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Debasis Das
Ph.D., Scholar, Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Sunil Kumar
Sr. Scientist, IGKV, Raipur, Chhattisgarh, India

Annie Poonam
Principal Scientist, ICAR-NRRI, Cuttack, Odisha, India

Debarati Bhaduri
Senior Scientist, ICAR-NRRI, Cuttack, Odisha, India

Rasmirekha Pattnaik
Assistant Professor, Department of Agronomy, Sri University, Cuttack, Odisha, India

Omprakash Rajwade
Ph.D., Scholar, Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Jitendra K Nayak
Assistant Professor, Department of Agronomy, SOA, Bhubaneswar, Odisha, India

Corresponding Author:
Debasis Das
Ph.D., Scholar, Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Effect of organic nutrient management on growth and yield attributes of rice (*Oryza sativa* L.) Cultivars under transplanted condition

Debasis Das, Sunil Kumar, Annie Poonam, Debarati Bhaduri, Rasmirekha Pattnaik, Omprakash Rajwade and Jitendra K Nayak

Abstract
A field experiment was conducted during kharif 2017 at ICAR-National Rice Research Institute, Cuttack (Odisha) on "Effect of organic nutrient management on growth and yield attributes of rice (*Oryza sativa* L.) Cultivars under transplanted condition". The soil was acidic in reaction and medium in fertility levels having available nitrogen, phosphorus and potassium content were low, high and medium, respectively. In experiment, treatments comprised of two cultivars (Ketekijoha and Padmini) in main plots and in sub plots with the eight organic management treatments that are control (T_1), FYM @ 12 t ha^{-1} (T_2), azolla @ 2 t ha^{-1} (T_3), green manuring @ 1.7 t ha^{-1} (T_4), vermicompost @ 3.75 t ha^{-1} (T_5), FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} (T_6), FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7) and FYM @ 6 t ha^{-1} + Vermicompost @ 1.9 t ha^{-1} (T_8). The findings on growth parameters of rice *viz.* plant height, number of tillers hill^{-1}, leaf area index, dry matter accumulation were significantly increased with the application of FYM @ 6 t ha^{-1} + Green manuring @ 0.85 t ha^{-1} (T_7) as compared other organic nutrient management. As regards to yield attributes and yield, application of FYM @ 6 t ha^{-1} + Green manuring @ 0.85 t ha^{-1} (T_7) produced highest yield attributes like effective tillers, panicle weight, number of filled grains and test weight. Thus increase in yield attributes results in increased yield of rice crop. The increase in grain and straw yield of rice crop observed more significantly with the application from FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7) as compared to application of other nutrient management.

Keywords: Organic, nutrient, management, rice, *Oryza sativa* L.

Introduction
Rice (*Oryza sativa* L.) is the most important staple food crop planted on one-tenth of earth's arable land and provides half of the daily food for one in every three persons on earth. Rice based production systems provide livelihood for more than 50 million households. It is projected that the world will need 70% more food to feed 9.2 billion people in 2050, by addressing multiple challenges such as intensifying crop production sustainably, reducing wastage of production inputs and improving efficiency in the use of key resources in agriculture. Until the middle of 20th century, agriculture all over the world was based on the principles of eco-friendly organic farming system, which ensured crop and animal food production as well as environmental safety to the human beings and other forms of domestic and non-domestic animals. However, since the commencement of green and industrial revolutions, people in some advanced agricultural countries and developing countries like India abandoned the traditional means of agriculture and stressed the need for more food production and economic growth through chemical inputs without environmental consideration, which led to environmental degradation and ecological imbalance. Energy crisis, higher fertilizer cost, sustainability in agri-production system and ecological stability are the important issues which renewed the interest of farmers and research workers in non-chemical sources of plant nutrients like biofertilizers, farmyard manure, green manure, composts etc. Awareness about crop quality and soil health increased the attention of people towards organic farming. Organic Agriculture is not a new concept to India and traditionally Indian farmers are organic. In this context, organic farming system is adjudged to be the most viable option to sustain agricultural growth. For maintaining sustainability over long term we have to adopt organic agriculture on the agro-ecosystem (FAO, 2011) [5].

Balanced use of nutrients through organic sources like farmyard manure, vermicompost, green manuring, neem cake and biofertilizers are prerequisites to sustain soil fertility, to produce maximum crop yield with optimum input level (Dahiphale *et al*. 2007) [3]. In addition to supply of nutrients, organic sources improve the physical condition and biological health of soil, which improves the availability of applied and native nutrients (Dick and Gregorich, 2004) [4]. Since the organo-foods are getting a fast boost up in the world export market, the potential of pure organic farming can be exploited.

