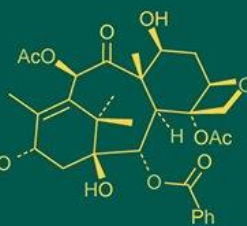
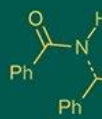


## International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693  
ISSN Online: 2617-4707  
NAAS Rating (2026): 5.29  
IJABR 2026; SP-10(9): 311-314  
[www.biochemjournal.com](http://www.biochemjournal.com)  
Received: 12-06-2026  
Accepted: 16-07-2026

**Vaibhav Vasanta Virutkar**  
PG Scholar, Soil Science  
Section, College of Agriculture,  
Nagpur, Maharashtra, India

**RM Ghodpage**  
Associate Professor, Soil  
Science Section, College of  
Agriculture, Nagpur,  
Maharashtra, India

**Ommala D Kuchanwar**  
Professor, Soil Science Section,  
College of Agriculture, Nagpur,  
Maharashtra, India

**SS Potdar**  
Principal, Anand Niketan  
College of Agriculture, Warora,  
Maharashtra, India

**SA Patil**  
Assistant Professor,  
Department of Botany, College  
of Agriculture, Nagpur,  
Maharashtra, India

**SP Wagh**  
Assistant Professor, Soil  
Science Section, Anand  
Niketan College of Agriculture,  
Warora, Maharashtra, India

**Dhanshri H Bulbule**  
PG Scholar, Soil Science  
Section, College of Agriculture,  
Nagpur, Maharashtra, India

**AD Bhosale**  
PG Scholar, Soil Science  
Section, College of Agriculture,  
Nagpur, Maharashtra, India

**HR Patil**  
PG Scholar, Soil Science  
Section, College of Agriculture,  
Nagpur, Maharashtra, India

**Corresponding Author:**  
**Vaibhav Vasanta Virutkar**  
PG Scholar, Soil Science  
Section, College of Agriculture,  
Nagpur, Maharashtra, India

## Influence of Organo-Mineral Briquette-Based Nutrient Management on NPK Uptake and Grain Nutritional Quality of Lowland Rice

**Vaibhav Vasanta Virutkar, RM Ghodpage, Ommala D Kuchanwar, SS Potdar, SA Patil, SP Wagh, Dhanshri H Bulbule, AD Bhosale and HR Patil**

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9Sd.9849>

### Abstract

A field experiment was conducted during the kharif season of 2025–26 at the Research Farm, Anand Niketan College of Agriculture, Anandwan, Warora, District Chandrapur, Maharashtra, to assess the influence of organo-mineral briquette-based nutrient management on nitrogen (N), phosphorus (P) and potassium (K) uptake and selected nutritional quality attributes of lowland rice. The experiment was conducted in a randomized block design with eight treatments and three replications using rice variety PDKV Tilak. Treatments comprised conventional recommended dose of fertilizer (RDF), urea-DAP briquette with recommended potash, 100, 80 and 60% RDF through organo-mineral briquette, supplemented fertilizer treatments with sulphur, zinc and boron, and an absolute control. The total N, P and K uptake was highest with 100% RDF through organo-mineral briquette (T3), recording 84.71, 16.78 and 97.96 kg ha<sup>-1</sup>, respectively. Relative to conventional RDF (T1), T3 increased total N, P and K uptake by 29.56, 19.35 and 22.94%, respectively. Grain protein content ranged from 7.21 to 7.88%, with the highest value under T3. Starch content ranged from 77.04 to 78.24% and was highest under 80% RDF through organo-mineral briquette (T4). Lysine ranged from 0.26 to 0.37%, with the maximum under T7, while fat (0.63–0.83%), fibre (0.42–0.48%), moisture (11.33–12.33%) and ash (1.43–1.53%) were not significantly influenced by nutrient management. The results indicate that 100% RDF supplied through the INM-based organo-mineral briquette was particularly effective for improving NPK uptake and grain protein content, whereas the response of other grain quality attributes was parameter-specific.

