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The names and affiliations of all authors are provided below, following the references.

## Effect of organic manures and fertilizer sources on soil nutrient availability and nutrient content in rice under coastal saline soil

SR Kamble<sup>1</sup>, MR Wahane<sup>2</sup>, MC Kasture<sup>3</sup>, VG Chavan<sup>4</sup>, NA Meshram<sup>5</sup>, NH Khobragade<sup>6</sup>, AD Kuwar<sup>7</sup>, SS Patil<sup>8</sup>, SB Abhale<sup>9</sup>

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### ABSTRACT

Field investigation was carried out during the Kharif season of 2025 at the Khar Land Research Station, Panel, Raigad, Maharashtra, to assess the influence of organic manures and fertilizer sources on soil nutrient availability and nutrient content in rice (*Oryza sativa* L.) under coastal saline environments. The experiment followed a factorial randomized block design with five organic manure treatments (control, farmyard manure (FYM), *Gliricidia*, dhaincha, and bhend) and four fertilizer treatments (no fertilizer, recommended dose of fertilizer (RDF), UB-DAP briquette, and Konkan Annapurna Briquette (KAB)), replicated thrice. Soil samples were collected at the maximum tillering and harvest stages to determine available nitrogen (N), phosphorus (P), and potassium (K), along with their contents in grain and straw. Organic manure treatments significantly influenced soil available N and P at both stages, while fertilizer application significantly affected nutrient contents in grain and straw. Among the organic manures, *Gliricidia* recorded the highest available N, whereas dhaincha recorded the highest available P. The combination of dhaincha + KAB produced the highest available P at harvest (78.27 kg ha<sup>-1</sup>), while dhaincha + UB-DAP recorded the highest available P at maximum tillering (85.11 kg ha<sup>-1</sup>) stage. In grain, the integration of FYM + UB-DAP caused in the highest N content (1.79%), and *Gliricidia* + KAB recorded significantly highest P content (0.35%). In straw, KAB application showed the highest K content (0.43%), whereas RDF displayed the maximum K content in grain (0.24%). Correlation analysis showed positive associations between soil available nutrients at both sampling stages and nutrient contents in rice grain and straw. In general, the findings indicate that the combined application of organic manures and fertilizer sources enhanced soil nutrient availability and nutrient accumulation in rice under coastal saline conditions.

**Keywords:** Coastal saline soil, Briquettes, Fertilizers, Manures, Rice, Soil fertility

### Introduction

Rice (*Oryza sativa* L.) is a major food crop in India, but its productivity in coastal regions is significantly declined by soil salinity. Coastal saline soils of the Konkan region are impacted by seawater or creek-water inundation, saline groundwater, capillary rise of salts, and poor drainage. About 65,000 ha in Maharashtra are affected by coastal salinity (Dodake *et al.*, 2022<sup>[1]</sup>; Patil *et al.*, 2024<sup>[2]</sup>) [1, 2]. These areas face further risks from tidal effects related with sea-level rise, poor-quality saline groundwater, and the occurrence of saline and acidic soils, all of which hamper crop establishment and decline productivity (Dodake *et al.*, 2022<sup>[1]</sup>, 2023<sup>[3]</sup>; Patil *et al.*, 2024<sup>[2]</sup>; Khobragade *et al.*, 2025<sup>[4]</sup>; Abhale *et al.*, 2026<sup>[5]</sup>). Soil electrical conductivity in the region varies from 1.69 to 31.29 dS m<sup>-1</sup>, representing substantial salinity stress (Patil *et al.*, 2024<sup>[2]</sup>; Rakhonde *et al.*, 2024<sup>[6]</sup>, 2025<sup>[7]</sup>) [2, 6]. Salinity carries out osmotic and ionic stresses on rice, limiting water uptake and disturb the ionic balance and uptake of critical nutrients to the crop. Subsequently, sustaining satisfactory nutrient availability and enhancing nutrient-use efficiency are life-threatening for supporting rice production in coastal saline soils (Munns and Tester, 2008<sup>[8]</sup>; Patil *et al.*, 2014<sup>[2]</sup>; Rakhonde *et al.*, 2024<sup>[6]</sup>) [8, 2, 6]. Seasonal variation in water-soluble ions has also been reported in these soils, indicating dynamic changes in salinity during the monsoon period (Gaikwad *et al.*, 2025<sup>[9]</sup>).

Organic manures can improve the fertility of salt-affected soils by delivering organic matter and nutrients and by subsidiary microbial-mediated nutrient cycling (Abhale *et al.*, 2024<sup>[10]</sup>, 2026<sup>[5]</sup>; Khobragade *et al.*, 2025<sup>[4]</sup>; Vanave *et al.*, 2026<sup>[11]</sup>) [5, 10, 4]. Farmyard manure and green manures such as *Gliricidia* and dhaincha increase nutrient mineralization and recover nutrient availability (Rathod *et al.*, 2018<sup>[12]</sup>; Abhale *et al.*, 2024<sup>[10]</sup>, 2026<sup>[5]</sup>) [12, 10]. In contrast, inorganic fertilizers offer readily available nutrients, but their efficacy under flooded conditions depends on the source, timing, and method of application. Briquette-based fertilizer application has been shown to influence soil properties, nutrient concentration, and nutrient uptake in rice (Bedse *et al.*, 2021<sup>[13]</sup>; Wahane *et al.*, 2022<sup>[14]</sup>, 2023<sup>[15]</sup>) [13, 14]. Deep placement of fertilizer briquettes progresses nutrient availability in the rice root zone and minimize nutrient losses. Earlier studies have re

### Corresponding Author: SR Kamble

M.Sc. (Agri.), Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri (M.S.), 415 712, India.

