples were estimated by triple acid digestion method (Jackson, 1973) using flame photometer (Elico CL 22D). The content of the sample was calculated from the standard curve drawn. The uptake was computed by multiplying K content (%) with DMP of that treatment then divided by 100 and recorded in kg $ha^{-1}$.

**Micronutrients content & uptake**

Tri acid digested sample fed into atomic absorption spectrophotometer to obtain micronutrients content, then multiplying it with DMP then divided by 1000 to express in g $ha^{-1}$ (Page *et al.*, 1982).

**Statistical analysis**

The data pertaining to nutrient content and nutrient uptake were analyzed statistically by AGRES software to interpret the results.

## 3. Results and Discussion

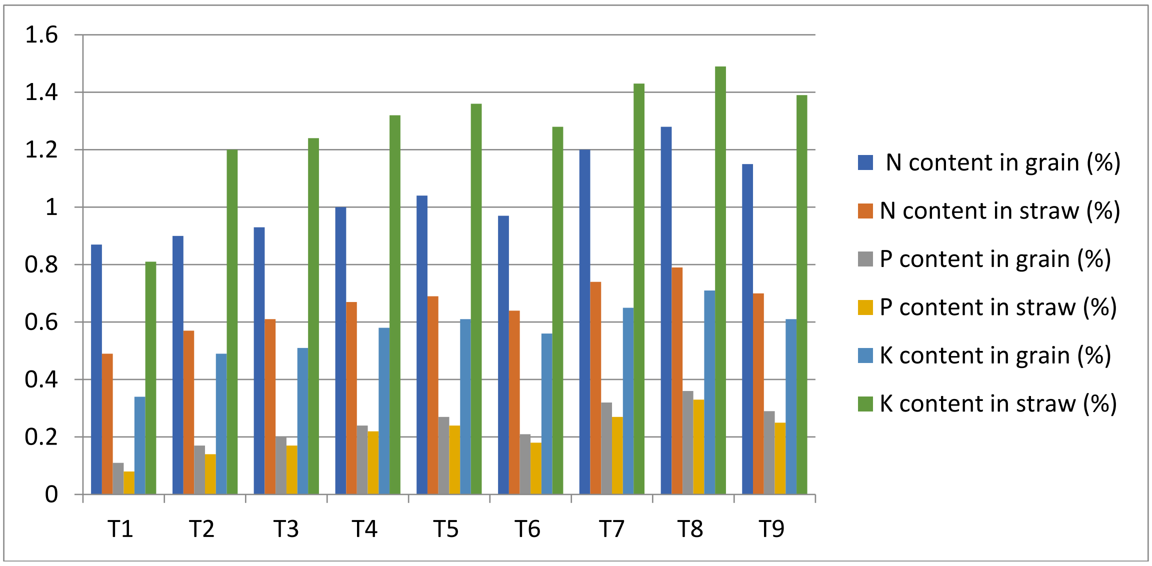
**NPK contents (Table 1):**

When compared to control and other treatments, the application of 125% RDF + Vermicompost at 6 t ha$^{-1}$ + 2% Zinc Solubilizing bacteria ($T_8$) resulted in higher values for NPK content in grain and straw. Grain and straw nitrogen and phosphorus concentration was recorded significantly higher in $T_8$. Potassium concentration in grain is significantly higher in $T_8$ while straw potassium concentration is comparable to $T_7$. The application of vermicompost, which is a rich source of nutrients and enhances the availability of macronutrients in soil, is responsible for the increase in nutritional content. Similar outcomes were discovered by Taheri Rahimabadi *et al.*, (2017) and Papia Biswas *et al.*, (2020). The control plots were found to have the lowest NPK concentration in grain and straw ($T_1$).