**Keywords:** Deep placement, grain quality, INM, lysine, NPK uptake, organo-mineral briquette, rice

### 1. Introduction

Rice (*Oryza sativa* L.) is an important cereal crop and requires substantial nutrient inputs to sustain productivity. Fertilizer management is an important component of rice production, while incomplete recovery of applied nutrients can occur through processes such as volatilization, leaching, runoff and fixation. Consequently, balanced fertilization, improved placement and synchronization of nutrient supply with crop demand are important for improving nutrient recovery in rice (Bijay-Singh and Vinod, 2017; Dobermann and Cassman, 2002; Nayak *et al.*, 2018) [4, 7, 15]. Integrated nutrient management provides an approach for combining organic and inorganic nutrient sources. In lowland rice, deep placement of fertilizer briquettes places nutrients below the soil surface and has been reported in the thesis literature as a strategy for reducing nitrogen loss and improving nutrient-use efficiency (FAO, 2000; Mikkelsen *et al.*, 1978; Rahman *et al.*, 2016) [14, 18]. Deep placement of urea and NPK briquettes has also been associated with greater nitrogen uptake than broadcast application of prilled urea (Sharna *et al.*, 2021) [21]. Nutrient management can also influence grain nutritional characteristics. Previous work cited in the thesis indicates that integrated nutrient management may improve grain protein content, while responses of proximate composition and lysine can vary with genotype and nutrient management (Sharma *et al.*, 2015; Bharali and Baruah, 2022; Karikatti, 2018; Verma and Srivastav, 2017; Umon *et al.*, 2018) [14, 3, 13, 23]. The present study therefore focused specifically on the response of N, P and K uptake and

d selected grain nutritional quality attributes—protein, starch, lysine, fat, fibre, moisture and ash—to different fertilizer sources, doses and placement approaches in lowland rice.

## 2. Materials and Methods

### 2.1 Experimental site and soil

The experiment was conducted during kharif 2025–26 at the Research Farm, Anand Niketan College of Agriculture, Anandwan, Warora, District Chandrapur, Maharashtra. The experimental soil was a fairly uniform clay-loam Inceptisol. The initial soil was slightly alkaline, with low available N and P, high available K and medium organic carbon. The initial soil pH was 7.62, electrical conductivity  $0.21 \text{ dS m}^{-1}$ , organic carbon  $5.1 \text{ g kg}^{-1}$ , available N  $187.6 \text{ kg ha}^{-1}$ , available P  $14.10 \text{ kg ha}^{-1}$  and available K  $291.5 \text{ kg ha}^{-1}$ .

### 2.2 Experimental design and treatments

The experiment was laid out in a randomized block design with eight treatments, each replicated three times, giving 24 plots. Rice variety PDKV Tilak was transplanted at  $20 \times 15 \text{ cm}$  spacing. The recommended fertilizer dose was 100:50:50 kg N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>.

| Treatment      | Treatment description                                   |
|----------------|---------------------------------------------------------|
| T <sub>1</sub> | RDF 100:50:50 NPK kg ha <sup>-1</sup>                   |
| T <sub>2</sub> | Recommended urea-DAP briquette + recommended potash     |
| T <sub>3</sub> | 100% RDF through organo-mineral briquette               |
| T <sub>4</sub> | 80% RDF through organo-mineral briquette                |
| T <sub>5</sub> | 60% RDF through organo-mineral briquette                |
| T <sub>6</sub> | T <sub>1</sub> + S 5 + Zn 5 + B 0.3 kg ha <sup>-1</sup> |
| T <sub>7</sub> | T <sub>2</sub> + S 5 + Zn 5 + B 0.3 kg ha <sup>-1</sup> |
| T <sub>8</sub> | Absolute control                                        |

In T<sub>1</sub>, 50% N along with the full P, K and supplemental nutrients was applied at puddling and the remaining 50% N after 30 days of transplanting. In T<sub>2</sub>–T<sub>7</sub>, treatment-wise quantities of organo-mineral or urea-DAP briquettes were placed at 5–7 cm depth within four hills after transplanting. The organo-mineral briquette was prepared using vermicompost, gliricidia leaves, DAP, urea, MOP, elemental sulphur, zinc sulphate and borax; the briquette size was 2.5–2.7 g.

### 2.3 Plant sampling and NPK uptake

Grain and straw samples were collected after harvest and chemically analysed. Total N in plant material was estimated by Kjeldahl's method (Piper, 1966) [17]. For P and K determination, plant samples were digested using a nitric acid–perchloric acid di-acid mixture in a 9:4 ratio; total P was determined by the vanadomolybdate phosphoric yellow colour method and total K by flame photometry (Jackson, 1973) [12]. Nutrient uptake was calculated from nutrient concentration and corresponding yield data.

