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Effect of integrated nutrient management on rice yield parameter's and nutrient uptake

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Abstract
The field experiments were conducted to evaluate combination of inorganic fertilizers along with organic manures at the Experimental Farm, Department of Agronomy, Annamalai University, Tamil Nadu. The treatments were tested in Split- plot Design and replicated thrice. It was observed that the growth and yield attributes of rice crop *viz*., no. of panicle m^{-2}, no. of filled grains $panicle^{-1}$ and nutrient uptake were favourably influenced by combined application of inorganic fertilizers and organic manures. The effect of application of 125% NPK + Vermicompost 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + Foliar application of Sea weed extract @ 0.2% at 15 and 30 DAT influenced the growth of rice and recorded highest in all aspects no. of panicles m^{-2} and no. of filled grains $panicle^{-1}$ and NPK uptake which was on par with the application of 125% NPK + Vermicompost 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1}.

Keywords: INM, organic manure, yield attributes, nutrient uptake, vermicompost

Introduction
Rice is grown worldwide including Asia, North and South America, European Union, Middle Eastern and African countries. Rice is the world's most important food for more than half of the world population. Rice is cultivated in 117 countries across the world. More than 90 per cent of the world's rice is grown and consumed in Asia (Seema *et al*., 2014) [11]. Nitrogen is required by plants in the processes of photosynthesis and is involved in the energy reactions in the form of ATP; a key component of chlorophyll, proteins and enzymes and assists the plants in the synthesis and use of carbohydrates (Mengel and Kirkby, 2001; Sara *et al*., 2013) [8, 10].
Phosphorus plays a crucial role in the root proliferation, consistent grain filling and higher grain yield and quality as well being a constituent of nucleotides such as in ADP and ATP energy bonds and also being involved in many processes such as photosynthesis, mitotic activities, tissue growth and development (Bhattacharyya and Jain, 2000) [4]. Potassium is an important plant nutrient and is required in higher amount especially for rice. Potassium is essential for the maintenance of electrical potential across cellular membranes and cellular turgor enhancing the cell expansion and enlargement, opening and closing of stomata and pollen tube development. It is also involved in activation of many enzymes, translocation of nitrate and sucrose (Britto and Kronzucker, 2008) [6].
Vermicompost is a good quality organic fertilizer. Vermicompost is the decomposition product of organic solid waste by earthworms gut and egested as casts (Janagan *et al.* 2003) [7].
Biofertilizers provide eco-friendly organic agro input and are most cost effective than chemical fertilizers (Amudha *et al*., 2014) [1]. Biofertilizers are living cells of different types of microorganisms (bacteria, fungi and algae) which have an ability to mobilize nutritionally important elements from non-usable form. These microorganisms require organic matter for their growth and activity in soil and provide valuable nutrients to the plant. (Saini *et al.*, 2004) [9]. Microbiological fertilizers are important to environment friendly and sustainable agricultural practices (Bloemberg *et al*., 2000) [5]. A compost biofertilizer inoculums containing both Azospirillum and Phosphobacteria is known as Azophos. The main advantage of this single biofertilizer containing both ''N'' fixer and phosphorus solubilizer and it is less expensive, easy to use and also better efficacy of both organisms in mixed culture.
Seaweeds constitute the most essential live organisms used on a wide scale commercially and the extracts from seaweeds are commonly called as seaweed liquid fertilizer (SWLF) (Bai *et al.*, 2007) [2].

Materials and methods
The field experiment was conducted to study the effect of INM on rice at Experimental Farm, Department of Agronomy, Annamalai University, with rice Var Co- 51.

