



Effect of organic and inorganic nutrient management practices on economics of low land rice

Biswanath Ganguly, Imayavaramban V, Murugan G

Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

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 higher net income and B:C ratio of rice crop influenced by combined application of inorganic fertilizers and organic manures. The effect of application of 150% of recommended NPK + 75% of recommended dose of Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT. This was on par with 125% of recommended NPK + 75% of recommended dose of Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT.

Keywords: inorganic and organic manure, economic

Introduction

The association between rice and human community could clearly be revealed from the Archeological excavations made at He-my-du, Luo-jia-jiao and Pen-tou-shan in China where rice was the principal food plant for more than 7000 years ago (Chandrasekaran *et al.*, 2013). It is the second most widely consumed cereal next to wheat and it has occupied an area of 153.47 million ha with the production of 505.01 million tonnes of grains (USDA, 2021). In Tamilnadu rice is the prime food crop with the contribution of around eight per cent to the total national production from an area of 2.08 million ha with the production of 7.56 million tonnes through the average per hectare productivity of 3.40 tonnes (MoA, 2019) ^[11]. While considering both the national and state level per hectare productivities they are far below the average productivities of other rice producing countries *viz.*, Egypt with 7.5 t ha⁻¹, China with 6.7 t ha⁻¹, Japan with 6.5 t ha⁻¹ and Israel with 5.5 t ha⁻¹ (Harikarasuthan, 2011) ^[8]. Although sixteen numbers of nutrients constituted of macro, secondary and micronutrients are required for optimal growth and establishment of crop plants, the major nutrient elements *viz.*, nitrogen, phosphorus and potassium are essentially needed for varied metabolic process of crop plants, while nitrogen is the key nutrition synthesis of ATP. It is the prime component of chlorophyll, proteins and enzymes and it also assists the plants in synthesis and utilization of carbohydrates (Mengel and Kirkby, 2001; Sara *et al.*, 2013) ^[10, 18]. Phosphorus being a constituent of nucleotides such as in ADP and ATP energy bonds, it involved in many processes such as mitotic activities, tissue growth and development (Bhattacharyya and Jain, 2000) ^[2]. The crop plants could not achieve its maximum yield potentials without supply of adequate phosphorus (Alam *et al.*, 2009; Murtaza *et al.*, 2014) ^[1, 12]. It also play a crucial role in root proliferation, consistent grain filling and quality. Similarly, potassium is essential for the maintenance of electrical potential across cellular membranes and cellular turgor, which permits cell expansion and enlargement, opening and closing of stomata and pollen tube development. Further, it is also an activator of many enzymes and it also involved in translocation of nitrate and sucrose (Britto and Kronzucker, 2008) ^[3]. The farmyard manure (FYM) is the only available bulky organic manure which is being utilized for crop production by the farmers for the past several decades. It is a mixture of cattle dung, urine, litter or bedding material, portion of fodder not consumed by cattle and domestic wastes. Application of farmyard manure improves the soil fertility (Gora *et al.*, 2017) ^[12]. Its incorporation, significantly improves soil physico-chemical characteristics, prevents soil erosion improves soil organic carbon content, enhances microbial activity, neutralizers soil pH, minimizes the electrical conductivity and furthermore the decomposed FYM, act as an 'chelate', which would retains the nutrient elements within its biomass and release them as and when the crop require. However, is becoming scarcely available, due to drastically dwindling cattle population. However, its timely inavailability escorted cost factor, the cumbersome and the extended time involvement for its transportation limits its usage. Vermicompost consisted of varied plant growth hormones, high load of beneficial soil microbes, enzymes and it also tend to hold more nutrient elements over longer period of time without adverse impacts on the environment (Ndegwa and Thompson, 2001) ^[13]. Despite the beneficial impact of vermicompost on soil and crops, the farmers are reluctant to utilize this organic input component due to the prevailing high input cost. Further, at present the production of vermicompost was almost maintaining at