### 2.4 Grain quality analysis

Protein content was determined by Kjeldahl's method (AOAC, 2000), starch by the colorimetric method of Dubois *et al.* (1956) [8], lysine by the spectrophotometric method of Tsai *et al.* (1972) [22], and fat by the Soxhlet method (AOAC, 1998). Fibre was determined using 1.25% H<sub>2</sub>SO<sub>4</sub> and 1.25% NaOH as extraction reagents according to AOAC (2000). Moisture was determined by the oven-dry

method of Oxley *et al.* (1960) [16], and ash by the ignition method described by Jackson (1973) [12].

## 2.5 Statistical analysis

Experimental data were analysed using Fisher's analysis of variance for randomized block design following Gomez and Gomez (1984) [11]. Significance was tested at  $p = 0.05$ , and critical difference (CD) values were calculated where the F-test was significant.

## 3. Results and Discussion

### 3.1 Nitrogen uptake

Total N uptake was significantly affected by the fertilizer treatments. It ranged from  $40.43 \text{ kg ha}^{-1}$  in the absolute control (T<sub>8</sub>) to  $84.71 \text{ kg ha}^{-1}$  with 100% RDF through organo-mineral briquette (T<sub>3</sub>). The corresponding straw and grain N uptake under T<sub>3</sub> were  $31.39$  and  $53.33 \text{ kg ha}^{-1}$ , respectively. T<sub>4</sub> recorded  $80.21 \text{ kg ha}^{-1}$ , while T<sub>7</sub> recorded  $76.94 \text{ kg ha}^{-1}$ . Conventional RDF (T<sub>1</sub>) resulted in  $65.38 \text{ kg ha}^{-1}$ . The total N uptake under T<sub>3</sub> was 29.56% higher than conventional RDF. The higher uptake under the briquette treatment is consistent with the experimental rationale that deep placement supplies nutrients within the reduced soil zone and can improve nutrient availability while reducing losses. The result also agrees with the thesis-cited findings of Sharna *et al.* (2021) [21], who reported higher N uptake with deep placement of urea and NPK briquettes than with broadcast prilled urea. The response is also consistent with Sharma *et al.* (2015) [19], who reported that nutrient management practices affecting N nutrition were reflected in rice protein content.

### 3.2 Phosphorus uptake

Total P uptake varied from  $8.15 \text{ kg ha}^{-1}$  in T<sub>8</sub> to  $16.78 \text{ kg ha}^{-1}$  in T<sub>3</sub>. Under T<sub>3</sub>, P uptake by straw and grain was  $6.83$  and  $9.95 \text{ kg ha}^{-1}$ , respectively. T<sub>4</sub> and T<sub>7</sub> recorded  $15.86$  and  $15.89 \text{ kg ha}^{-1}$ , respectively, whereas T<sub>1</sub> recorded  $14.06 \text{ kg ha}^{-1}$ . The total P uptake under T<sub>3</sub> was 19.35% higher than conventional RDF.

The higher P uptake with the organo-mineral briquette treatment indicates that the combination of nutrient sources and placement used in the experiment supported greater crop acquisition of P. The thesis attributes the response to continued nutrient availability within the reduced soil zone and improved soil conditions around the placed briquette. Darade and Bankar (2009) [6] similarly reported higher N, P and K uptake with deeply placed urea-DAP briquettes in hybrid rice.

### 3.3 Potassium uptake

Total K uptake was highest under T<sub>3</sub> ( $97.96 \text{ kg ha}^{-1}$ ), followed by T<sub>4</sub> ( $91.73 \text{ kg ha}^{-1}$ ) and T<sub>7</sub> ( $88.70 \text{ kg ha}^{-1}$ ), while the lowest value was recorded in T<sub>8</sub> ( $55.09 \text{ kg ha}^{-1}$ ). Conventional RDF (T<sub>1</sub>) resulted in  $79.68 \text{ kg ha}^{-1}$ . Straw and grain K uptake under T<sub>3</sub> were  $77.78$  and  $20.18 \text{ kg ha}^{-1}$ , respectively. The total K uptake under T<sub>3</sub> was 22.94% higher than T<sub>1</sub>. The greater K uptake under T<sub>3</sub> is consistent with the overall NPK uptake response of the crop to organo-mineral briquette placement. The thesis associates higher uptake under briquette treatments with balanced nutrient supply, steady nutrient availability and placement in the reduced soil zone. Similar improvement in NPK uptake under briquette-based nutrient management has been reported by Darade and Bankar (2009) [6].