The research comprised of main plot M_1: 150% NPK, M_2: 125% NPK, M_3: 100% NPK, M_4: 75% NPK. Sub-plot: S_1: FYM 12.5 t ha^{-1}, S_2: FYM 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla 10 kg ha^{-1}, S_3: vermicompost 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla 10 kg ha^{-1}, S_4: Soil application Humic Acid @ 30 kg ha^{-1} at 15, 30 and 45 DAT + Foliar application of Humic Acid @ 0.3% at 15, 30 and 45 DAT + Azophos @ 25 kg ha^{-1} + Azolla 10 kg ha^{-1}, S_5: vermicompost 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla 10 kg ha^{-1} + Foliar application of Seaweed extract @ 0.2% at 15 and 30 DAT, S_6: Soil application Humic Acid @ 30 kg ha^{-1} at 15, 30 and 45 DAT + Foliar application of Humic Acid @ 0.3% at 15, 30 and 45 DAT + Azophos @ 25 kg ha^{-1} + Azolla 10 kg ha^{-1} + Azolla 10 kg ha^{-1} + Foliar application of Seaweed extract @ 0.2% at 15 and 30 DAT.

Results and discussion

Yield parameters

No. of panicles m^{-2} and no. of filled grains panicle^{-1}

A significant difference in number of panicle m^{-2} was recorded at harvest stage as a result of INM practices.

Among the treatments, M_2- 125% NPK gave the highest mean number of panicles m^{-2} (346.03) of for experiment-I as well as (327.30) for experiment-II. The least was recorded in M_4- 75% NPK gave lowest panicles m^{-2} (209.39) for experiment-I as well as (166.00) for experiment-II respectively.

Regarding the sub treatments *i.e*., Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (S_5) recorded the highest number of panicles m^{-2} of (293.22) for experiment-I as well as (264.92) for experiment-II respectively, which was with on par with Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_3). The least panicles m^{-2} of (250.38) for experiment-I as well as (228.49) for experiment-II respectively, was obtained with FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_2).

There was significant interaction between the inorganic fertilizer and organic manures application on rice for number panicle m^{-2}. The treatment combination of 125% NPK+ Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (M_2S_5) recorded highest number panicle m^{-2} (378.96) for experiment-I as well as (345.78) for experiment-II respectively. The least number of panicle m^{-2} (191.28) for experiment-I (147.91) for experiment-II respectively, was recorded by the treatment 75% NPK + FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (M_4S_2).

Number of filled grains panicle^{-1} at harvest was significantly influenced by application of INM.

Among the treatments, M_2- 125% NPK gave the highest mean number of filled grains panicles^{-1} of (96.16) for experiment-I as well as (93.52) for experiment-II respectively. The least number of filled grains panicles^{-1} was recorded in M_4- 75% NPK gave lowest number of filled grains panicles m^{-1} of (63.80) for experiment-I as well as (58.17) for experiment-II respectively.

Regarding the sub treatments *i.e*., Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (S_5) recorded the highest number of filled grains panicles^{-1} of (83.64) for experiment-I as well as (79.82) for experiment-II respectively, which was on par with Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_3). The least number of filled grains panicles^{-1} (76.27) for experiment-I as well as (71.82) for experiment-II respectively, was obtained with FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_2).

There was significant interaction between the inorganic fertilizer and organic manures application on rice for number panicle m^{-2}. The treatment combination of 125% NPK+ Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (M_2S_5) recorded highest number of filled grains panicle^{-1}of (99.86) for experiment-I as well as (97.59) for experiment-II respectively. The least number of filled grains panicle^{-1} of (60.18) for experiment-I as well as (54.21) for experiment-II respectively, was recorded by the treatment 75% NPK + FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (M_4S_2). The variation in no. of panicle m^{-2} with integration of nutrients due to the availability and translocation of nutrients as well as photosynthesis from source to sink resulting in increased no. of panicle m^{-2} and no. of filled grains panicle^{-1}. The increase in yield attributes of rice with use of integrated sources of plant nutrients might be due to availability of plant nutrient for longer period of crop growth. Similar results have also been in line by Suresh *et al*., (2013) [12].

Nutrient Uptake

NPK Uptake

Higher ''N''uptake by rice observed under the application INM practices. Application M_2- 125% NPK gave the highest mean nitrogen uptake by plant of (153.91) for experiment-I as well as (147.41) for experiment-II. The least nitrogen uptake by plant was recorded in M_4- 75% NPK gave lowest ''N'' uptake (136.40) for experiment-I as well as (133.21) for experiment-II respectively.