ported positive effects of briquette-based fertilization on nutrient uptake and yield attributes of rice (Bedse *et al.*, 2021<sup>[13]</sup>; Wahane *et al.*, 2023<sup>[15]</sup>) [13, 15]. Research in coastal saline areas of Maharashtra has also confirmed beneficial effects of organic amendments and fertilizer briquettes on rice production and nutrient management (Khobragade *et al.*, 2025<sup>[4]</sup>; Abhale *et al.*, 2026<sup>[5]</sup>; Vanave *et al.*, 2026<sup>[11]</sup>) [4, 5, 11]. The integration of organic manures and efficient fertilizer sources may therefore offer harmonizing benefits by refining soil nutrient availability and nutrient uptake by rice under saline conditions. However, information on the response of rice to different organic manure–fertilizer source combinations in the coastal saline soils of Maharashtra remains limited. Therefore, the present study was undertaken to evaluate the influence of farmyard manure (FYM), *Gliricidia*, dhaincha, and bhend in combination with the recommended dose of fertilizer (RDF), UB-DAP briquette, and Konkan Annapurna Briquette (KAB) on soil nutrient availability and nitrogen (N), phosphorus (P), and potassium (K) contents of rice under coastal saline conditions at the Khar Land Research Station, Panvel, Raigad, Maharashtra.

## Materials and Methods

A field experiment was conducted during the Kharif season of 2025 at the Khar Land Research Station, Panvel, District Raigad, Maharashtra, on coastal saline soil. The experimental site is located at 18°59' N latitude and 73°10' E longitude, about 5 m above mean sea level and about 50 m from the Arabian Sea. The region experiences a hot and humid climate with annual rainfall exceeding 1,995 mm. Before planting, a representative surface soil sample (0–22.5 cm depth) was collected from the experimental field and analysed for initial fertility status. The soil was slightly acidic, with an electrical conductivity of 4.0 dS m<sup>-1</sup>, available nitrogen of 118.20 kg ha<sup>-1</sup>, available phosphorus of 45.51 kg ha<sup>-1</sup>, and available potassium of 2,038.56 kg ha<sup>-1</sup>.

Rice (*Oryza sativa* L.) variety Panvel-1, developed by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli from the cross IR 8 × BR 4-10, was used as the test crop. The crop was transplanted at a spacing of 25 × 15 cm in plots (net plot) measuring 4 × 3 m. The experiment was laid out in a factorial randomized block design (FRBD) with five organic manure treatments (M<sub>0</sub>: control (no manuring), M<sub>1</sub>: farmyard manure (FYM) @ 10 t ha<sup>-1</sup>, M<sub>2</sub>: *Gliricidia* (*Gliricidia sepium*) green manure @ 10 t ha<sup>-1</sup>, M<sub>3</sub>: Dhaincha (*Sesbania aculeata*) green manure @ 10 t ha<sup>-1</sup> and M<sub>4</sub>: Bhend (*Thespesia populnea*) green manure @ 10 t ha<sup>-1</sup>) and four chemical fertilizer treat-

ments (F<sub>0</sub>: control (no fertilizer/briquettes), F<sub>1</sub>: recommended dose of fertilizer (RDF) @ 100:50:50 kg N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O ha<sup>-1</sup>, F<sub>2</sub>: UB-DAP briquette containing 34:18.4% N: P<sub>2</sub>O<sub>5</sub> and F<sub>3</sub>: Konkan Annapurna briquette (KAB) containing 34:14:06% N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O) resulting in 20 treatment combinations, each replicated three times.

Representative surface soil samples (0–22.5 cm depth) were collected from each treatment at 45 days after sowing (DAS) and again at crop harvest. Composite samples were prepared by applying the quartering method for soil sample collection. The samples were air-dried under shade, gently crushed using a wooden mortar and pestle, and passed through a 2 mm sieve for general analysis. The processed samples were stored in plastic bags placed inside corrugated boxes until chemical analyses. Available nitrogen was determined by the alkaline potassium permanganate method (Subbiah *et al.*, 1956)<sup>[16]</sup>. Available phosphorus was estimated by the Olsen method using 0.5 M sodium bicarbonate as the extracting solution (Olsen, 1954)<sup>[17]</sup>. Available potassium was extracted with 1 N neutral ammonium acetate and measured using a flame photometer (Jackson, 1973)<sup>[18]</sup>. For plant analysis, total nitrogen was determined by the Micro-Kjeldahl method, phosphorus by the vanadomolybdate yellow colour method, and potassium by flame photometry after digestion of the plant material, following the procedures described by Tandon (1993)<sup>[19]</sup>.

## Results and Discussion

Data presented in Table 1 showed that soil available nitrogen (N) varied from 132.04 to 206.66 kg ha<sup>-1</sup> at the maximum tillering stage and from 125.40 to 180.66 kg ha<sup>-1</sup> at harvest. A reduction in available N towards harvest was observed owing to crop uptake and soil N transformations under submerged conditions. These values were comparable with those reported by Abhale *et al.* (2024)<sup>[10]</sup> for coastal saline soils of Maharashtra. At maximum tillering, *Gliricidia* application showed the highest mean available N (188.32 kg ha<sup>-1</sup>) compared to dhaincha (184.83 kg ha<sup>-1</sup>) and bhend (180.89 kg ha<sup>-1</sup>), while the control recorded the lowest (151.36 kg ha<sup>-1</sup>). The higher N availability under *Gliricidia* and dhaincha was related with their easily decomposable, N-rich residues and speedy mineralization (Bhatt, 2023<sup>[20]</sup>; Rakhonde *et al.*, 2024<sup>[6]</sup>; Lyu *et al.*, 2024<sup>[21]</sup>) [20, 6, 21]. At harvest, bhend application observed the highest mean available N (169.38 kg ha<sup>-1</sup>), followed by *Gliricidia* (162.60 kg ha<sup>-1</sup>) and dhaincha (161.46 kg ha<sup>-1</sup>), while the control recorded the lowest (142.31 kg ha<sup>-1</sup>). The higher residual N under bhend may have reflected because of continued decomposition of its organic residues.