**Table 1:** N, P and K uptake by rice as influenced by organo-mineral briquette (kg ha<sup>-1</sup>)

| Treatment      | N uptake |       |       | P uptake |       |        | K uptake |       |       |
|----------------|----------|-------|-------|----------|-------|--------|----------|-------|-------|
|                | Straw    | Grain | Total | Straw    | Grain | Total  | Straw    | Grain | Total |
| T <sub>1</sub> | 24.34    | 41.04 | 65.38 | 5.78     | 8.28  | 1s4.06 | 63.42    | 16.26 | 79.68 |
| T <sub>2</sub> | 25.85    | 43.15 | 69.00 | 5.14     | 8.30  | 13.45  | 63.02    | 16.32 | 79.34 |
| T <sub>3</sub> | 31.39    | 53.33 | 84.71 | 6.83     | 9.95  | 16.78  | 77.78    | 20.18 | 97.96 |
| T <sub>4</sub> | 30.43    | 49.78 | 80.21 | 5.62     | 10.24 | 15.86  | 73.15    | 18.58 | 91.73 |
| T <sub>5</sub> | 24.80    | 40.70 | 65.50 | 5.77     | 7.81  | 13.58  | 64.03    | 15.08 | 79.11 |
| T <sub>6</sub> | 26.63    | 43.57 | 70.20 | 5.03     | 8.19  | 13.22  | 65.07    | 16.08 | 81.16 |
| T <sub>7</sub> | 28.69    | 48.25 | 76.94 | 6.21     | 9.68  | 15.89  | 70.81    | 17.88 | 88.70 |
| T <sub>8</sub> | 17.72    | 22.71 | 40.43 | 3.85     | 4.30  | 8.15   | 47.18    | 7.91  | 55.09 |
| SE(m) ±        | 1.60     | 1.69  | 2.79  | 0.27     | 0.62  | 0.76   | 2.53     | 0.83  | 3.09  |
| CD at 5%       | 4.84     | 5.14  | 8.45  | 0.81     | 1.87  | 2.30   | 7.66     | 2.52  | 9.28  |

### 3.4 Grain protein

Grain protein content ranged from 7.21% in T<sub>8</sub> to 7.88% in T<sub>3</sub>. Treatments T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>, T<sub>6</sub> and T<sub>7</sub> were significantly higher than the absolute control, while T<sub>1</sub> and T<sub>5</sub> were statistically at par with the control. T<sub>3</sub>, T<sub>4</sub> and T<sub>7</sub> were mutually at par. The highest protein content under T<sub>3</sub> corresponded with its highest total N uptake, supporting the treatment relationship described in the thesis between N nutrition and grain protein accumulation. Sharma *et al.* (2015) [19] similarly reported a trend in rice protein content corresponding to N uptake, while Chauhan (2023) reported improved grain protein under integrated application of organic and inorganic nutrient sources.

### 3.5 Grain starch

Starch content varied from 77.04 to 78.24%. The highest value (78.24%) was recorded under T<sub>4</sub>, while the lowest (77.04%) occurred under T<sub>3</sub>. The treatment effect was statistically significant. Thus, the treatment producing the highest NPK uptake and protein content did not produce the highest starch content. The observed range was narrow compared with the treatment differences in NPK uptake, indicating that the response of starch was distinct from the response of nutrient uptake.

### 3.6 Grain lysine

Lysine content ranged from 0.26% in T<sub>8</sub> to 0.37% in T<sub>7</sub>. All fertilized treatments recorded numerically higher lysine than the absolute control. T<sub>7</sub> and T<sub>6</sub>, both receiving supplemental S, Zn and B, recorded significantly higher lysine than T<sub>1</sub>, T<sub>2</sub>,

T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> and were statistically at par with each other. Karikatti (2018) [13], as cited in the thesis, reported only a small influence of nutrient management on rice grain lysine concentration, indicating that lysine may show a comparatively limited response to fertilizer regime.