Materials and Methods

A field trial was conducted during *kharif* 2017 at Institute Research Farm of ICAR-National Rice Research Institute (NRRI), Cuttack (Odisha) which is located at 20 25′ North Latitude and 85 55′ East Longitude with an altitude elevation 24 m above mean sea level. The soil was acidic in reaction and medium in fertility levels having medium in organic carbon (0.56%) available nitrogen (208 kg/ha), phosphorus (18 kg/ha) and potassium (262 kg/ha) content were low, high and medium, respectively. The experiment was laid out in split plot which consisting of treatments comprised of two cultivars (Ketekijoha and Padmini) in main plots and in sub plots with the eight organic management treatments that are control (T_1), FYM @ 12 t ha^{-1} (T_2), azolla @ 2 t ha^{-1} (T_3), green manuring @ 1.7 t ha^{-1} (T_4), vermicompost @ 3.75 t ha^{-1} (T_5), FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} (T_6), FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7) and FYM @ 6 t ha^{-1} + Vermicompost @ 1.9 t ha^{-1} (T_8). The growth parameters of the plants were recorded at frequent intervals from germination up until harvest and finally, the yield parameters were recorded after harvest. These parameters were statistically analyzed using analysis of variance (ANOVA) as applicable to split plot.

Results and Discussion

Growth attributes

The rate of increase in height was maximum between 30 to 90 DAT and thereafter plant height increased progressively with time up to harvest but at a diminishing rate. Plant height varied significantly due to different organic nutrient management at all the growth intervals. Among the treatments, maximum plant height was registered in FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7), however, it was found comparable with FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} (T_6) at all the growth stages. On the other hand, control plot (T_1) produced the shortest. It was also observed that the plants of Padmini were taller than Ketekijoha at all growth stages. Number of tillers hill^{-1} increased rapidly with increasing the crop age up to 60 DAT and gradually slowed down thereafter. This decline may be ascribed to the mortality of rate formed tillers due to shading of upper tillers. Between the two cultivars, Ketekijoha recorded significantly higher number of tillers over Padmini cultivar at all the growth stages. Among different organic nutrient management treatments, application of FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7) produced significantly higher number of tillers hill^{-1}, which was at par to FYM @ 6 t ha^{-1} + vermicompost @ 1.9 t ha^{-1} (T_8) at all growth stages. This finding was supported by Patel *et al*. (2012) [6] and Balsubramaniam *et al*. (2002) [1] reported that tiller number was significantly influenced by organic manure and their combinations. The variety 'Ketekijoha' had an appreciably more LAI as compared to 'Padmini' which was mainly due to higher production of tillers at all growth stages. As regards to organic nutrient management, application of FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7) had resulted in significantly higher LAI in comparison to rest of the treatments at all the growth intervals, maximum being (5.31) at 90 DAT. Among the cultivars, Ketekijoha produced significantly higher dry matter (59.98 g) as compared to Padmini at all growth intervals. The dry matter production is a function of number of tillers, no of leaves and leaf area.

Yield attributes

Higher number of effective tillers (251.5) was recorded in Ketekijoha over Padmini (214.5). The rice cultivar Ketekijoha has vigorous growth at early stages and produced more number of tillers. Among the different organic nutrient management, significantly the highest number of effective tillers m^{-2} (261.5) was recorded in FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7) over other organic nutrient management treatments tested. However, it was found to be at par with the treatments of FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} (T_6), FYM @ 6 t ha^{-1} + vermicompost @ 1.9 t ha^{-1} (T_8) and azolla @ 2 t ha^{-1} (T_3). Panicle length of Ketekijoha was found almost similar to Padmini cultivar. Different organic nutrient management also exhibited marked differences in length of panicle. Among the organic nutrient management treatments, combination of FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7) registered longest panicle length (26.88cm) and it was at par with green manuring @ 1.7 t ha^{-1} (T_4), vermicompost @ 3.75 t ha^{-1} (T_5), FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} (T_6) and FYM @ 6 t ha^{-1} + vermicompost @1.9 t ha^{-1} (T_8). Between the rice cultivars, significantly heavier panicle (22.98g) was obtained under variety Ketekijoha over Padmini *i.e.* (17.21 g). It may probably be due to shorter panicle length and lesser test weight of Padmini. heavier panicle were noted with the application of FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (25.0g) and FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} *i.e.* T_6(24.72g), and they proved superior over rest of the organic nutrient treatments. Ketekijoha produced significantly higher filled grains panicle^{-1} (183.71) over Padmini (162.14) cultivar. Organic nutrient management exhibited significant variations in the number of filled grains panicle^{-1}. Significantly higher number of filled grains panicle^{-1} was noted with the application of FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} *i.e.* T_7 (191.17) which was found comparable to FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} (T_6), FYM @ 6 t ha^{-1} + vermicompost @1.9 t ha^{-1} (T_8) and azolla @ 2 t ha^{-1} (T_3) treatments. The Ketekijoha produced markedly higher grain yield (3.87 t ha^{-1}) as compared to Padmini (3.10 t ha^{-1}). The former cultivar Ketekijoha gave 19% higher grain yield than that of Padmini cultivar. The rice cultivar that produces more number of effective tillers m^{-2}, grains panicle^{-1}, test weight and reduces sterility percentages produces the higher grain yield as also reported by Pandey *et al*. (1991) [7] and Ghosh (2001).

