Organic Manure Seed Pelleting for Enhancing Soil Properties, Nutrient Uptake and Yield of Rice

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ABSTRACT

Background: Seed pelleting involves the sticking of target materials on to the surface of seeds. Pelleted seeds make planting of small seeds much easier by altering their shape, size and density. The call out on organic farming explains the requisite of user friendly and ecofriendly technique for seed management practices. The current study aimed to assess the effect of organic manure seed pelleting for enhancing soil properties, nutrient uptake and yield of rice.

Methods: A pot culture experiment was carried out at College of Agriculture, Vellayani during the year 2018-19 to prepare organic manure seed pellets for rice and to evaluate its influence on yield, nutrient uptake and soil nutrient status. Pelleting materials were prepared using various treatment combinations namely, FYM + Azospirillum + Phosphobacteria (T1), vermicompost + Azospirillum + Phosphobacteria (T2), bio-slurry flakes + Azospirillum + Phosphobacteria (T3), charcoal powder + Azospirillum + Phosphobacteria (T4), fly ash + Azospirillum + Phosphobacteria (T5), pongamia leaf powder + Azospirillum + Phosphobacteria (T6) and bio-slurry + plant extracts + Azospirillum + Pseudomonas (T7: Farmer practice).

Result: The results revealed that the highest grain yield (54.84 g pot⁻¹) and straw yield (66.10 g pot⁻¹) were recorded by T3. With regard to the uptake of nutrients, T3 registered the highest uptake of N, K, Ca, S, Zn, Cu and Si in grain and shoot. P uptake in grain was highest in the treatment T5 while T7 had the maximum P uptake in shoot. Nutrient status of the post-harvest soil was significantly influenced by the treatments.

Key words: Nutrient, Organic manure, Rice, Seed pelleting, Uptake, Yield.

INTRODUCTION

Rice (Oryza sativa L.) is a short duration crop which grows well in humid tropical regions. It is an important food crop in the world and staple food of more than 50 per cent of world population. China has the largest share in world rice production with an annual production of 208.10 million metric tons followed by India with 169.50 million metric tons. In Kerala, the area under rice cultivation is 1.98 lakh hectares with a total production of 5.77 lakh tonnes and a productivity of 2.92 tonnes per hectare (GoK, 2018).

The generally practiced conventional rice planting methods are transplanting, broadcasting and dibbling (KAU, 2011). Though these methods are widely acceptable among farmers, they often have some limitations. The rutted germination in broadcasting leads to overcrowding and the arbitrary transplanting method makes it arduous to maintain optimum plant density. Direct seeding leads to a substantial loss of seeds, non-uniform germination and thereby yield reduction. The limitations of these conventional methods can be overcome by seed treatment methods such as pelleting.

Seed pelleting is a technique of seed encapsulation with inert materials to change their size and shape (Jyoti and Bhandari, 2016). Pelleting increases the weight, size and shape of seed thereby reducing seed rate and improves germination. Seed pelleting aid in rigorous application of nutrients and accelerate germination and seedling emergence which is beneficial over conventional dibbling method. It stimulates the micro environment of seed by providing growth promoting substances and precludes the loss of materials as in broadcasting. Seed pelleting increases tillering with more shoot and root biomass.

Organic manure seed pelleting method is gaining popularity among farmers (Manoj, 2015). Farmers use several organic sources with varying levels of nutrients. Numerous studies have been done on seed pelleting in various crop. Hence, the present study was undertaken with the objective to assess the effect of organic manure seed pelleting for enhancing soil properties, nutrient uptake and yield of rice.

MATERIALS AND METHODS

Rice seed pelleting materials were prepared with different organic manures and microbial inoculants like FYM +...
Azospirillum + Phosphobacteria (T<sub>3</sub>), vermicompost + Azospirillum + Phosphobacteria (T<sub>3</sub>), bioslurry flakes + Azospirillum + Phosphobacteria (T<sub>3</sub>), charcoal powder + Azospirillum + Phosphobacteria (T<sub>3</sub>), fly ash + Azospirillum + Phosphobacteria (T<sub>3</sub>), charcoal powder + Azospirillum + Phosphobacteria (T<sub>3</sub>), pongamia leaf powder + Azospirillum + Phosphobacteria (T<sub>3</sub>), and bioslurry + plant extracts + Azospirillum + Pseudomonas (T<sub>3</sub>, Farmer practice).