**Table 1.** Effect of different manures and fertilizers on soil available nitrogen (kg ha<sup>-1</sup>) at various growth stages of rice

| Tr.            | Maximum Tillering Stage |                |                |                |        | At Harvest     |                |                |                |        |
|----------------|-------------------------|----------------|----------------|----------------|--------|----------------|----------------|----------------|----------------|--------|
|                | F <sub>0</sub>          | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean   | F <sub>0</sub> | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean   |
| M <sub>0</sub> | 132.04                  | 163.94         | 154.83         | 154.65         | 151.36 | 125.40         | 155.37         | 143.21         | 145.24         | 142.31 |
| M <sub>1</sub> | 154.19                  | 168.78         | 156.69         | 156.45         | 159.03 | 160.01         | 152.69         | 160.81         | 158.20         | 157.93 |
| M <sub>2</sub> | 158.70                  | 206.66         | 203.03         | 184.90         | 188.32 | 162.71         | 157.82         | 161.67         | 168.18         | 162.60 |
| M <sub>3</sub> | 157.33                  | 197.30         | 197.13         | 187.55         | 184.83 | 170.34         | 156.27         | 165.06         | 154.18         | 161.46 |
| M <sub>4</sub> | 151.44                  | 195.58         | 191.51         | 185.04         | 180.89 | 169.02         | 178.37         | 160.66         | 169.47         | 169.38 |
| Mean           | 150.74                  | 186.45         | 180.64         | 173.72         |        | 157.50         | 160.11         | 158.28         | 159.06         |        |
|                | O.M.                    | C.F.           |                | C.F. × O.M.    |        | O.M.           | C.F.           |                | C.F. × O.M.    |        |
| S.E.±          | 3.1                     | 2.77           |                | 6.2            |        | 2.39           | 2.14           |                | 4.78           |        |
| C.D.@5%        | 8.88                    | 7.94           |                | NS             |        | 6.84           | NS             |                | 13.67          |        |

Fertilizer treatments significantly influenced available N at maximum tillering but not at harvest. The recommended dose of fertilizer (RDF) recorded the highest mean available N (186.45 kg ha<sup>-1</sup>) in comparison to UB-DAP (180.64 kg ha<sup>-1</sup>), while the no-fertilizer treatment recorded the lowest (150.74 kg ha<sup>-1</sup>). At harvest, available N varies from 157.50 to 160.11 kg ha<sup>-1</sup> across fertilizer treatments, signifying that treatment differences had mostly reduced by crop maturity. The organic manure × fertilizer interaction was non-significant at maxi-

mum tillering but significant at harvest. *Gliricidia* + RDF recorded the highest numerical value at maximum tillering (206.66 kg ha<sup>-1</sup>), whereas bhend + UB-DAP recorded the highest available N at harvest (180.66 kg ha<sup>-1</sup>), followed by bhend + RDF (178.37 kg ha<sup>-1</sup>). The higher residual N under these blends advised a constant involvement from both organic residue decomposition and fertilizer N supply. Comparable effects of integrated nutrient management on soil N

availability have been reported by Kumar *et al.* (2024)<sup>[22]</sup>, Hou *et al.* (2023)<sup>[23]</sup>, and Zhong *et al.* (2024)<sup>[24]</sup>.

Soil available phosphorus (P) fluctuated from 51.98 to 78.27 kg ha<sup>-1</sup> at the maximum tillering stage and from 52.26 to 85.11 kg ha<sup>-1</sup> at harvest, with overall increase towards harvest (Table 2). This difference may be related with P mineralization and redox-induced transformations of Fe-associated P under submerged conditions (Abhale *et al.*, 2026)<sup>[5]</sup>. The observed values were similar with those reported by Rakhonde *et al.* (2024)<sup>[6]</sup> and Abhale *et al.* (2024)<sup>[10]</sup> for coastal saline soils of Maharashtra. Organic manure treatments significantly enhanced available P at both stages. Dhaincha recorded significantly highest mean available P at maximum tillering (71.21 kg ha<sup>-1</sup>) and at harvest (78.20 kg ha<sup>-1</sup>), while the control recorded the lowest values (56.84 and 63.69 kg ha<sup>-1</sup>, respectively). The higher P under dhaincha was linked with the decomposition of nutrient-rich biomass and greater P mineralization and mobilization (Gu *et al.*, 2024)<sup>[25]</sup>,<sup>[25]</sup>

Fertilizer application also significantly improved available P at both stages. Konkan Annapurna Briquette (KAB) showed the highest mean at maximum tillering (68.03 kg ha<sup>-1</sup>), while UB-DAP showed the highest value at harvest (78.38 kg ha<sup>-1</sup>). The stage-dependent response might have shown differences in P release and transformation under flooded conditions. The organic manure × fertilizer interaction was significant at both stages. At maximum tillering, dhaincha + KAB recorded the highest available P (78.27 kg ha<sup>-1</sup>), while at harvest, dhaincha + UB-DAP recorded the highest value (85.11 kg ha<sup>-1</sup>). The lowest values at both stages were recorded under the unfertilized and unmanured control (51.98 and 52.26 kg ha<sup>-1</sup>). Significant higher P under the integrated treatments designated corresponding effects of organic residue decomposition and fertilizer-derived P supply. Similar benefits of integrated nutrient management on P availability have been reported by Hou *et al.* (2023)<sup>[23]</sup>.