Among the organic nutrient management treatments, FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7) provided a balanced supply of all essential nutrients synchronized with crop needs and uptake and thus resulted in significantly higher grain yield (4.23 t ha^{-1}) over the rest of the other treatments except FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} (T_6) and FYM @ 6 t ha^{-1} + vermicompost @1.9 t ha^{-1} (T_8) significantly highest straw yield was produced by Ketekijoha (7.43 t ha^{-1})

over Padmini (7.02 t ha^{-1}) cultivar. This might be due to lesser partitioning of dry matter in to grains. Among the different organic nutrient management treatments, similar trend was noticed for straw yield as grain yield, highest value of 8.17 t ha^{-1} was obtained with the application of FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} (T_7), which was at par to FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1} (T_6).

Table 1: Different growth attributes as influenced by rice cultivars and organic nutrient management

Treatments	Plant height (cm) at 90 DAT	Number of tillers hill^{-1} at 90 DAT	Leaf area index at 90 DAT	Dry matter (g hill^{-1}) at 90 DAT
Cultivars				
V_1- Padmini	157.71	9.08	4.21	30.35
V_2- Ketekijoha	136.25	10.21	4.75	41.43
S.Em ±	1.04	0.24	0.08	1.08
CD (p=0.05)	6.35	0.86	0.50	6.57
Organic nutrient management				
T_1- Control	112.83	6.83	3.65	23.47
T_2- FYM @ 12 t ha^{-1}	142.33	9.67	4.00	30.35
T_3- Azolla @ 2 t ha^{-1}	148.83	9.83	4.28	37.39
T_4- Green manuring @ 1.7 t ha^{-1}	147.17	10.00	4.59	35.81
T_5- Vermicompost @ 3.75 t ha^{-1}	144.67	9.83	4.42	33.84
T_6- FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1}	153.33	11.33	4.78	42.82
T_7- FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1}	155.67	12.33	5.31	42.97
T_8- FYM @ 6 t ha^{-1} + vermicompost @1.9 t ha^{-1}	151.00	11.33	4.83	40.48
S.Em ±	1.68	0.37	0.16	1.74
CD (p=0.05)	4.88	1.08	0.48	5.03
Interaction (V×T)	NS	NS	NS	NS

Table 2: Different yield attributes as influenced by rice cultivars and organic nutrient management

Treatments	No. of effective tillers (m^{-2})	Panicle length (cm)	Panicle weight (g)	No. of filled grains panicle^{-1}	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Cultivars						
V_1- Padmini	214.5	25.22	19.6	162.14	3.10	7.02
V_2- Ketekijoha	251.5	25.65	24.95	183.71	3.87	7.43
S.Em ±	6.4	0.13	0.22	2.36	0.09	0.05
CD (p=0.05)	NS	NS	1.32	14.35	0.54	0.32
Organic nutrient management						
T_1- Control	159.8	21.5	17	131.17	2.08	5.95
T_2- FYM @ 12 t ha^{-1}	222.8	25.32	21.47	160.83	3.28	6.80
T_3- Azolla @ 2 t ha^{-1}	244.8	25.73	22.72	182.06	3.51	7.43
T_4- Green manuring @ 1.7 t ha^{-1}	238.7	26.4	22.4	174.17	3.53	7.16
T_5-Vermicompost @ 3.75 t ha^{-1}	230.7	25.42	21.74	171.50	3.42	7.05
T_6- FYM @ 6 t ha^{-1} + azolla @ 1 t ha^{-1}	256.3	26.25	24.72	187.67	3.98	7.74
T_7- FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1}	261.5	26.88	25.00	191.17	4.23	8.12
T_8- FYM @ 6 t ha^{-1} + vermicompost @1.9 t ha^{-1}	249.2	25.97	23.17	184.83	3.86	7.57
S.Em ±	7.8	0.39	0.67	3.72	0.14	0.18
CD (p=0.05)	22.5	1.14	1.94	10.78	0.39	0.53
Interaction (V×T)	NS	NS	NS	NS	NS	NS

Conclusion

Based on my research trail, the treatment combination Ketekijoha and FYM @ 6 t ha^{-1} + green manuring @ 0.85 t ha^{-1} was found to be more productive. Although the findings are based on one season further research is needed to confirm the findings and their recommendation.

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