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Research Article

Effect of Integration of Organic and Inorganic Sources of Nitrogen on Rice (*Oryza sativa* l.) Yield

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ABSTRACT

Field experiments were conducted during Kharif-2017 and 2018 at ICAR-Krishi Vigyan Kendra (KVK), Mangaluru of coastal Karnataka to study the effect of integration of organic and inorganic sources of nitrogen on the yield of midland rice. The results indicated that the integration of organic and inorganic sources of nitrogen significantly influenced the growth and yield attributes of rice. The highest grain yield (5434 and 5372 kg ha^{-1}) and straw yield (6817 and 6927 kg ha^{-1}) were recorded in the treatment comprising VC substituted with 50 percent recommended dose of nitrogen which was on par with PM substituted at 50 percent in both the years. A similar trend was also noticed in both the years for the growth and yield parameters where the highest plant height (94.93 and 96.30 cm) highest productive tillers (16.85 and 18.12) and longer panicle length (17.54 and 18.65 cm) was recorded in the treatment where 50 percent nitrogen was substituted by vermicompost compared to control. The remaining treatments of organic substitution ratios with urea also had a beneficial effect on yield and yield parameters of rice compared to control.
Keywords: Fish manure, Nitrogen Management, Organic, Poultry Manure, Rice, Vermicompost

INTRODUCTION

Rice (*Oryza sativa* L) is one of the most important cereal crops in the world. It is a staple food for half of the world population Globally, rice is cultivated in an area of 162 million ha with a production of 461 million tons (Anonymous, 2015). In India, rice occupies an area of 43.19 million ha with a production of 110.15 million tons. (Anonymous, 2017). India has the largest area and is the second-highest producer of rice in the world. It is a staple food for more than two-thirds of the Indian population contributing more than 40 percent of the total grain production (Pathak *et al.*, 2018). However, the productivity of rice is only 2.55 t/ha (milled rice) which is less compared to global productivity of 3.28 t/ha (Anonymous,2018). Sustainable, profitable, and resilient smallholder agriculture is the key to food and nutritional security for the growing populations of India. With the growing population and increase in demand for rice, there is a need to re-orient the research efforts to ensure higher productivity with environmental-friendly technologies (Samal, 2013). Increasing the productivity remains the main challenge since 40 percent of the rice cultivation area is grown under rainfed condition and 90 percent of the cultivated area belong to small farmers. The challenge is to integrate productivity and profitability improvement in rice while enhancing the climate resilience and quality of the environment on which production depends. (Pathak *et al.*, 2018). Fertilizers have contributed substantially to nearly 50 percent of rice varietal yield potential. However, a part of the applied N and P fertilizers are not utilized by the crop and are lost to the environment, and such losses significantly contribute to the reduction in the efficiency of fertilizer usage and greater environmental pollution (Zhang *et al*.,2013)

Nitrogen (N) is the most essential nutrient element in rice which plays a crucial role in enhancing the yield by promoting rapid plant growth and improving grain yield and quality (Prathap *et al*., 2019). An adequate supply of nitrogen is essential throughout the growing period of rice for realizing potential yields (Sureka *et al.*,2016). Globally rice cultivation consumes approximately 9-10 million tons of fertilizer nitrogen per year which accounts for about 10 percent of the total N fertilizer production in the world (Nayak *et al.*, 2018). The impact of increased fertilizer use on crop production has been large but the ever-increasing cost of energy is an important critical factor limiting for increased usage of inorganic fertilizer (Alim,2012). Among the various factors contributing to rice productivity in India, nitrogen fertilizer contributes nearly 47 percent for increased rice yield. However, the nitrogen use efficiency (NUE) is less (30-40 percent) and its overuse has led to environmental issues due to losses of nitrogen in form of volatilization, denitrification, and leaching under flooded conditions. (Prasad *et al.*, 2014). Achieving high NUE in rice production has become a major challenge with increasing food demand, depletion of natural resources, and environmental deterioration. Therefore, the development of an efficient N management strategy for sustaining soil fertility and maximizing crop yields by integration of organic manure with inorganic fertilizers is essential to achieve sustained production of rice and maintain the soil fertility for a longer period. (Gill and Walia, 2014). Integration of organic manure (Vermicompost/Poultry manure/ Fish manure) in the rice production system which helps to improve soil structure, microbial activity and contributes to rice production is receiving the attention of research workers worldwide (Mohana *et al*,2019). This will recycle organic wastes and minimize the adverse environmental effects of mineral-fertilizer overuse.