**Table 2.** Effect of different manures and fertilizers on soil available phosphorus (kg ha<sup>-1</sup>) at various growth stages of rice

| Tr.            | Maximum Tillering Stage |                |                |                |       | At Harvest     |                |                |                |       |
|----------------|-------------------------|----------------|----------------|----------------|-------|----------------|----------------|----------------|----------------|-------|
|                | F <sub>0</sub>          | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean  | F <sub>0</sub> | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean  |
| M <sub>0</sub> | 51.98                   | 61.67          | 59.07          | 54.64          | 56.84 | 52.26          | 60.78          | 72.73          | 69.01          | 63.69 |
| M <sub>1</sub> | 58.78                   | 64.77          | 61.05          | 65.65          | 62.56 | 63.82          | 65.35          | 75.10          | 73.76          | 69.51 |
| M <sub>2</sub> | 60.97                   | 68.33          | 68.62          | 73.00          | 67.73 | 70.03          | 71.43          | 83.68          | 79.64          | 76.20 |
| M <sub>3</sub> | 62.98                   | 68.72          | 74.86          | 78.27          | 71.21 | 71.28          | 73.88          | 85.11          | 82.53          | 78.20 |
| M <sub>4</sub> | 57.94                   | 67.25          | 61.40          | 68.57          | 63.79 | 66.45          | 65.52          | 75.27          | 72.58          | 69.95 |
| Mean           | 58.53                   | 66.15          | 65.00          | 68.03          |       | 64.77          | 67.39          | 78.38          | 75.50          |       |
|                | O.M.                    | C.F.           | C.F. × O.M.    |                |       | O.M.           | C.F.           | C.F. × O.M.    |                |       |
| S.E.±          | 0.17                    | 0.15           | 0.35           |                |       | 0.26           | 0.24           | 0.53           |                |       |
| C.D.@5%        | 0.49                    | 0.44           | 0.99           |                |       | 0.76           | 0.68           | 1.51           |                |       |

Soil available potassium (K) ranged from 1,318.50 to 1,655.00 kg ha<sup>-1</sup> at the maximum tillering stage and from 1,133.97 to 1,452.93 kg ha<sup>-1</sup> at harvest, with a general decline towards harvest attributable to advanced crop uptake (Table 3). Organic manure, fertilizer source, and their interaction meaningfully influenced available K at maximum tillering; however, the fertilizer effect was non-significant at harvest. Among the organic manures, farmyard manure (FYM) recorded the highest mean available K at maximum tillering (1,549.68 kg ha<sup>-1</sup>), whereas dhaincha confirmed the highest value at harvest (1,421.08 kg ha<sup>-1</sup>). Among the fertilizer treatments, the recommended dose of fertilizer (RDF) proved the highest mean at maximum tillering (1,565.25 kg ha<sup>-1</sup>). The highest interaction values were

observed under FYM + RDF (1,655.00 kg ha<sup>-1</sup>) at maximum tillering and under dhaincha + no fertilizer (1,453.57 kg ha<sup>-1</sup>) at harvest, although the unfertilized and unmanured control normally recorded the lowest values. The higher available K under organic amendments was linked with K release and recycling during residue decomposition. Similar enhancements in soil K cycling under organic and integrated nutrient management have been reported by Wang *et al.* (2023)<sup>[26]</sup>. The observed variation in soil K was also consistent with the dynamic distribution of K fractions reported for coastal soils of Raigad district (Rakhonde *et al.*, 2024<sup>[6]</sup>, 2025<sup>[7]</sup>, 2025<sup>[27]</sup>; Abhale *et al.*, 2026<sup>[5]</sup>)<sup>[7]</sup>,<sup>[6]</sup>.

**Table 3.** Effect of different manures and fertilizers on soil available potassium (kg ha<sup>-1</sup>) at various growth stages of rice

| Tr.            | Maximum Tillering Stage |                |                |                |         | At Harvest     |                |                |                |         |
|----------------|-------------------------|----------------|----------------|----------------|---------|----------------|----------------|----------------|----------------|---------|
|                | F <sub>0</sub>          | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean    | F <sub>0</sub> | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean    |
| M <sub>0</sub> | 1318.50                 | 1442.70        | 1454.20        | 1427.40        | 1410.70 | 1143.97        | 1364.47        | 1388.23        | 1452.93        | 1337.40 |
| M <sub>1</sub> | 1485.93                 | 1655.00        | 1509.00        | 1548.80        | 1549.68 | 1372.03        | 1400.40        | 1381.63        | 1366.70        | 1380.19 |
| M <sub>2</sub> | 1437.43                 | 1503.80        | 1482.20        | 1559.43        | 1495.72 | 1401.10        | 1423.37        | 1404.13        | 1425.47        | 1413.52 |
| M <sub>3</sub> | 1435.50                 | 1587.80        | 1559.40        | 1503.40        | 1521.53 | 1453.57        | 1437.30        | 1390.70        | 1402.77        | 1421.08 |
| M <sub>4</sub> | 1383.93                 | 1636.97        | 1560.07        | 1442.77        | 1505.93 | 1449.33        | 1394.03        | 1394.10        | 1401.43        | 1409.73 |
| Mean           | 1412.26                 | 1565.25        | 1512.97        | 1496.36        |         | 1364.00        | 1403.91        | 1391.76        | 1409.86        |         |
|                | O.M.                    | C.F.           | C.F. × O.M.    |                |         | O.M.           | C.F.           | C.F. × O.M.    |                |         |
| S.E.±          | 14.41                   | 12.89          | 28.82          |                |         | 15.59          | 13.95          | 31.19          |                |         |
| C.D.@5%        | 41.25                   | 36.9           | 82.51          |                |         | 44.64          | NS             | 89.28          |                |         |

### Nutrient content in plant parts

Nitrogen concentration in rice straw and grain was significantly influenced by organic manure and fertilizer sources. Straw N ranged from 0.93% under farmyard manure (FYM) to 1.04% under *Gliricidia*, while grain N ranged from 1.35% under the control to 1.52% under

*Gliricidia* (Table 4). Among the fertilizer treatments, Konkan Annapurna Briquette (KAB) showed the highest straw N (1.03%), while UB-DAP had the highest grain N (1.56%). The organic manure × fertilizer interaction was non-significant for straw N but significant for grain N, with the highest grain N concentration (1.79%) observed

under FYM + UB-DAP. The higher N concentration under integrated nutrient treatments was linked with better N availability and uptake, mainly during grain development. Alike effects of integrated nutrient

management on N uptake and accumulation in rice have been opined by Bhardwaj *et al.* (2023)<sup>[28]</sup> and Shukla *et al.* (2024)<sup>[29]</sup>.