**Table 1.** Impact of inorganic, organic, and biological sources of nutrients on NPK contents (%) in rice

| Treatments details | Nutrient contents (%) | | | | | |
|---|---|---|---|---|---|---|
| | N content | | P content | | K content | |
| | Grain | Straw | Grain | Straw | Grain | Straw |
| $T_1$ | 0.87 | 0.49 | 0.11 | 0.08 | 0.34 | 0.81 |
| $T_2$ | 0.90 | 0.57 | 0.17 | 0.14 | 0.49 | 1.20 |
| $T_3$ | 0.93 | 0.61 | 0.20 | 0.17 | 0.51 | 1.24 |
| $T_4$ | 1.00 | 0.67 | 0.24 | 0.22 | 0.58 | 1.32 |
| $T_5$ | 1.04 | 0.69 | 0.27 | 0.24 | 0.61 | 1.36 |
| $T_6$ | 0.97 | 0.64 | 0.21 | 0.18 | 0.56 | 1.28 |
| $T_7$ | 1.20 | 0.74 | 0.32 | 0.27 | 0.65 | 1.43 |
| $T_8$ | 1.28 | 0.79 | 0.36 | 0.33 | 0.71 | 1.49 |
| $T_9$ | 1.15 | 0.70 | 0.29 | 0.25 | 0.61 | 1.39 |
| **S.Ed** | **0.021** | **0.012** | **0.005** | **0.005** | **0.011** | **0.026** |
| **CD (p=0.05)** | **0.044** | **0.027** | **0.012** | **0.011** | **0.025** | **0.056** |

**Fig 1**. Impact of different sources of nutrients on NPK contents of rice



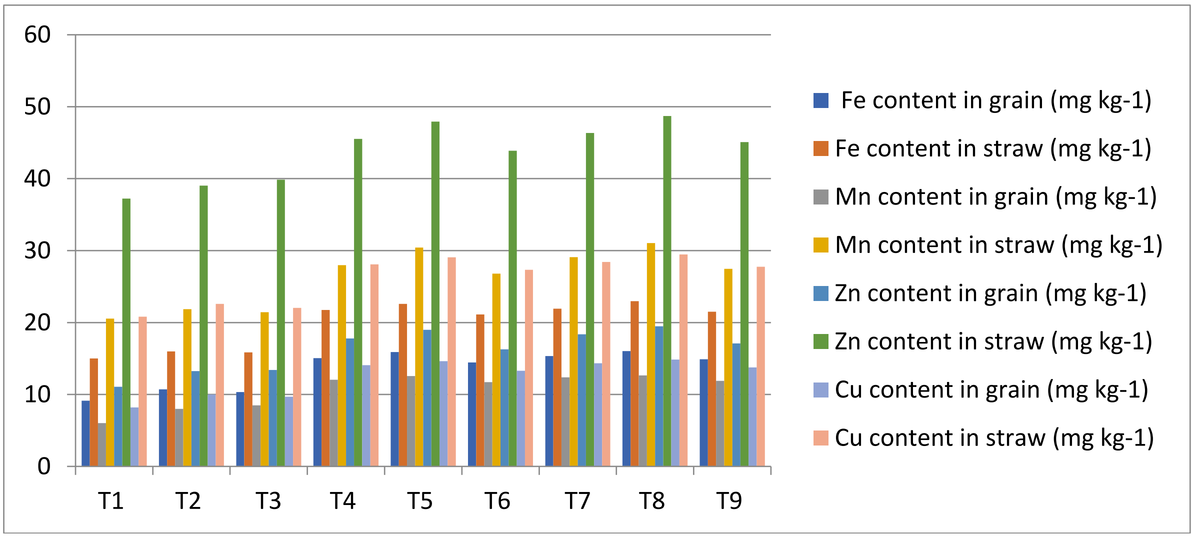

**Micronutrients content (Table 2):**

The application of 125% RDF + Vermicompost at 6 t ha$^{-1}$ + 2% Zinc Solubilizing bacteria ($T_8$) produced the highest values for Fe, Mn, Zn, and Cu content in grain and straw among the various treatments. Grain and straw Fe concentration was comparable to that of $T_5$. Grain's manganese concentration was comparable to that of $T_5$ and $T_7$. Straw's manganese concentration was comparable to that of $T_5$. Grain and straw Zn content was comparable to $T_5$. Grain and straw Cu concentration was comparable to that of $T_5$ and $T_7$. These treatments had effects on micronutrient content that were comparable to those on macronutrient content. The application of vermicompost, which is a rich source of nutrients and enhances the availability of micronutrients in the soil, is responsible for the rise in micronutrient concentrations. Moreover, this was supported by Sharma *et al.*, (2015). The control plots were found to have the lowest micronutrient content in grain and straw ($T_1$).