Numerous studies of the beneficial effect of the long-term application of organic and inorganic fertilizer on rice yield have been reported by many research workers. (Han *et al.*, 2020, Qaswar *et al*.,2020). In these studies, organic amendments were added based on chemical fertilizer dosage such that total nutrient amounts in the field were increased. However, little information is available regarding rice yield responses to integrated application of organic and inorganic sources of nitrogen in coastal Karnataka. Therefore, the present study was conducted to evaluate the influences of organic substitution regimes under different organic-inorganic substitution ratios on yield and yield attributes in Kharif- rice.

MATERIALS AND METHODS

The experiment was conducted during kharif of 2017 and 2018. in the field of ICAR-Krishi Vigyan Kendra, Mangaluru of coastal Karnataka to study the response of rice to the integration of organic and inorganic sources of nitrogen under the midland situation. The results of the composite soil sample of the experimental site collected before experimentation indicated that soil was lateritic characterized by acidic pH (5.5) and EC value was 0.14 DSM^{-1}. The soil fertility status of the experimental field contained medium available nitrogen (380 kg ha^{-1}), high available phosphorus (97.4 kg ha^{-1}), and low available potassium (96.13 kg ha^{-1}). The experiment was laid out in randomized block design (RBD) with three replications. There was eleven treatment comprising combinations of three organic manures with mineral fertilizer urea where nitrogen was substituted at 25,50 and 100 percent along with control and recommended package of practices (POP). Well decomposed Vermicompost (VC), Poultry Manure (PM), and Fish manure (FM) were used in the experiment as the organic source. Based on an equal nitrogen basis, required quantities of organic manures treatment-wise were incorporated into the soil 20 days before rice transplanting. The popular medium duration rice variety MO-4 (Bhadra) was raised in a nursery in June-2017 and 22-day old seedlings were transplanted during the first week of July 2017 and 2018 at a spacing of 20 cm x 10 cm. The recommended dose of fertilizers (60:30:60 NPK kg N ha^{-1}) was applied. Nitrogen was applied in three equal splits at the transplanting, tillering, and panicle initiation stage. Recommended crop management practices and plant protection measures were followed. The rainfall received during for the crop growth period (June to October) was 3245 mm and 2792 mm during 2017 and 2018 espectively. Biometric observations were recorded at harvest for yield and yield-related parameters. The data on all parameters were analyzed statistically following analysis of variance (ANOVA) according to methods described for randomized block design (Gomez and Gomez,1984) and the treatment means were compared using the least significant difference (LSD) test ($p<0.05$).

RESULTS AND DISCUSSION

The effect of organic and inorganic sources of nitrogen on the growth and yield attributes of rice over two years are presented in Table-1. The results indicated that plant height and number of effective tillers hill^{-1} were significantly influenced by the application of organic and inorganic sources of nitrogen in both years. During 2017, the highest plant height (94.93 cm) at harvest was recorded in treatment T4 (POP+50 percent VC) which was significantly (<0.05) higher than control (72.15 cm) but was on par with T6 (POP+50 percent PM) which was recorded plant height of 92.17 cm. In 2018 the highest plant height (96.30 cm) at harvest was recorded in treatment T4 (POP+50 percent VC) which was significantly (<0.05) higher than control (75.60 cm) but was on par with T6- 50 RDN through PM (94.93 cm). The significant increase in plant height with the application of VC could be attributed to greater availability and steady release of N and other nutrients from VC by accelerated activities of microorganisms in the soil. Nitrogen increases the chlorophyll content at all growth stages as it is a constituent and might have increased the photosynthesis resulting in increased plant height. During 2017, the maximum number of effective tillers hill^{-1} (16.85) were recorded in treatment T4

(POP+50 percent VC) which was significantly (<0.05) higher compared to T1-control (9.23). This was followed by treatment T6-POP+50 percent PM (15.48). A similar trend was also noticed in the second year (2018) where the maximum number of effective tillers hill^{-1} (18.12) were recorded in treatment T4 (POP+50 percent VC) which was significantly (<0.05) higher compared to T1-control (8.52). This was followed by treatment T6-POP+50 percent PM (15.76). The variations in the availability of nitrogen and other nutrients from the organic sources during panicle formation and development could have led to an increase in the number of effective tillers. These findings are supported by Miller (2007) who reported that organic sources offer more balanced nutrition to the plants, especially micronutrients which positively affect the number of tillers.