### 3.7 Grain fat and fibre

Grain fat content ranged from 0.63% in T<sub>7</sub> to 0.83% in T<sub>5</sub>, and the treatment effect was non-significant. Fibre content ranged from 0.42 to 0.48%, with the highest numerical value under T<sub>3</sub>; however, the differences among treatments were non-significant. Therefore, neither fat nor fibre showed a statistically reliable response to the nutrient management treatments in the present experiment. The thesis literature similarly reports that grain proximate composition can vary among rice genotypes and that responses to nutrient management are parameter-dependent (Verma and Srivastav, 2017; Ekanayake *et al.*, 2026) [23].

### 3.8 Grain moisture and ash

Moisture content ranged from 11.33% under T<sub>4</sub> to 12.33% under T<sub>1</sub>, T<sub>3</sub>, T<sub>6</sub> and T<sub>8</sub>. The treatment effect was non-significant. Ash content ranged from 1.43 to 1.53% and was also not significantly influenced by the treatments. The thesis attributes the lack of a consistent treatment response in moisture partly to sampling and environmental variability. The observed moisture range falls within the range reported for Indian rice accessions by Verma and Srivastav (2017) [23], although the present study concerns a single rice variety.

**Table 2:** Grain nutritional quality as influenced by organo-mineral briquette

| Treatment      | Protein (%) | Starch (%) | Lysine (%) | Fat (%) | Fibre (%) | Moisture (%) | Ash (%) |
|----------------|-------------|------------|------------|---------|-----------|--------------|---------|
| T <sub>1</sub> | 7.40        | 77.68      | 0.32       | 0.73    | 0.43      | 12.33        | 1.43    |
| T <sub>2</sub> | 7.60        | 78.03      | 0.30       | 0.77    | 0.43      | 11.67        | 1.50    |
| T <sub>3</sub> | 7.88        | 77.04      | 0.32       | 0.80    | 0.48      | 12.33        | 1.47    |
| T <sub>4</sub> | 7.73        | 78.24      | 0.30       | 0.70    | 0.47      | 11.33        | 1.53    |
| T <sub>5</sub> | 7.48        | 77.80      | 0.29       | 0.83    | 0.42      | 12.00        | 1.47    |
| T <sub>6</sub> | 7.56        | 77.89      | 0.35       | 0.73    | 0.42      | 12.33        | 1.50    |
| T <sub>7</sub> | 7.81        | 77.35      | 0.37       | 0.63    | 0.45      | 12.00        | 1.43    |
| T <sub>8</sub> | 7.21        | 78.04      | 0.26       | 0.77    | 0.45      | 12.33        | 1.50    |
| SE(m) ±        | 0.12        | 0.02       | 0.01       | 0.06    | 0.02      | 1.41         | 0.04    |
| CD at 5%       | 0.35        | 0.06       | 0.03       | NS      | NS        | NS           | NS      |

## 5. Conclusion

Under the conditions of the present kharif 2025–26 field experiment, application of 100% RDF through an INM-based organo-mineral briquette (T<sub>3</sub>) was the most effective treatment for increasing total N, P and K uptake and grain protein content of lowland rice. Total N, P and K uptake under T<sub>3</sub> reached 84.71, 16.78 and 97.96 kg ha<sup>-1</sup>,

respectively, while grain protein reached 7.88%. The 80% RDF briquette treatment produced the highest starch content (78.24%), whereas the treatment combining urea-DAP briquette, potash and S, Zn and B supplementation (T<sub>7</sub>) produced the highest lysine content (0.37%). Fat, fibre, moisture and ash were not significantly affected. Thus, within the scope of the present experiment, organo-mineral

briquette application showed a clear advantage for NPK uptake and grain protein, while responses of other nutritional quality traits were variable or non-significant.