**Table 4.** Effect of different manures and fertilizers on plant nitrogen content (%) at harvest stages of rice

| Tr             | Straw (%)      |                |                |                |      | Grain (%)      |                |                |                |      |
|----------------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|
|                | F <sub>0</sub> | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean | F <sub>0</sub> | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean |
| M <sub>0</sub> | 0.84           | 0.99           | 1.07           | 0.99           | 0.97 | 1.10           | 1.26           | 1.58           | 1.45           | 1.35 |
| M <sub>1</sub> | 0.90           | 0.91           | 0.94           | 0.97           | 0.93 | 1.38           | 1.43           | 1.79           | 1.42           | 1.51 |
| M <sub>2</sub> | 0.92           | 1.10           | 1.07           | 1.07           | 1.04 | 1.43           | 1.54           | 1.57           | 1.55           | 1.52 |
| M <sub>3</sub> | 0.91           | 0.94           | 0.98           | 1.05           | 0.97 | 1.43           | 1.57           | 1.46           | 1.51           | 1.49 |
| M <sub>4</sub> | 0.97           | 1.05           | 1.06           | 1.05           | 1.03 | 1.35           | 1.49           | 1.38           | 1.42           | 1.41 |
| Mean           | 0.91           | 1.00           | 1.02           | 1.03           |      | 1.34           | 1.46           | 1.56           | 1.47           |      |
|                | O.M.           | C.F.           |                | C.F. × O.M.    |      | O.M.           | C.F.           |                | C.F. × O.M.    |      |
| S.E.±          | 0.02           | 0.01           |                | 0.03           |      | 0.02           | 0.02           |                | 0.05           |      |
| C.D.@5%        | 0.05           | 0.04           |                | NS             |      | 0.07           | 0.06           |                | 0.14           |      |

**Table 5.** Effect of different manures and fertilizers on plant phosphorus content (%) at harvest stages of rice

| Tr.            | Straw (%)      |                |                |                |      | Grain (%)      |                |                |                |      |
|----------------|----------------|----------------|----------------|----------------|------|----------------|----------------|----------------|----------------|------|
|                | F <sub>0</sub> | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean | F <sub>0</sub> | F <sub>1</sub> | F <sub>2</sub> | F <sub>3</sub> | Mean |
| M <sub>0</sub> | 0.06           | 0.12           | 0.13           | 0.12           | 0.11 | 0.10           | 0.30           | 0.27           | 0.21           | 0.22 |
| M <sub>1</sub> | 0.11           | 0.11           | 0.13           | 0.12           | 0.12 | 0.19           | 0.21           | 0.32           | 0.21           | 0.23 |
| M <sub>2</sub> | 0.11           | 0.13           | 0.13           | 0.13           | 0.13 | 0.16           | 0.22           | 0.20           | 0.35           | 0.23 |
| M <sub>3</sub> | 0.11           | 0.12           | 0.12           | 0.13           | 0.12 | 0.20           | 0.24           | 0.23           | 0.21           | 0.22 |
| M <sub>4</sub> | 0.11           | 0.13           | 0.12           | 0.14           | 0.13 | 0.19           | 0.23           | 0.31           | 0.23           | 0.24 |
| Mean           | 0.101          | 0.120          | 0.125          | 0.127          |      | 0.17           | 0.24           | 0.27           | 0.24           |      |
|                | O.M.           | C.F.           |                | C.F. × O.M.    |      | O.M.           | C.F.           |                | C.F. × O.M.    |      |
| S.E.±          | 0.01           | 0.005          |                | 0.01           |      | 0.02           | 0.02           |                | 0.04           |      |
| C.D.@5%        | NS             | 0.01           |                | NS             |      | NS             | 0.05           |                | 0.11           |      |

Phosphorus concentration in rice straw and grain was significantly affected by organic manure and fertilizer sources. Straw P ranged from 0.11% under the no-manure treatment to 0.13% under farmyard manure (FYM), *Gliricidia*, and bhend, however grain P ranged from 0.22% under the control and dhaincha to 0.24% under bhend (Table 5). Among the fertilizer sources, Konkani Annapurna Briquette (KAB) had the highest straw P (0.127%), but UB-DAP showed the highest grain P (0.27%). The manure × fertilizer interaction was non-significant for straw P but significant for grain P. The highest grain phosphorus (P) content (0.35%) was observed under *Gliricidia* + Konkani Annapurna Briquette (KAB), followed by bhend + UB-DAP (0.31%). The greater P concentration under integrated nutrient management directed better P availability and uptake subsequent from the corre-

sponding effects of organic residue decomposition and fertilizer-derived P supply. Similar improvements in P uptake under integrated nutrient management have been reported by Mitran and Mani (2017)<sup>[30]</sup> and Liu *et al.* (2024)<sup>[31]</sup>.

Potassium (K) concentration in rice straw and grain was influenced primarily by fertilizer sources, while the effect of organic manures was less pronounced. Straw K varied from 0.35% under the no-manure treatment to 0.41% under dhaincha, however grain K ranged from 0.16% under the control to 0.23% under bhend (Table 6). Among the fertilizer sources, KAB recorded the highest straw K (0.43%), while the recommended dose of fertilizer (RDF) showed the highest grain K (0.24%).