minimal level due to the declined availability of primary raw materials like pressmud and farmyard manure besides its cumbersome, production and procedures. Pressmud rich in essential plant nutrients *viz.*, organic carbon, nitrogen, phosphorus, potassium, calcium, magnesium along with traces of Zn, Fe, Cu and Mn micronutrients for promoting appropriate crop growth and productivity, which leads towards sustainable crop production, despite appreciable improvements in soil health (Ramaswami 1999 and Kumar *et al.*, 2017) ^[16, 9]. Although pressmud is being recommended organic components for several crops, its high quantum of recommendation, accompanied with cumbersome process in its transportations declines its mass usage. Under such situations the sugar factories aerated the raw pressmud in wind rows to minimize the surplus temperature generated during cane crushing and the subsequent pressmud production, further, the bio-inoculants like *Pseudomonas*, Effective microbial consortia (EMS), *Azospirillum*, *Phosphobacteria* and *Azotobacter* were mixed to the pressmud in appropriate quantities for decomposition and nutrient enrichment, to obtain enriched pressmud. Biofertilizers are living cells of different microorganisms (bacteria, fungi and algae) which have an ability to convert nutritional elements of usable fixed forms to readily available form for easier crop uptake and it also provides varied nutrients substitution for the crop plant (Saini *et al.*, 2004) ^[17]. A compost biofertilizer inoculums containing both *Azospirillum* and *Phosphobacteria* is known as 'Azophos'. The main advantage of this biofertilizer mixture constitutes both 'N' fixer and phosphorus solubilizer and it is less expensive, easy for usage and also has better efficacy of both organisms in mixed culture. Seaweeds also constitutes ample quantities of proteins, lipids, minerals and vitamins (Norziah *et al.*, 2002) ^[14]. Seaweed as soil incorporation improves the soil fertility, moisture holding capacity and the soil structure (Dhargalkar and Neelam Peseira, 2005). Hence, the usage of seaweed extract especially in organic farming is one of the ideal and safe way to conserve environmental resources devoided with pollution hazards (Devi and Mani, 2015) ^[5].

Materials and Methods

The field experimental 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

A. Main: Plot (NPK doses)

M₁: 100% of recommended NPK

M₂: 125% of recommended NPK

M₃: 150% of recommended NPK

B. Sub: Plot (Organic inputs levels)

S₁: 100% of recommended dose of FYM @ 12.5 t ha⁻¹

S₂: 75% of recommended dose of FYM @ 9.5 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT.

S₃: 50% of recommended dose of FYM @ 6.25 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT.

S₄: 75% of recommended dose of Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT.

S₅: 50% of recommended dose of Vermicompost @ 2.50 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT.

S₆: 75% of recommended dose of fortified pressmud @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT.

S₇: 50% of recommended dose of fortified pressmud @ 2.5 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT.

Results and Discussion

Economics (Table 1)

The data on economics of cost of cultivation, gross return, net return and benefit cost ratio. Integrated nutrient management practices exerted marked influenced on economics of rice cultivation.

Interaction among the inorganic and organic sources of nutrients, the gross return and net return varied to a considerable extent. The Higher gross return (R 132146) and net return (R 65245) and B: C ratio (R 1.97) were realized in the rice crop under INM with the application of 150% of recommended NPK + 75% of recommended dose of Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT (M₃S₄). Next promising treatment combination is 125% of recommended NPK + 75% of recommended dose of Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT (M₂S₄) which gave the gross return (R 125944) and net return (R 61386) and B:C ratio (R 1.95). The lower gross return (R 104921) and net return (R 45841) and B: C ratio (R 1.78) were obtained under 100% of recommended NPK + 50% of recommended dose of fortified pressmud @ 2.5 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT (M₁S₇).

The higher gross return (R 132146) and net return (R 65245) and B: C ratio (R 1.97) were realized in the rice crop under INM with the application of 150% of recommended NPK + 75% of recommended dose of

Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT (M₃S₄). Next promising treatment combination is 125% of recommended NPK + 75% of recommended dose of Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT (M₂S₄) which gave the gross return (R 125944) and net return (R 61386) and B:C ratio (R 1.95). The lower gross return (R 104921) and net return (R 45841) and B:C ratio (R 1.78) was obtained 100% of recommended NPK + 50% of recommended dose of fortified pressmud @ 2.5 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT (M₁S₇). Among the main plot treatments, application of 150% of recommended NPK (M₃) has registered higher net return ha⁻¹ and return rupee⁻¹ invested. This might be due to higher grain yield and straw yield. With respect to subplot treatments, 75% of recommended dose of Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT (S₄) has registered higher net return ha⁻¹ and return rupee⁻¹ invested. Among the various treatment combinations, 150% of recommended NPK + 75% of recommended dose of Vermicompost @ 3.75 t ha⁻¹ + Azophos @ 10 kg ha⁻¹ + *in situ* application of Azolla @ 10 kg ha⁻¹ on 10 DAT + foliar application of seaweed extract @ 2.0% on 15 and 30 DAT (M₃S₄) has registered higher net return ha⁻¹ and return rupee⁻¹ invested. This might be due to higher grain yield and straw yield. Despite the addition of input cost involved, the substantial yield increment obtained with this treatment combination have resulted in increased net income and benefit cost ratio. The above results are in accordance with the earlier findings of Ram *et al.* (2020).