The yield attributing characters namely panicle length, grain yield, and straw yield of rice was significantly influenced by integrated N application through organic and inorganic sources and showed a similar trend during both years. During the year 2017, the treatment T4-POP with 50 percent VC recorded significantly (<0.05) higher panicle length (17.54 cm) compared to T1-control (11.09 cm). This was followed by treatment T6-POP + 50 percent PM (16.60 cm). a similar trend was observed in the second year where the treatment T4-POP with 50 percent VC recorded significantly (<0.05) higher panicle length (18.65 cm) compared to T1-control (10.23 cm). The panicle length recorded for different combinations of organic and inorganic sources of nitrogen was higher compared to control. The grain yield recorded at harvest was significantly (<0.05) higher in T4-POP+ 50 percent VC (5434 and 5372 kg ha^{-1}) compared to T1-control (3541 and 5372 kg ha^{-1}) over two years. This was followed by T6-POP+50 percent PM which recorded grain yield 5240 kg ha^{-1} and 5348 kg ha^{-1} during 2017 and 2018 respectively. The straw yield also followed a similar trend with T4-POP+ 50 percent VC recording significantly higher yield (6817 and 6927 kg ha^{-1}) compared to T1-control (4426 and 4576 kg ha^{-1}) over two years viz.2017 and 2018. The significant improvement in yield and yield parameters of rice might be attributed to balanced availability of nutrients, presence of beneficial microflora and plant growth regulators like gibberellin, auxins, etc present in VC which might have resulted in the positive conversion of the source to sink reflecting in form of higher panicle length, grain and straw yield. Manivannan and Sriramachandrashekharan (2016) recorded higher grain and straw yield with vermicompost substituted at 50 percent of recommended nitrogen in rice compared to control but was on par with poultry manure substituted at 50 percent of recommended nitrogen. Paramesh *et al.* (2014) reported that substituting 50 percent of recommended nitrogen with vermicompost had a beneficial effect on plant height, leaf area, number of tillers hill^{-1} grain, and straw yield in rice. Mondal *et al*., (2016). reported the beneficial effect of mustard cake as organic manure when used at 50 percent of the recommended dose of nitrogen in rice.

Table 1. Effect of organic and inorganic sources of nitrogen on growth and yield of rice at harvest

Treatments	Plant height (cm)		Effective tillers hill $^{-1}$		Panicle length (cm)		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	Kharif-2017	Kharif-2018	Kharif-2017	Kharif-2018	Kharif-2017	Kharif-2018	Kharif-2017	Kharif-2018	Kharif-2017	Kharif-2018
Control	72.15	75.60	09.23	8.52	11.09	10.23	3541	3864	4426	4576
POP	85.67	86.32	11.65	12.41	14.24	15.36	4586	4648	5732	5872
POP +25% N through VC	89.70	92.03	14.38	15.62	16.17	17.82	4732	4865	5915	5936
POP +50% N through VC	94.93	96.30	16.85	18.12	17.54	18.65	5434	5372	6817	6927
POP +25% N through PM	86.59	88.27	14.23	15.86	15.10	16.23	4680	4761	5850	5974
POP +50% N through PM	92.17	94.93	15.76	16.45	16.60	17.28	5240	5348	6550	6620
POP +25% N through FM	88.50	89.60	13.28	14.82	14.85	15.62	4554	4667	5692	5780
POP +50% N through FM	90.97	93.90	15.48	16.05	15.25	16.72	4784	4889	5980	5996
100% N through VC	92.63	94.63	14.50	15.60	16.39	17.48	5123	5234	6403	6488
100% N through PM	92.64	94.23	13.20	14.28	15.52	16.35	4935	5034	6168	6267
100% N through FM	92.47	93.26	12.60	13.26	15.15	16.31	4886	4965	6107	6242
SEm $\pm$	2.07	1.84	0.80	0.96	0.86	1.23	196	208	293	164
CD (5%)	6.12	5.44	2.34	3.42	2.54	3.56	576	614	859	485

POP=Package of Practices: VC= vermicompost. PM= Poultry Manure. FM= Fish manure.
Recommended dosage of fertilizers=60:30:60 kg ha^{-1} N, P_2O_5, K_2O.

CONCLUSION

The integration of organic sources in the nutrient management of rice can help to maintain or improve soil productivity. The approach to improve the productivity, profitability, soil health, and quality of products through the locally available resources like vermicompost, poultry manure, and fish manure will attract the farmers for effective recycling of farm wastes. From the present study, it can be concluded that integrating organic sources of nitrogen at different substitution ratios had a beneficial effect on rice yield. The treatment T4-POP with 50 percent VC recorded significantly higher plant height, productive tillers hill$^{-1,}$ panicle length, grain yield, and straw yield at harvest compared to control followed by treatment T6-POP with 50 percent through PM. It can be concluded that integrated use of organic manure (VC, PM, and FM) with inorganic fertilizers could be beneficial to maintain sustainable rice production in coastal Karnataka

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