**Table 6.** Effect of different manures and fertilizers on plant potassium content (%) at harvest stages of rice

| Tr             | Straw (%)      |                |                |                |                | Grain (%)      |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                | F <sub>0</sub> | F <sub>1</sub> | F <sub>0</sub> | F <sub>1</sub> | F <sub>0</sub> | F <sub>1</sub> | F <sub>0</sub> | F <sub>1</sub> | F <sub>0</sub> | F <sub>1</sub> |
| M <sub>0</sub> | 0.28           | 0.36           | 0.34           | 0.43           | 0.35           | 0.12           | 0.18           | 0.16           | 0.18           | 0.16           |
| M <sub>1</sub> | 0.32           | 0.41           | 0.37           | 0.45           | 0.39           | 0.20           | 0.23           | 0.20           | 0.24           | 0.22           |
| M <sub>2</sub> | 0.39           | 0.37           | 0.33           | 0.40           | 0.37           | 0.18           | 0.25           | 0.23           | 0.23           | 0.22           |
| M <sub>3</sub> | 0.34           | 0.41           | 0.42           | 0.46           | 0.41           | 0.20           | 0.21           | 0.20           | 0.24           | 0.21           |
| M <sub>4</sub> | 0.39           | 0.39           | 0.38           | 0.40           | 0.39           | 0.20           | 0.23           | 0.22           | 0.26           | 0.23           |
| Mean           | 0.34           | 0.39           | 0.37           | 0.43           |                | 0.18           | 0.22           | 0.20           | 0.23           |                |
|                | O.M.           | C.F.           |                | C.F. × O.M.    |                | O.M.           | C.F.           |                | C.F. × O.M.    |                |
| S.E.±          | 0.02           | 0.02           |                | 0.04           |                | 0.01           | 0.01           |                | 0.02           |                |
| C.D.@5%        | NS             | 0.05           |                | NS             |                | 0.03           | 0.03           |                | NS             |                |

(continued on next page)

The manure effect was non-significant for straw K but significant for grain K, whereas the manure  $\times$  fertilizer interaction was non-significant for both straw and grain K. Numerically, the highest straw K (0.46%) was recorded under dhaincha + KAB and the highest grain K (0.26%) under bhend + KAB. The higher K concentration under fertilized treatments showed improved K availability and uptake, while organic manure application associated to nutrient recycling through residue decomposition. Similar improvements in K uptake under integrated nutrient management have been reported by Sethi *et al.* (2024) [32], Shukla *et al.* (2024) [29], and Liu *et al.* (2024) [31].

### Correlation among soil available nutrients and content

Correlation analysis showed positive relationships between soil available nitrogen (N), phosphorus (P), and potassium (K) at the maximum tillering and harvest stages, as well as with nutrient contents in rice grain and straw (Table 7). Soil available N at maximum tillering had a strong positive association with soil available P ( $r = 0.726^{**}$ ) and a moderate positive relationship with soil available K ( $r = 0.513^{**}$ ). Likewise, soil available P at harvest was positively associated with soil available K at harvest ( $r = 0.446^{**}$ ), signifying interrelationships among the available macronutrients during rice growth. Among the relationships between soil nutrients and grain nutrient contents, soil

available P at maximum tillering shown the solid positive correlation with grain N ( $r = 0.580^{**}$ ), followed by soil available P at harvest ( $r = 0.288^{**}$ ). Grain K was positively related with soil available N at harvest ( $r = 0.469^{**}$ ), soil available P at maximum tillering ( $r = 0.494^{**}$ ), and soil available K at maximum tillering ( $r = 0.316^{**}$ ). Grain P had positive correlations with soil available N, P, and K at both sampling stages, though the strength of these relationships varied.

Nutrient concentrations in rice straw also had positive relationships with soil nutrient availability. Straw N was strongly associated with soil available N at maximum tillering ( $r = 0.589^{**}$ ) and positively correlated with soil available P at harvest ( $r = 0.457^{**}$ ). Straw P had positive relationship with soil available N at maximum tillering ( $r = 0.468^{**}$ ) and soil available P at harvest ( $r = 0.491^{**}$ ). Straw K showed moderately weak relationships with soil nutrient availability; the relationship between straw K and soil available K at harvest was non-significant ( $r = 0.087$ ). Among plant nutrient contents, grain N was positively associated with grain P ( $r = 0.384^{**}$ ), but straw N was positively correlated with straw P ( $r = 0.496^{**}$ ). Grain and straw nutrient contents also had positive relationship with one another, but the strength of the relationships varied across nutrients. Similar relationships between soil nutrient availability,

**Table 7.** Correlation coefficients among soil available N, P and K at maximum tillering and harvest and nutrient content in rice grain and straw.

| Properties       |    | Available N |         | Available P |         | Available K |         | Grain N | Grain P | Grain K | Grain N | Grain P | Grain K |
|------------------|----|-------------|---------|-------------|---------|-------------|---------|---------|---------|---------|---------|---------|---------|
|                  |    | MT          | HS      | MT          | HS      | MT          | HS      |         |         |         |         |         |         |
| Available N      | MT | 1.000       |         |             |         |             |         |         |         |         |         |         |         |
|                  | HS | 0.355**     | 1.000   |             |         |             |         |         |         |         |         |         |         |
| Available P      | MT | 0.726**     | 0.400** | 1.000       |         |             |         |         |         |         |         |         |         |
|                  | HS | 0.584**     | 0.340** | 0.741**     | 1.000   |             |         |         |         |         |         |         |         |
| Available K      | MT | 0.513**     | 0.308** | 0.507**     | 0.350** | 1.000       |         |         |         |         |         |         |         |
|                  | HS | 0.240**     | 0.387** | 0.298**     | 0.446** | 0.256**     | 1.000   |         |         |         |         |         |         |
| Content in grain | N  | 0.332**     | 0.205** | 0.374**     | 0.580** | 0.406**     | 0.414** | 1.000   |         |         |         |         |         |
|                  | P  | 0.266**     | 0.120** | 0.212**     | 0.288** | 0.346**     | 0.244** | 0.384** | 1.000   |         |         |         |         |
|                  | K  | 0.428**     | 0.469** | 0.494**     | 0.385** | 0.316**     | 0.321** | 0.171** | 0.250** | 1.000   |         |         |         |
| Content in straw | N  | 0.589**     | 0.225** | 0.422**     | 0.457** | 0.213**     | 0.301** | 0.358** | 0.309** | 0.309** | 1.000   |         |         |
|                  | P  | 0.468**     | 0.416** | 0.411**     | 0.491** | 0.278**     | 0.387** | 0.430** | 0.327** | 0.357** | 0.496** | 1.000   |         |
|                  | K  | 0.289**     | 0.185** | 0.345**     | 0.296** | 0.210**     | 0.087ns | 0.171** | 0.087ns | 0.184** | 0.001ns | 0.277** | 1.000   |