**Table 2.** Impact of inorganic, organic, and biological sources of nutrients on micronutrients content (mg kg$^{-1}$) in rice

| Treatments | Fe | | Mn | | Zn | | Cu | |
|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| $T_1$ | 9.13 | 15.00 | 6.02 | 20.55 | 11.06 | 37.24 | 8.21 | 20.81 |
| $T_2$ | 10.72 | 15.98 | 8.00 | 21.85 | 13.25 | 39.03 | 10.00 | 22.59 |
| $T_3$ | 10.33 | 15.85 | 8.49 | 21.43 | 13.41 | 39.86 | 9.70 | 22.04 |
| $T_4$ | 15.06 | 21.75 | 12.06 | 27.97 | 17.79 | 45.53 | 14.07 | 28.09 |
| $T_5$ | 15.90 | 22.60 | 12.56 | 30.42 | 18.98 | 47.93 | 14.64 | 29.07 |
| $T_6$ | 14.45 | 21.13 | 11.72 | 26.80 | 16.27 | 43.89 | 13.30 | 27.34 |
| $T_7$ | 15.34 | 21.92 | 12.38 | 29.09 | 18.36 | 46.34 | 14.35 | 28.41 |
| $T_8$ | 16.03 | 22.96 | 12.66 | 31.04 | 19.47 | 48.70 | 14.86 | 29.47 |
| $T_9$ | 14.89 | 21.50 | 11.89 | 27.47 | 17.10 | 45.07 | 13.76 | 27.75 |
| **S.Ed** | **0.30** | **0.41** | **0.23** | **0.54** | **0.34** | **0.87** | **0.26** | **0.53** |
| **CD (p=0.05)** | **0.64** | **0.89** | **0.49** | **1.15** | **0.72** | **1.84** | **0.56** | **1.13** |

**Fig 2.** Impact of different sources of nutrients on micronutrients contents of rice




**NPK uptake (Table 3):**

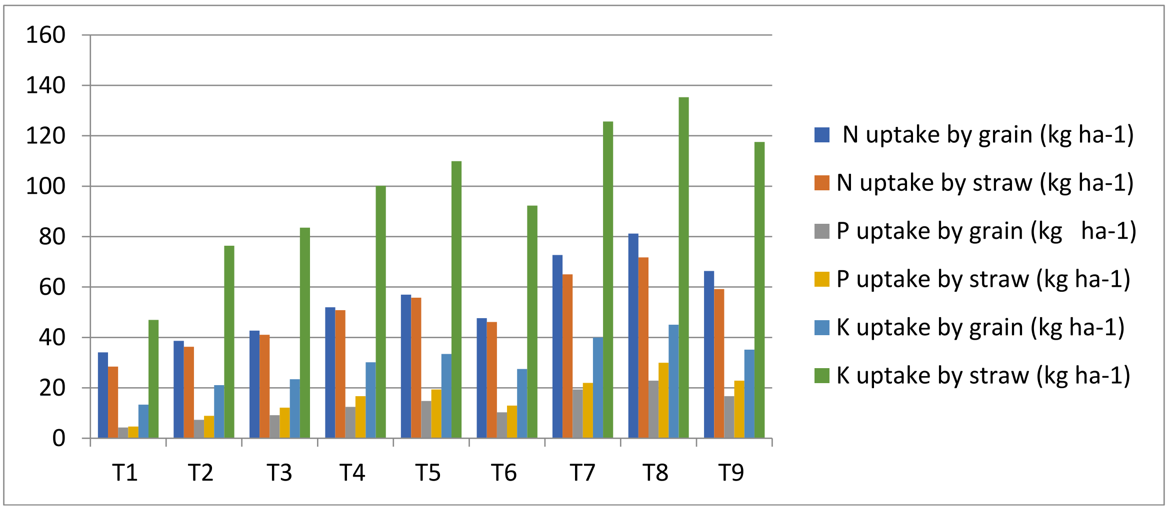
When compared to control and other treatments, the application of 125% RDF + Vermicompost @ 6 t ha$^{-1}$ + 2% Zinc Solubilizing bacteria ($T_8$) resulted in significantly higher values for NPK uptake in grain and straw. This is because the concentration of nutrients in the soil was raised by using vermicompost in conjunction with chemical fertilisers. Similar outcomes were discovered by Ranjitha *et al.*, (2013), Kumar *et al.*, (2014), and Kamaleshwaran and Elayaraja (2021). In control plots, the least NPK absorption in grain and straw was noted ($T_1$).