## References

1. AOAC International. Official methods of analysis of AOAC International. 16th ed. Washington (DC), USA: Association of Official Analytical Chemists; 1998.
2. AOAC International. Official methods of analysis of AOAC International. 17th ed. Gaithersburg (MD), USA: Association of Official Analytical Chemists; 2000.
3. Bharali A, Baruah KK. Effects of integrated nutrient management on sucrose phosphate synthase enzyme activity and grain quality traits in rice. *Physiol Mol Biol Plants*. 2022;28(2):383-389.
4. Bijay-Singh, Vinod K. Fertilizer management in rice. In: Chauhan BS, Jabran K, Mahajan G, editors. *Rice production worldwide*. Cham, Switzerland: Springer; 2017. p. 217-258.
5. Chauhan A. Optimizing rice (*Oryza sativa* L.) productivity, quality and soil health through a balanced use of organic and inorganic nutrient sources [doctoral dissertation]. Kanpur, Uttar Pradesh, India: Chandra Shekhar Azad University of Agriculture and Technology; 2023.
6. Darade AB, Bankar KB. Effect of urea-DAP briquettes and zinc levels on nitrogen, phosphorus and potassium uptake and yield of hybrid rice. *Int J Agric Sci*. 2009;5(2):510-512.
7. Dobermann A, Cassman KG. Plant nutrient management for enhanced productivity in intensive grain production systems of the United States and Asia. *Plant Soil*. 2002;247:153-175.
8. Dubois M, Gilles KA, Hamilton JK, Rebers PA, Smith F. Colorimetric method for determination of sugars and related substances. *Anal Chem*. 1956;28(3):350-356.
9. Ekanayake S, Pathirana R, Vivekraj S, Premarathna M, Nanayakkara B, Madawala S, *et al*. Enhancing nutritional biofortification of rice through integrated use of biofilm biofertilizer and bio-organo-mineral fertilizers. *Arch Agron Soil Sci*. 2026;72(1):1-14.
10. Food and Agriculture Organization of the United Nations. *Fertilizers and their use: a pocket guide for extension officers*. 4th ed. Rome, Italy: FAO; 2000.
11. Gomez KA, Gomez AA. *Statistical procedures for agricultural research*. 2nd ed. New York, USA: John Wiley & Sons; 1984. 680 p.
12. Jackson ML. *Soil chemical analysis*. New Delhi, India: Prentice Hall of India Ltd.; 1973.
13. Karikatti P. Long term effect of organic, inorganic and integrated nutrient management practices on soil characteristics, yield and quality of paddy (*Oryza sativa* L.) in a Vertisol of TBP command area [thesis]. 2018.
14. Mikkelsen DS, De Datta SK, Obcemea WN. Ammonia volatilization losses from flooded rice soils. *Soil Sci Soc Am J*. 1978;42(5):725-730.
15. Nayak AK, Mohanty S, Chatterjee D, Bhaduri D, Khanam R, Shahid M, *et al*. Nutrient management for enhancing productivity and nutrient use efficiency in rice. In: *Rice research for enhancing productivity, profitability and climate resilience*. Cuttack, Odisha, India: ICAR-National Rice Research Institute; 2018.
16. Oxley TA, Pixton SW, Howe RW. Determination of moisture content in cereals. *J Sci Food Agric*. 1960;11(1):18-25.
17. Piper CS. *Soil and plant analysis*. 4th ed. Adelaide, Australia; 1966. p. 135-200.
18. Rahman MM, Samanta SC, Rashid MH, Abuyusuf M, Hassan MZ, Sukhi KFN. Urea super granule and NPK briquette on growth and yield of different varieties of Aus rice in tidal ecosystem. *Asian J Crop Sci*. 2016;8(1):1-2.
19. Sharma GD, Thakur R, Chouhan N, Keram KS. Effect of integrated nutrient management on yield, nutrient uptake, protein content, soil fertility and economic performance of rice (*Oryza sativa* L.) in a Vertisol. *J Indian Soc Soil Sci*. 2015;63(3):320-326.
20. Sharna SBZ, Islam S, Huda A, Jahiruddin M, Islam MR. Effects of prilled urea, urea briquettes and NPK briquettes on the growth, yield and nitrogen use efficiency of BRRI Dhan48. *Asian J Soil Sci Plant Nutr*. 2021;7(3):19-27.
21. Sumon MJ, Roy TS, Haque MN, Ahmed S, Mondal K. Growth, yield and proximate composition of aromatic rice as influenced by inorganic and organic fertilizer management. *Not Sci Biol*. 2018;10(2):211-219.
22. Tsai CY, Hansel LW, Nelson OE. A colorimetric method of screening maize seeds for lysine content. *Cereal Chem*. 1972;49:572.
23. Verma DK, Srivastav PP. Proximate composition, mineral content and fatty acids analyses of aromatic and non-aromatic Indian rice. *Rice Sci*. 2017;24(1):21-31.