MT = Maximum tillering stage, HS = Harvest stage, \* Correlation is significant at the 0.05 level (2-tailed), \*\* Correlation is significant at the 0.01 level (2-tailed), ns = non-significant

nutrient uptake, and rice productivity have been documented under integrated nutrient management systems (Mi *et al.*, 2018 [33]; Jun *et al.*, 2022 (Xie *et al.*, 2022) [34] [34, 33]. These findings showed that soil nutrient availability was correlated with nutrient accumulation in rice grain and straw, but the observed relations did not find contributing relationships.

### Conclusion

The study confirmed that the integrated application of organic manures and fertilizer sources improved soil nutrient availability and nutrient concentration in rice under coastal saline conditions. Among the organic manures, *Gliricidia* and dhaincha showed positive effect in improving available nitrogen (N) and phosphorus (P), respectively. Fertilizer sources enhanced soil nutrient availability and plant nutrient concentration, with responses varying according to the nutrient and growth stage. Among the integrated treatments, farmyard manure (FYM) + UB-DAP showed the highest grain N concentration (1.79%), while *Gliricidia* + Konkan Annapurna Briquette (KAB) had the highest grain P concentration (0.35%). KAB confirmed the highest straw potassium (K) concentration (0.43%), but the recommended dose of fertilizer (RDF) showed the highest grain K concentration

(0.24%). Correlation analysis further discovered positive relationship between soil nutrient availability and nutrient content in rice grain and straw. In general, the findings showed that integrated nutrient management can improve soil nutrient status and nutrient accumulation in rice grown under coastal saline conditions. Nevertheless, as the study was conducted for a single season, the findings are preliminary and require further confirmation through long-term and multi-season experiments under varying coastal saline conditions.

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### References

1. Dodake SB, Khobragade SS, Borse DK, Vaidya KP, Kaledhonkar MJ, Wahane MR, Palkar JJ. Effect of saline water irrigation on growth, yield and economics of spinach, radish and dill under coastal saline soils of North Konkan region of Maharashtra. *JSSWQ*. 2022;14(1):76–83.
2. Patil KD, Khobragade SS, Palkar JJ, Dodake SB, Wahane MR, Borse DK, Vaidya KP, Kaledhonkar MJ, Meena BL. Profitability of rainwater harvesting pond-based integrated farming systems in coastal plains of Western India: A Case Study. *JAEL*. 2024;61(2):219-231.