**Table 3.** Impact of inorganic, organic, and biological sources of nutrients on NPK uptake (kg ha$^{-1}$) in rice

| Treatments details | Nutrient uptake (kg ha$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|
| | N | | P | | K | |
| | Grain | Straw | Grain | Straw | Grain | Straw |
| $T_1$ | 34.06 | 28.42 | 4.30 | 4.64 | 13.31 | 46.98 |
| $T_2$ | 38.68 | 36.28 | 7.30 | 8.91 | 21.06 | 76.38 |
| $T_3$ | 42.72 | 41.09 | 9.18 | 12.12 | 23.41 | 83.53 |
| $T_4$ | 51.94 | 50.85 | 12.46 | 16.69 | 30.12 | 100.18 |

| | | | | | | |
|---|---|---|---|---|---|---|
| $T_5$ | 57.01 | 55.77 | 14.80 | 19.39 | 33.44 | 109.92 |
| $T_6$ | 47.63 | 46.15 | 10.31 | 12.98 | 27.50 | 92.31 |
| $T_7$ | 72.70 | 65.03 | 19.38 | 21.97 | 39.98 | 125.68 |
| $T_8$ | 81.20 | 71.73 | 22.83 | 29.96 | 45.04 | 135.30 |
| $T_9$ | 66.35 | 59.19 | 16.73 | 22.83 | 35.19 | 117.55 |
| **S.Ed** | **1.24** | **1.12** | **0.33** | **0.42** | **0.68** | **2.19** |
| **CD (p=0.05)** | **2.63** | **2.37** | **0.71** | **0.89** | **1.46** | **4.66** |