FYM, vermicompost and charcoal powder were collected locally. Bioslurry flakes were prepared after drying biogas slurry. Pongamia leaf collected from the college premises were dried, powdered and used. Leaves of cowpea (Vigna unguiculata), gliricidia (Gliricidia maculata) and kilukki (Crotalaria juncea) were mixed in equal proportion by weight, moistened and kept in earthen pot for two weeks and the extract was collected.

Carrier based inoculum of Azospirillum and Phosphobacteria were used at the rate of 5 g kg<sup>-1</sup> and fenugreek (Trigonella foenum-graecum) paste was added at the rate of 25 g kg<sup>-1</sup> as adhesive. Fenugreek paste was prepared by grinding fenugreek after soaking overnight in water.

**Experimental site, design and treatments**

The organic manure seed pellets were evaluated in a pot culture experiment laid out at College of Agriculture, Vellayani, in Completely Randomized Design (CRD) with 8 treatments replicated 4 times with the test crop rice variety Uma. Organic manure seed pellets were prepared using the 7 pelleting materials with one seed per pellet. The treatments included Control treatment T<sub>C</sub> (seed alone without pelleting) and the 7 organic manure seed pellets (T<sub>1</sub> to T<sub>7</sub>). The pots required for the pot culture experiment were filled with 20 kg of experimental soil. Lime and FYM were applied on soil weight basis. Planting was done at the rate of one seed per pot for T<sub>C</sub> and one pellet per pot for the remaining treatments. Fertilizer application and crop management practices were done as per package of practices (KAU, 2011).

**Characterization of organic manure pellets**

Bulk density of organic manure pelleting material was determined using tap volume (Saha et al., 2010). Water holding capacity was measured using Keen Rackowski box method. pH and Electrical Conductivity (EC) were measured after extraction with distilled water (1:5) using pH and EC meter, respectively. Ammoniacal and nitrate nitrogen were determined by macrokjeldahl distillation and titrimetry after extraction with 2M KCl (Hesse, 1971). Total P and K were determined using spectrophotometer and flame photometer, respectively. Total Ca and Mg were estimated using Versanate titration method. Total micronutrients were determined using atomic absorption spectrometry. Total S was determined using turbidimetry. Total B was determined by Azomethine-H method using spectrophotometry. Urease activity was estimated using colorimetric determination of NH<sub>4</sub><sup>+</sup> released by p-dimethyl amino benzaldehyde (Porter, 1965). Acid phosphatase activity was analysed using colorimetric estimation of p-nitro phenol released (Tabatabai and Brenner, 1969). Dehydrogenase activity was estimated using colorimetric determination of 2,3,5-triphenyl formazan (Casida et al., 1964). Humic and fulvic acid were separated by extraction with 0.5 N sodium hydroxide for 12 hours followed by acidification with concentrated HCl (Jackson, 1973).

**Soil and plant analysis**

Soil samples were analysed for pH, EC, ammoniacal nitrogen, nitrate nitrogen, available P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B following standard procedures. Yeld and yield attributes like productive tillers, length of panicle, spikelets per panicle, filled grain %, 1000 grain weight were recorded. Plant samples were collected at harvest and analysed for total N, P, K, Ca, Mg, S, Zn, Cu and Si. Total Si was estimated using blue siliconolybdous acid method (Ma et al., 2002). Nutrient uptake was calculated from the nutrient content and dry matter weight of samples.

**Statistical analysis**

The data obtained from the experiment were analysed statistically using OPSTAT software. The critical difference (CD) was compared to assess the significance of treatment means at 5 % level of probability.

**RESULTS AND DISCUSSION**

Characterization of organic manure pelleting materials (Table 1) revealed that T<sub>3</sub> (fly ash + Azospirillum + Phosphobacteria) recorded the highest bulk density of 1.07 Mg m<sup>-3</sup> which might be due to the high bulk density of fly ash (1-1.8 Mg m<sup>-3</sup>) (Kishor et al., 2010). The highest water holding capacity (380.8 %) was recorded by T<sub>1</sub> (pongamia leaf powder + Azospirillum + Phosphobacteria) and this might be due to the presence of functional groups having more affinity towards water as well as hydration of colloids in pongamia leaf powder (Prakash et al., 2018). All pelleting materials recorded near neutral to slightly alkaline pH. The highest EC was recorded by T<sub>3</sub> (bioslurry flakes + Azospirillum + Phosphobacteria) which might be due to the release of soluble salts.