Table 1: Economics

Treatments	Cost of cultivation (R ha ⁻¹)	Gross return (R ha ⁻¹)	Net return (R ha ⁻¹)	B:C Ratio
M ₁ S ₁	62580	112326	49746	1.79
M ₁ S ₂	62180	115301	53121	1.85
M ₁ S ₃	59330	104112	44782	1.75
M ₁ S ₄	62456	120443	57987	1.93
M ₁ S ₅	59330	108022	48962	1.82
M ₁ S ₆	62086	110906	48820	1.79
M ₁ S ₇	59080	104921	45841	1.78
M ₂ S ₁	64683	120257	55574	1.85
M ₂ S ₂	64283	122204	58001	1.90
M ₂ S ₃	61433	112308	50875	1.82
M ₂ S ₄	64558	125944	61386	1.95
M ₂ S ₅	61433	116278	54845	1.89
M ₂ S ₆	64183	119134	54951	1.85
M ₂ S ₇	61183	112249	51066	1.83
M ₃ S ₁	67026	124921	57895	1.86
M ₃ S ₂	66626	127785	61159	1.95
M ₃ S ₃	63776	118655	54879	1.85
M ₃ S ₄	66901	132146	65245	1.97
M ₃ S ₅	63776	119913	56137	1.88
M ₃ S ₆	66526	122705	56179	1.84
M ₃ S ₇	63526	116060	52534	1.82

Conclusion

The present study clearly demonstrates that shifting from conventional rice cultivation method to an sustainable rice cultivation approached integrated nutrient management can reduce the cost of production with similar and increase gross return, net return and B: C ratio.

References

1. Alam MM, Ali MH, Amin AKMR, Hasanuzzaman M. Yield attributes, yield and harvest index of three irrigated rice varieties under different levels of phosphorus. *Adv. Biol. Res.*,2009;3:132-139.
2. Bhattacharyya P, Jain RK. Phosphorus solubilizing biofertilizers in the whirlpool of rock phosphate-challenges and opportunities. *Fert. News*,2000;45:45-51.
3. Britto DT, Kronzucker HJ. Cellular mechanisms of potassium transport in plants. *Physiol. Plant*,2008;133:637-650.
4. Chandrasekaran S, Ramanathan S, Basak T. Microwave food processing–A review. *Food Res.Int.*,2013;52(1):243-261.
5. Devi, Leindah N, Mani S. Effect of seaweed saps *Kappaphycus alvarezii* and *Gracilaria* on growth, yield and quality of rice. *Indian Journal of Science and Technology*,2015;8:1-6.
6. Dhargalkar VK, Pereira N. Seaweed: promising plant of the millennium. *Sci. Cult.*,2005;71:60-66.

7. Gora MK, Choudhary RR, Sharma OP, Shankar Lal Choudhary. Effect of organic manures and molybdenum on growth, yield and quality of Groundnut. *Int. J. Curr. Microbiol. And Appl. Sci*,2017;6(6):736-742.
8. Harikarasuthan V, Vilavasi Uyarvuku Karanam Yenna? *Dailymalar*, 2011, 3.
9. Kumar S, Meena RS, Jinger D, Jatav HS, Banjara T. Use of pressmud compost for improving crop productivity and soil health. *Int. J. Chem. Stud*,2017;5:384-389.
10. Mengel K, Kirkby EA. Boron: In principles of plant nutrition, 5 th ed. Kluwer Academic Publishers (5th ed.) Dordrecht, Boston, London, Netherlands, 2001.
11. MoA (Ministry of Agriculture). Agricultural statistics, 2019. www.agricoop.nic.in.
12. Murtaza G, Zohaib A, Hussain S, Rasool T, Shehzad H, Ehsanullah. The influence of rhizobium seed inoculation and different levels of phosphorus application on growth, yield and quality of mashbean (*Vigna mungo* L.). *Intl. J. Mod. Agri*,2014;3:92-96.
13. Ndegwa PM, Thompson SA. Integrating composting and vermicomposting in the treatment of bioconversion of biosolids. *Biores. Technol*,2001;76:107-112.
14. Norziah MH, Ching Y. Nutritional composition of edible seaweeds- (*Gracilaria changgi*). *Food Chem*,2002;68:69-76.
15. Ram MS, Shankar T, Maitra S, Duvvada SK. Effect of integrated nutrient management on growth, yield, nutrient content and economics of summer rice (*Oryza sativa* L.). *Ind. J. Pure App. Biosci*,2020;8:421-427.
16. Ramaswami PP. Recycling of agricultural and agro-industry wastes for sustainable agriculture production. *J. Indian Soc. Soil Sci*,1999;47:661-665.
17. Saini V, Berwal R, Sharma J, Singh A. Biofertilizers: current status and perspectives in agriculture. *Poll. Res*,2004;23:665-676.
18. Sara S, Morad M, Reza CM. Effects of seed inoculation by Rhizobium strains on chlorophyll content and protein percentage in common bean cultivars (*Phaseolus vulgaris* L.). *Intl. J. Biosci*,2013;3:1-8.
19. USDA. Table 11 rice area, yield and production. United States Department of Agriculture, Foreign Agriculture Service, 2021.