**Fig 3.** Impact of different sources of nutrients on NPK uptake of rice



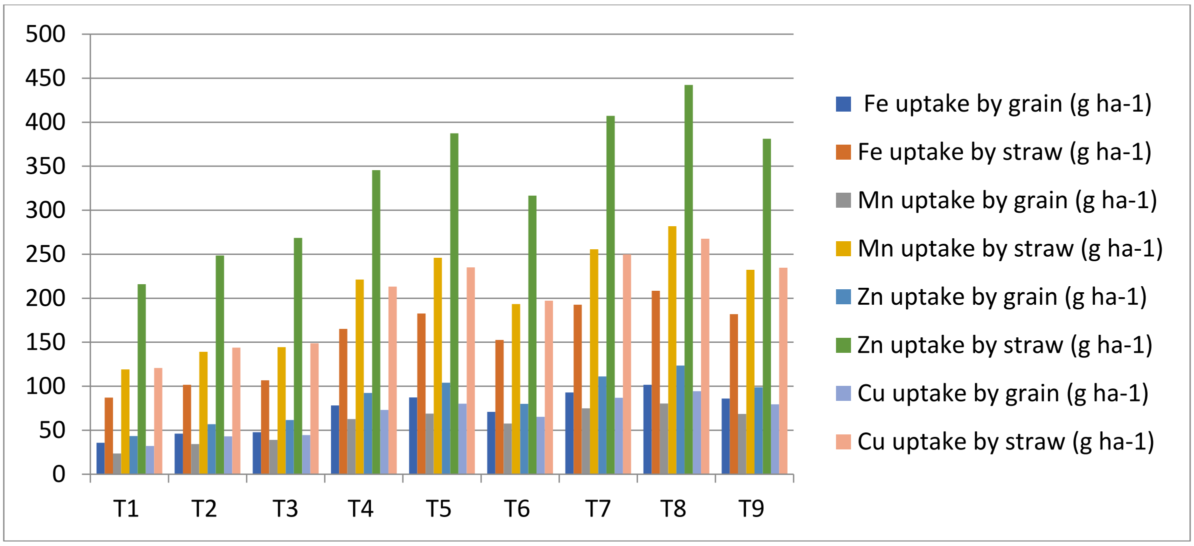

**Micronutrients uptake (Table 4):**

The application of 125% RDF + Vermicompost @ 6 t ha-1 + 2% Zinc Solubilizing bacteria ($T_8$) reported significantly higher values for Fe, Mn, Zn, and Cu absorption in grain and straw compared to the other treatments. The improvement in root proliferation and higher nutrient concentration in the soil may be the cause of the significant improvement in nutrient uptake as a result of the combination of vermicompost and chemical fertilizers. Additionally, this was supported by Sharma *et al.*, (2015). In control plots, the least micronutrient absorption in grain and straw was noted ($T_1$).

**Table 4.** Impact of inorganic, organic, and biological sources of nutrients on micronutrients uptake (g ha$^{-1}$) in rice

| Treatments | Fe | | Mn | | Zn | | Cu | |
|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| $T_1$ | 35.75 | 87.00 | 23.57 | 119.19 | 43.31 | 215.99 | 32.15 | 120.69 |
| $T_2$ | 46.07 | 101.71 | 34.38 | 139.07 | 56.94 | 248.42 | 42.98 | 143.78 |
| $T_3$ | 47.75 | 106.78 | 39.00 | 144.37 | 61.60 | 268.53 | 44.56 | 148.78 |
| $T_4$ | 78.22 | 165.08 | 62.63 | 221.29 | 92.40 | 345.57 | 73.07 | 213.20 |
| $T_5$ | 87.21 | 182.67 | 68.85 | 245.88 | 104.04 | 387.41 | 80.25 | 234.97 |
| $T_6$ | 70.96 | 152.68 | 57.55 | 193.28 | 79.90 | 316.53 | 65.31 | 197.17 |
| $T_7$ | 92.86 | 192.65 | 74.94 | 255.67 | 111.15 | 407.28 | 86.87 | 249.69 |
| $T_8$ | 101.69 | 208.49 | 80.31 | 281.87 | 123.51 | 442.24 | 94.27 | 267.61 |
| $T_9$ | 85.91 | 181.82 | 68.60 | 232.31 | 98.66 | 381.15 | 79.39 | 234.68 |
| **S.Ed** | **1.59** | **3.31** | **1.29** | **4.36** | **1.91** | **7.06** | **1.49** | **4.28** |
| **CD (p=0.05)** | **3.39** | **7.03** | **2.74** | **9.24** | **4.05** | **14.93** | **3.16** | **9.09** |

**Fig 4. Impact of different sources of nutrients on micronutrients uptake of rice**




## 4. Conclusion

Based on the experimental findings, it could be concluded that vermicompost is a organic source of nutrient which is a product of decomposition process using various species of earthworms. Rice variety ADT-37 significantly responded through vermicompost application along with inorganic and biological nutrient sources. Application of 125% RDF + Vermicompost at 6 t $ha^{-1}$ + 2% Zinc Solubilizing Bacteria (ZSB) recorded higher values in nutrient content and significantly higher in nutrient uptake of macro as well as micronutrients over other treatments in Inceptisol soil of Tamil Nadu. Since vermicompost influenced nutrient content and uptake parameters in rice variety ADT-37 significantly has its influence on quality parameters line (hulling and milling per cent) needs to be further researched.

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### Conflict of interest

The authors declared that there is no conflict of interest.

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