There was no significant difference among the treatments for ammoniacal and nitrate nitrogen. The P content of pelleting materials varied significantly and the highest (1.36 %) was estimated in T<sub>3</sub> (bioslurry flakes + Azospirillum + Phosphobacteria) which is attributed to the higher P content in bioslurry (Jeptoo et al., 2013). The highest K content (1.18 %) was in T<sub>3</sub> (pongamia leaf powder + Azospirillum + Phosphobacteria). Ramanjaneyulu et al. (2017) observed that pongamia leaves have a K content of 1.30 per cent. With respect to secondary nutrients, the highest content of Ca, Mg and S were recorded by T<sub>3</sub> Malav et al. (2015) reported that digested bioslurry contains nutrients such as Ca, Mg and S. T<sub>3</sub> (fly ash + Azospirillum + Phosphobacteria) recorded the highest value for Fe (1.62 %). This is possibly due to the presence of Fe in fly ash.
**Table 1:** Characterization of organic manure pelleting materials.

| Parameters                  | FYM | Vermicompost | Phosphobacteria, T. | Phosphobacteria, T. + Azospirillum | Phosphobacteria, T. + Pseudomonas | T. + Fly ash | Bioslurry | Plant extracts | Bioslurry + Fly ash | Phosphobacteria, T. + Pseudomonas |
|-----------------------------|-----|--------------|---------------------|-------------------------------------|-----------------------------------|--------------|-----------|----------------|-------------------|-----------------------------------|
| Bulk density (Mg m\(^{-3}\)) | 0.38\(^{b}\) | 0.86\(^{b}\) | 0.57\(^{b}\) | 0.59\(^{b}\) | 0.59\(^{b}\) | 0.59\(^{b}\) | 0.59\(^{b}\) | 0.59\(^{b}\) | 0.59\(^{b}\) | 0.59\(^{b}\) |
| Water holding capacity (%)  | 253\(^{c}\) | 129\(^{c}\) | 126\(^{c}\) | 120\(^{c}\) | 120\(^{c}\) | 120\(^{c}\) | 120\(^{c}\) | 120\(^{c}\) | 120\(^{c}\) | 120\(^{c}\) |
| pH                          | 8.03\(^{a}\) | 7.41\(^{a}\) | 7.51\(^{a}\) | 7.46\(^{a}\) | 7.46\(^{a}\) | 7.46\(^{a}\) | 7.46\(^{a}\) | 7.46\(^{a}\) | 7.46\(^{a}\) | 7.46\(^{a}\) |
| EC (dS m\(^{-1}\))          | 3.12\(^{b}\) | 3.12\(^{b}\) | 3.12\(^{b}\) | 3.12\(^{b}\) | 3.12\(^{b}\) | 3.12\(^{b}\) | 3.12\(^{b}\) | 3.12\(^{b}\) | 3.12\(^{b}\) | 3.12\(^{b}\) |
| Organic N (%)               | 0.008 | 0.006 | 0.007 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Nitrates (%)                | 0.002 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| C (%)                       | 0.71\(^{b}\) | 0.71\(^{b}\) | 0.71\(^{b}\) | 0.71\(^{b}\) | 0.71\(^{b}\) | 0.71\(^{b}\) | 0.71\(^{b}\) | 0.71\(^{b}\) | 0.71\(^{b}\) | 0.71\(^{b}\) |
| C/N                         | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| Mn (mg kg\(^{-1}\))         | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| Fe (mg kg\(^{-1}\))         | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Zn (mg kg\(^{-1}\))         | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Cu (mg kg\(^{-1}\))         | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Urease (g of urea g\(^{-1}\) manure h\(^{-1}\)) | 8.46 | 8.46 | 8.46 | 8.46 | 8.46 | 8.46 | 8.46 | 8.46 | 8.46 | 8.46 |
| Acid phosphatase (µg of P in 0.50 ml of manure h\(^{-1}\)) | 29.5 | 29.5 | 29.5 | 29.5 | 29.5 | 29.5 | 29.5 | 29.5 | 29.5 | 29.5 |
| Dehydrogenase (µg of TPF g\(^{-1}\) manure 24 h\(^{-1}\)) | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 |
| Fulvic acid (%)             | 23.34 | 23.34 | 23.34 | 23.34 | 23.34 | 23.34 | 23.34 | 23.34 | 23.34 | 23.34 |
| Humic acid (%)              | 20.34 | 20.34 | 20.34 | 20.34 | 20.34 | 20.34 | 20.34 | 20.34 | 20.34 | 20.34 |