3. Dodake SB, Khobragade SS, Borse DK, Wahane MR, Vaidya KP, Kaledhonkar MJ, Meena BL. Effect of irrigation level and sowing date on yield of field bean in saline soils of Konkan region of Maharashtra. *JAEI*. 2023;60(1):100–107.
4. Khobragade SS, Vanave PB, Wahane MR, Bhangare KB, Kaledhonkar MJ, Borse DK, Meena RL, Meena BL, Dodake SB, Vaidya KP. Effect of manure and mulching under drip irrigation on salinity and yield of brinjal in coastal saline soils. *JSSWQ*. 2025;17(2):288–296.
5. Abhale SB, Wahane MR, Khobragade NH, Chavan VG, Dodake SB, Patil SS, Nevase SV, Pisal VV, Jagdish Prasad. Effect of organic manures and fertilizers on potassium fractions in coastal saline soil under rice. *J Indian Soc Soil Sci*. 2026;74(1):73–83.
6. Rakhonde SY, Jondhale DG, Wahane MR, Choudhari CS, Sambhare PP, Khedkar SM, Raut BV, Jadhav KW. Macro and micronutrients status in soils of khar land research station Girne, Raigad. *Int J Res Agron*. 2024;7(10):33–37.
7. Rakhonde SY, Jondhale DG, Wahane MR, Borse DK, Dodake SB, Khobragade NH, Kasture MC, Jagdish Prasad. Distribution of potassium fractions in soils under different land uses in coastal region of Raigad district, Maharashtra. *J Indian Soc Soil Sci*. 2025a;73(4):424–432.
8. Munns R, Tester M. Mechanisms of salinity tolerance. *Annu. Rev. Plant Biol*. 2008;59:651–681.
9. Gaikwad AR, Khobragade NH, Kasture MC, Meshram NA, Deshmukh SV, Rakhonde SY, Kamble SR, Purohit A, Wahane MR. Seasonal variation in water soluble ions in coastal saline soils during monsoon: A case study. *Int J Res Agron*. 2025;8(10):698–702.
10. Abhale SB, Wahane MR, Khobragade NH, Dodake SB, Chavan VG, Patil SS, Nevase SV. Integration of organic manures and inorganic fertilizers on soil properties at different growth stages and yield of paddy in coastal saline soil of Maharashtra. *Int J Res Agron*. 2024;7(10):306–312.
11. Vanave PB, Khobragade SS, Wahane MR, Bhangare KB, Kaledhonkar MJ, Meena RL, Meena BL, S Kumar, Dodake SB, Vaidya KP. Impact of manure and mulching under drip irrigation on salinity and tomato yield in coastal saline soil. *JISCAR*. 2026;44(1):52–63.
12. Rathod P, Salvi VG, Kamble M, Wahane MR. Effect of integrated nutrient management on micronutrient uptake, status, microbial count and yield of ridge gourd in lateritic soil. *JISCAR*. 2018;36(2):98–105.
13. Bedse TJ, Wahane MR, Jondhale DG, Khobragade NH, Dodake SB. Yield attributes, yield and nutrient uptake of rice (*Oryza sativa* L.) as influenced by zinc fortified briquettes in medium black soil. *Indian J Agric Res*. 2021;58:1198–1202.
14. Wahane MR, Bedse TJ, Jondhale DG, Khobragade NH, Dodake SB. Effect of zinc application on yield, nutrients uptake and biochemical properties of rice under Inceptisols. *Oryza*. 2022;59(4):434–442.
15. Wahane MR, Bedse TJ, Jondhale DG, Dodake SB. Significance of zinc fortified briquettes on soil properties, zinc concentration, uptake and economics of rice. *Commun. Soil Sci. Plant Anal*. 2023;54:855–863.
16. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. *Curr Sci*. 1956;25:259–260.
17. Olsen SR. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Department of Agriculture, Circular No. 939. 1954.
18. Jackson ML. Soil chemical analysis. Prentice Hall of India; 1973.
19. Tandon HLS. Methods of analysis of soils, plants, waters and fertilizers. Fertilizer Development and Consultation Organization. 1993.
20. Bhatt GD. Sesbania-a green manure for soil productivity and crop enhancement. *Int J Plant Env*. 2023;9(1):69–72.
21. Lyu H, Li Y, Wang Y, Wang P, Shang Y, Yang X, Yu A. Drive soil nitrogen transformation and improve crop nitrogen absorption and utilization-a review of green manure applications. *Front Plant Sci*. 2024;14:1305600.
22. Kumar N, Shambhavi S, Das A, Yasmeen S, Ganguly P, Kumar S, Rakshit R. Soil biological indicators associated with nitrogen mineralization patterns in rice soils under long-term integrated nutrient management. *Soil Use Manag*. 2024;40(1):e12963.
23. Hou Q, Ni Y, Huang S, Zuo T, Wang J, Ni W. Effects of substituting chemical fertilizers with manure on rice yield and soil labile nitrogen in paddy fields of China: A meta-analysis. *Pedosphere*. 2023;33(1):172–184.
24. Zhong J, Li Z, Tang H, Dong W, Wei C, He T. The application of varying amount of green manure combined with nitrogen fertilizer altered the soil bacterial community and rice yield in karst paddy areas. *BMC Plant Biol*. 2024;24(1):646.
25. Gu CM, Li YS, Yang L, Dai J, Hu W, Yu CB, Qin L. Effects of oilseed rape green manure on phosphorus availability of red soil and rice yield in rice-green manure rotation system. *Front Plant Sci*. 2024;15:1417504.
26. Wang X, Zheng H, Wu L, Ding X, Lu T. Responses of soil organic and inorganic carbon to organic and phosphorus fertilization in a saline-alkaline paddy field. *Geosci Lett*. 2023;10:15.
27. Rakhonde SY, Jondhale DG, Wahane MR, Borse DK, Dodake SB, Jagdish Prasad. Depth-wise Distribution of Potassium Fractions and Micronutrients and their Relationship in Coastal Saline Soils of Raigad, Maharashtra. *JISCAR*. 2025b;43(2):110–125.
28. Bhardwaj AK, Malik K, Chejara S, Rajwar D, Narjary B, Chandra P. Integration of organics in nutrient management for rice-wheat system improves nitrogen use efficiency via favourable soil biological and electrochemical responses. *Front Plant Sci*. 2023;13:1075011.
29. Shukla AK, Singh RR, Mishra T, Tripathi KM, Mishra S, Kumar D. Optimizing nutrient uptake in rice crops through integrated organic manure application: A comprehensive analysis of grain and straw composition. *Asian J. Soil Sci. Plant Nutr*. 2024;10(1):167–174.
30. Mitran T, Mani PK. Effect of organic amendments on rice yield trend, phosphorus use efficiency, uptake and apparent balance in soil under long-term rice-wheat rotation. *J. Plant Nutr*. 2017;40(9):1312–1322.
31. Liu D, Xiao Z, Zhang Z, Qiao Y, Chen Y, Wu H, Hu C. The crop phosphorus uptake, use efficiency and budget under long-term manure and fertilizer application in a rice-wheat planting system. *Agriculture*. 2024;14(8):1393.
32. Sethi S, Patel JN, Alam MS. Impact of integrated nitrogen management practices on nutrient content and their uptake by transplanted rice crop (*Oryza sativa* L.). *Int. J. Environ. Clim. Chang*. 2024;14(6):460–469.
33. Mi W, Sun Y, Xia S, Zhao H, Mi W, Brookes PC, Wu L. Effect of inorganic fertilizers with organic amendments on soil chemical properties and rice yield in a low-productivity paddy soil. *Geoderma*. 2018;320:23–29.

34. Xie J, Evgenia B, Zhang Y, Wan Y, Zhang CM, Wang J, Zhang YQ. Substituting nitrogen and phosphorus fertilizer with optimal amount of crop straw improves rice grain yield, nutrient use efficiency and soil carbon sequestration. *J Integr Agric.* 2022;21(11):3345-3355.

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## Authors

### SR Kamble

M.Sc. (Agri.), Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri (M.S.), 415 712, India.

### MR Wahane

Jr. Soil Scientist, Khar Land Research Station, Panvel, Dist. Raigad (M.S.), India

### MC Kasture

Professor and Head Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dapoli Ratnagiri (M.S.), 415712, India.

### VG Chavan

Associate Professor (CAS) Department of Agronomy, College of Agriculture, Dapoli Ratnagiri (M.S.), 415712, India.

### NA Meshram

Scientist (S-I), AICRP on Agroforestry, Dr. B.S.K.K.V., Dapoli Ratnagiri (M.S.), 415712, India.

### NH Khobragade

Assistant Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri (M.S.), 415712, India.

### AD Kuwar

M.Sc. (Agri.), Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri (M.S.), 415 712, India.

### SS Patil

M.Sc. (Agri.), Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri (M.S.), 415 712, India.

### SB Abhale

Ph.D. Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.), 44404, India.