Regarding the sub treatments *i.e*., Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (S_5) recorded the highest nitrogen uptake by plant of (147.04) for experiment-I as well as (142.00) for experiment-II respectively, which was on par with Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_3). The least nitrogen uptake by plant of (142.95) for experiment-I as well as (138.72) for experiment-II respectively, was obtained with FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_2).

There was significant interaction between the inorganic fertilizer and organic manures application on rice for nitrogen uptake. The treatment combination of 125% NPK+ Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (M_2S_5) recorded highest nitrogen uptake by plant (155.91) for experiment-I as well as (149.07) for experiment-II. The least nitrogen uptake by plant of (134.09) for experiment-I as well as (131.58) for experiment-II respectively, was recorded by the treatment 75% NPK + FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (M_4S_2). The INM practices promoted nutrient utilization, accumulating for better NPK uptake of rice. Increased uptake might be due to higher availability of nutrients from the soil reservoir and also from the added sources of organic manures. The results were inconformity with the findings of Balamurugan and Sudhakar (2012) [3].

Higher ''P'' uptake by rice observed under the application of INM practices. Application of M_2- 125% NPK gave the highest mean phosphorus uptake by plant of (29.14) for

experiment-I as well as (28.72) for experiment-II respectively. The least phosphorus uptake by plant was recorded in M_4- 75% NPK gave lowest ''P'' uptake of (23.84) for experiment-I as well as (23.76) for experiment-II respectively.

Regarding the sub treatments *i.e*., Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (S_5) recorded the highest phosphorus uptake by plant of (27.17) for experiment-I as well as (26.89) for experiment-II respectively, which was on par with Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_3). The least phosphorus uptake by plant of (25.86) for experiment-I as well as (25.60) for experiment-II respectively, was obtained with FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_2).

There was significant interaction between the inorganic fertilizer and organic manures application on rice for phosphorus uptake. The treatment combination of 125% NPK+ Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (M_2S_5) recorded highest phosphorus uptake by plant of (29.75) for experiment-I as well as (29.29) for experiment-II respectively. The least phosphorus uptake by plant (23.16) for experiment-I as well as (22.91) for experiment-II respectively, was recorded by the treatment 75% NPK + FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (M_4S_2).

Higher ''K'' uptake by rice was observed under the application of INM practices. Application of M_2- 125% NPK gave the highest mean potassium uptake by plant (179.51) of for experiment-I as well as (174.78) for experiment-II. The least potassium uptake by plant was recorded in M_4- 75% NPK gave lowest ''K'' uptake (158.05) for experiment-I as well as (154.70) for experiment-II respectively.

Regarding the sub treatments *i.e*., Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (S_5) recorded the highest potassium uptake by plant of (171.24) for experiment-I as well as (167.00) for experiment-II respectively, which was on par with Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_3). The least potassium uptake by plant of (166.34) for Navarai season as well as (162.44) for Kuruvai season respectively, was obtained with FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (S_2).

There was significant interaction between the inorganic fertilizer and organic manures application on rice for potassium uptake. The treatment combination of 125% NPK+ Vermicompost @ 5 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} + foliar application of Sea Weed Extract @ 0.2% at 15 and 30 DAT (M_2S_5) recorded highest potassium uptake by plant of (181.92) for experiment-I as well as (177.08) for experiment-II respectively. The least potassium uptake by plant of (155.59) for experiment-I as well as (152.46) for experiment-II respectively, was recorded by the treatment 75% NPK + FYM @ 6.25 t ha^{-1} + Azophos @ 25 kg ha^{-1} + Azolla @ 10 kg ha^{-1} (M_4S_2).

Conclusion

Yield attributes and nutrient uptake of rice were increased due affect of integration of nutrients into the field. Application of balanced nutrients through inorganic fertilizers and organic manure shows positively impact on rice plant, which utilized all combined nutrients accumulates and transfer into food materials to the plants.

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