**Table 2:** Effect of organic manure seed pelleting on yield attributes and yield of rice.

| Treatment                          | 1000 grain weight (g) | Straw yield (g) | Filled grain (g) | Spikelet tillers (per panicle) | Plant height (cm) | Panicle weight (g) | Weight of 1000 seeds (g) |
|------------------------------------|-----------------------|-----------------|------------------|--------------------------------|-------------------|-------------------|-------------------------|
| FYM + Azospirillum                  | 24.22                 | 22.66            | 24.22            | 114 (w)                        | 90.5               | 15.5              | 15.5                    |
| FYM + Azospirillum + Pseudomonas    | 26.63                 | 25.10            | 26.63            | 135 (w)                        | 92.5               | 16.3              | 16.3                    |
| FYM + Azospirillum + Phosphobacteria | 26.63                 | 25.10            | 26.63            | 135 (w)                        | 92.5               | 16.3              | 16.3                    |
| FYM + Azospirillum + Phosphobacteria + Pseudomonas | 24.22 | 22.66 | 24.22 | 114 (w) | 90.5 | 15.5 | 15.5 |

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Chemically, 95-99 per cent of fly ash consists of oxides of Si, Al, Fe and Ca and remaining 0.5-3.5 per cent is Na, P, K, Mg, Mn and S (Nawaz, 2013). Mn, Zn and Cu content were highest in T₃ (Malav et al. 2015) reported that biogas slurry contains micronutrients such as Cu (0.004 ppm), Mn (0.008 ppm) and Zn (0.023 ppm). The B content was the highest in T₃ (vermicompost + Azospirillum + Phosphobacteria).

Enzymatic activity of pelleting materials was significantly influenced by the treatments (Table 1). T₂ (pongama leaf powder + Azospirillum + Phosphobacteria) registered the highest urease (51.65 ppm of urea g⁻¹ soil h⁻¹) and acid phosphatase activity (113.1 µg of p-nitrophenol g⁻¹ soil h⁻¹). This might be due to the presence of specific substrate in pongama leaf powder which would have favoured the colonization of microbes enhancing urease and acid phosphatase activities. Dehydrogenase activity was maximum in T₃ (vermicompost + Azospirillum + Phosphobacteria). Carpenter-Boggs et al. (2000) reported that microbial biomass, respiration and dehydrogenase activity increased with addition of compost.

Table 1 indicates that humic and fulvic acid content were highest in T₃ (vermicompost + Azospirillum + Phosphobacteria). The castings of red worm contain high per cent of humic acid and this serves as binding sites for nutrients such as Ca, Fe, K, S and P (Adhikary, 2012). The per cent of humic acid remained high in all treatments as humic acid fraction is more stable than fulvic acid fraction. Organic manure seed pelleting significantly influenced yield and yield attributes (Table 2). T₃ (vermicompost + Azospirillum + Phosphobacteria) registered the maximum number of productive tillers (16.50) while T₁ recorded the lowest value (9.00). T₃ recorded the maximum number of spikelets per panicle (159.7) which was on par with T₁ (158.3) while the lowest value of 114.4 was recorded by T₄. Similar trend was observed with respect to filled grain per cent which varied from 72.59 % to 94.16 %. Vermicompost contains significant quantities of nutrients and N mineralization activates various enzymes and produce hormones which are involved in cell expansion which might have contributed to higher yield characters. This was in line with the findings of Atiyeh et al. (2002). Increment of yield attributes in T₃ might be due to higher uptake of nutrients and more dry matter content. Thirunavukkarasu and Vinoth (2013) observed that addition of vermicompost increased the number of productive tillers in rice and was attributed to the higher availability of nutrients from vermicompost.

The grain and straw yield of rice were significantly influenced by organic manure seed pelleting. T₃ (vermicompost + Azospirillum + Phosphobacteria) recorded the highest value for grain yield (54.84 g pot⁻¹) and straw yield (66.10 g pot⁻¹) while the lowest was recorded by T₁ (control) with values of 35.63 g pot⁻¹ and 43.98 g pot⁻¹, respectively (Table 2). This substantiates with the findings of Thirunavukkarasu and Vinoth (2013) that addition of vermicompost increased yield attributing characters and finally yield. Influence of T₃ on increasing nutrient availability and uptake could have contributed to increase in grain and straw yields. This was in conformity with the findings of Arancon et al. (2005).

The pH and EC of post-harvest soil were significantly influenced by treatments (Table 3). The pH of soil after harvest ranged from 5.52 to 5.77. The highest pH was observed in T₃ which was on par with T₂. This might be due to the presence of carbonates and hydroxide salts in fly ash which would have reduced soil acidity (Das, 2011). T₄ (bioslurry flakes + Azospirillum + Phosphobacteria) had the highest value of EC (0.363 dS m⁻¹). This can be attributed to the release of soluble salts from bioslurry flakes.

Organic manure seed pelleting significantly influenced available nutrient status of soil. Fig 1 shows that T₂ (FYM + Azospirillum + Phosphobacteria) recorded maximum value for ammoniacal N (50.40 mg kg⁻¹). This might be attributed to decomposition and gradual mineralization of nutrients from FYM. Similar results were reported by Sommer and
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Hutchings (2011). Data presented in Table 3 shows that $T_5$ (bioslurry flakes + Azospirillum + Phosphobacteria) recorded the highest (34.36 mg kg$^{-1}$) available P. Organic manure seed pelleting had a significant influence on available K in soil. It ranged from 40.00 mg kg$^{-1}$ in $T_1$ to 85.00 mg kg$^{-1}$ in $T_2$. Exchangeable Ca and available S were maximum in $T_2$ with values 285.0 mg kg$^{-1}$ and 16.50 mg kg$^{-1}$ respectively. This might be due to the high Ca and S content in bioslurry. The results are in line with the findings of Islam et al. (2010) who observed that addition of bioslurry apparently increased the availability of macro nutrients. $T_3$ (vermicompost + Azospirillum + Phosphobacteria) influenced micronutrients such as Fe, Mn and Zn (Table 3). This might be due to the release of micronutrients from vermicompost leading to increased availability. This is in accordance with the findings of Srivastava et al. (2011). $T_2$, $T_3$ and $T_5$ registered highest values for available B (0.22 mg kg$^{-1}$) in soil.

The experimental results with respect to uptake of nutrients in grain and shoot are presented in Table 4. Results on N uptake in grains indicated that $T_5$ (vermicompost + Azospirillum + Phosphobacteria) recorded the highest value (0.99 g pot$^{-1}$) which was on par with $T_2$ (0.98 g pot$^{-1}$). N uptake in shoot ranged from 0.26 g pot$^{-1}$ ($T_1$) to 0.51 g pot$^{-1}$ ($T_2$). The increase in N uptake might be due to the enhanced availability of N in vermicompost. $T_5$ (bioslurry flakes + Azospirillum + Phosphobacteria) recorded the highest P uptake in grain (0.08 g pot$^{-1}$). The P uptake in shoot (0.14 g pot$^{-1}$) was maximum in $T_3$. With respect to K uptake in grain, $T_3$ registered the highest value and was on par with $T_5$ (0.26 g pot$^{-1}$). $T_2$ recorded maximum K uptake in shoot (1.25 g pot$^{-1}$) while $T_5$ recorded the lowest value (0.58 g pot$^{-1}$). Ca uptake in grain and shoot was highest in $T_3$ with values 0.30 g pot$^{-1}$ and 0.20 g pot$^{-1}$ respectively. There was no significant difference in Mg uptake by grain and shoot. S uptake in grain (0.029 g pot$^{-1}$) and shoot (0.045 g pot$^{-1}$) was maximum in $T_3$. $T_2$ also recorded the highest Zn uptake of grain (3.81 mg pot$^{-1}$) and shoot (4.47 mg pot$^{-1}$). Cu uptake in grain and shoot was significantly influenced by $T_5$ with values 1.00 mg pot$^{-1}$ and 1.48 mg pot$^{-1}$ respectively. The uptake of B in grain and shoot was maximum in $T_5$ and both were on par with $T_4$. Grain and shoot uptake of Si was maximum in $T_5$ with values of 2.49 g pot$^{-1}$ and 4.50 g pot$^{-1}$ respectively.

The higher uptake of nutrients in grain and shoot in $T_5$ might be due to increased tiller number, dry matter, higher yield attributes as well as grain and straw yield and also due to the influence of vermicompost. Vermicompost has the ability to hold more nutrients due to the presence of microorganisms facilitated by high surface area of vermicompost (Atiyeh et al., 2002). Vermicompost would have promoted microbial activity resulting in nutrient mobilization leading to more uptake of nutrients. Similar results were reported by Prasad et al. (2010) and Thirunavukkarasu and Vinoth (2013). Release of nutrients due to the production of organic acids by decomposition of vermicompost and release of

### Table 3: Effect of organic manure seed pelleting on pH, EC and available nutrients in soil.

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
|------------|-------|-------|-------|-------|-------|
| pH (dS m$^{-1}$) | 5.69 | 5.71 | 5.52 | 5.58 | 5.77 |
| EC (dS m$^{-1}$) | 0.351 | 0.351 | 0.351 | 0.351 | 0.351 |
| Available P (mg kg$^{-1}$) | 3.48 | 3.48 | 3.48 | 3.48 | 3.48 |
| Available K (mg kg$^{-1}$) | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 |
| Available Ca (mg kg$^{-1}$) | 78.75 | 78.75 | 78.75 | 78.75 | 78.75 |
| Available Mg (mg kg$^{-1}$) | 27.25 | 27.25 | 27.25 | 27.25 | 27.25 |
| Available S (mg kg$^{-1}$) | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| Available Fe (mg kg$^{-1}$) | 11.28 | 11.28 | 11.28 | 11.28 | 11.28 |
| Available Zn (mg kg$^{-1}$) | 3.42 | 3.42 | 3.42 | 3.42 | 3.42 |
| Available Cu (mg kg$^{-1}$) | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Available B (mg kg$^{-1}$) | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |

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### Table 4: Effect of organic manure seed pelleting on nutrient uptake in rice.

| Parameters | T<sub>1</sub> | T<sub>2</sub> | T<sub>3</sub> | T<sub>4</sub> | T<sub>5</sub> | T<sub>6</sub> | T<sub>7</sub> | T<sub>8</sub> |
|------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| N          | 0.52±0.09    | 0.69±0.05    | 0.69±0.07    | 0.63±0.08    | 0.63±0.11    | 0.67±0.08    | 0.77±0.06    | 0.80±0.09    |
| P          | 0.14±0.04    | 0.15±0.05    | 0.15±0.05    | 0.14±0.04    | 0.18±0.05    | 0.20±0.04    | 0.22±0.05    | 0.21±0.04    |
| K          | 0.28±0.01    | 1.25±0.03    | 1.25±0.03    | 1.25±0.03    | 1.25±0.03    | 1.25±0.03    | 1.25±0.03    | 1.25±0.03    |
| Ca         | 0.07±0.02    | 0.14±0.03    | 0.14±0.03    | 0.14±0.03    | 0.14±0.03    | 0.14±0.03    | 0.14±0.03    | 0.14±0.03    |
| Mg         | 0.08±0.02    | 0.20±0.04    | 0.20±0.04    | 0.20±0.04    | 0.20±0.04    | 0.20±0.04    | 0.20±0.04    | 0.20±0.04    |
| S          | 0.03±0.01    | 0.04±0.01    | 0.04±0.01    | 0.04±0.01    | 0.04±0.01    | 0.04±0.01    | 0.04±0.01    | 0.04±0.01    |
| Zn         | 0.02±0.00    | 0.03±0.00    | 0.03±0.00    | 0.03±0.00    | 0.03±0.00    | 0.03±0.00    | 0.03±0.00    | 0.03±0.00    |
| Si         | 1.07±0.02    | 2.14±0.05    | 2.14±0.05    | 2.14±0.05    | 2.14±0.05    | 2.14±0.05    | 2.14±0.05    | 2.14±0.05    |
| **SEm (±)**| **0.11**     | **0.22**     | **0.22**     | **0.22**     | **0.22**     | **0.22**     | **0.22**     | **0.22**     |

T<sub>1</sub>: Control (Seeds alone without pelleting), T<sub>2</sub>: FYM + Azospirillum + Phosphobacteria, T<sub>3</sub>: Vermicompost + Azospirillum + Phosphobacteria, T<sub>4</sub>: Bioslurry + Azospirillum + Phosphobacteria, T<sub>5</sub>: Fly ash + Azospirillum + Phosphobacteria, T<sub>6</sub>: Charcoal powder + Azospirillum + Phosphobacteria, T<sub>7</sub>: Pongamia leaf powder + Azospirillum + Phosphobacteria, T<sub>8</sub>: Bioslurry + Plant extracts + Azospirillum + Pseudomonas.
various substances promoting growth would have resulted in higher nutrient uptake and dry matter yield (Prakash and Bhadoria, 2003).

CONCLUSION
It can be concluded that the yield and nutrient uptake of rice was significantly influenced by organic manure seed pelleting. It was highest in the treatment where vermicompost, Azospirillum and Phosphobacteria were used as the pelleting material. Seed pelleting using vermicompost, Azospirillum and Phosphobacteria and bioslurry flakes, Azospirillum and Phosphobacteria were able to maintain significantly higher quantities of available nutrients in soil.

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