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Effect of Organic Nutrient Management Practices on Growth, Yield and Pests Incidence of Scented Rice (*Oryza sativa* L.) in Rainfed Situation of Assam

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ABSTRACT

The field experiment was conducted in organic block on experimental farm of AAU-Assam Rice Research Institute, Assam Agricultural University, Titabar, Assam during *kharif* season of 2019 and 2020 to study the effect of organic nutrient management practices on growth, yield and pests incidence of scented rice (*Oryza sativa* L.) in rainfed situation of Assam. Eight treatment combinations of organic inputs were laid out in Randomized Block Design with three replications including one control where no organic nutrients were added. The study revealed that combined application of different proportion of green manure, enriched compost, azolla, vermicompost, neem cake with bio fertilizer consortium and rock phosphate as different treatment significantly improved the growth behavior, yield and also reduced pests incidence of scented rice. Among the organic nutrient management treatments, combination of Green manure (2.5 t/ha)+ Vermicompost (2.5 t/ha)+ Biofertilizer consortium (4 kg/ha seedling) as root dip +Rock phosphate (17 kg/ha)+Azolla (20 kg/ha) recorded the highest yield (3.80 t/ha) by improving yield attributing parameters, viz., Panicles (276.3 /m^2), Spikelet /panicle (25.50 number) and Panicle weight (3.37g). The organic treatments also significantly enhanced the growth physiology viz., leaf area index (4.32), and specific leaf weight (8.56 mg/cm^2) at panicle initiation stage (90 DAT). In organic management treatments, pests and disease incidence significantly reduced compared to control plot. Highest reduction of dead heart (DH%) and white ear head (WEH%) infestation due to stem borer, gall midge (silver shoot) and leaf folder damage was noticed in the treatment combination of Green manure (2.5 t/ha) + Vermicompost (2.5 t/ha)+ Biofertilizer consortium (4 kg/ha seedling) as root dip+Rock phosphate (17 kg/ha)+Azolla (20 kg/ha).

Keywords Scented rice, Green manuring, Vermicompost, Biofertilizer, Yield.

INTRODUCTION

In the past few decades, chemical fertilizers have widely spread throughout the world focusing that the soil is inert medium for plant roots, rather than as a living biosphere in which the crop is only one of hundreds or thousands of interacting species. There is heavy application of chemicals in fields under

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intensive agricultural practices. It appears to slow down the productivity of soils. Applications of nitrogen fertilizers are responsible for emissions of green house gases like nitrous oxide (N_2O) and ammonia (NH_3). Besides supplying nitrogen, ammonia can also increase soil acidity. The birth rate, longevity, builds up of resistance and overall fitness of certain pests creates pests problems due to excessive nitrogen fertilizer applications.

There were increased and injudicious applications of chemical fertilizers and pesticides during green revolution period. It created pesticide residual and harmful effects on soil, water as well as air causing their pollution. This has reduced the inherent quality of the soil by deteriorating soil health in terms of soil fertility and biological activity. Pesticide residue appeared in many agricultural food items which decreased market value. It also stands a cause of death for natural enemies and development of resurgence/ resistance to pesticides. These problems can be overcome by following the organic farming system. Organic farming is believed to sustain soil productivity and pest control by enhancing natural processes and cycles in harmony with environment. Green manure can increased soil physical, chemical and biological properties resulting in creation of favorable condition suitable for better root growth and proliferation lead to higher absorption of water and nutrients (Sujatha *et al.* 2017). Organic farming has emerged as an important priority area globally in view of the growing demand of safe and healthy food and long term sustainability and concern on environmental pollution associated with indiscriminate use of agrochemicals (Geetha and Balasubramaniyan 2015).

Organic manure can improves soil organic carbon for sustaining the physical quality and also increases the soil N. However N use efficiency is very low particularly in rice and it is difficult to sustain in the soil system due to leaching, volatilization and denitrification losses. The replacement of chemical inputs viz., chemical fertilizers by farm derived organic inputs, normally reduce variable input cost under organic management. In Assam, by virtue of using less quantity of chemical fertilizers and pesticides, more dependency upon naturally available sources of nutrients, organic food could provide better vistas towards high remuneration with premium price in market with inherent lesser cost advantage.

Assam is also known to be the centers of its origin along with wide range of variations in rice cultivars. The aromatic rice is favored over other rice varieties for its high flavor, palatability and quality. Demand of aromatic rice in recent years has increased to a great extent (Anjan *et al.* 2022). Among all cultivars, scented rice, more particularly the joha group of this region enjoys top position. Most of the trade of aromatic rice in the world is also from India, Pakistan and Thailand (Sharma *et al.* 2017). Organic farming can improve the quality of scented rice along with price and it has huge export potential (Nayak *et al.* 2017). The aroma, superfine kernel, good cooking qualities and excellent palatability of joha rice led to a unique position (Changmai and Thakuria 2017). Assam Joha is gaining popularity in all over India because of its aroma and quality. It is now established globally that organic farming can improve the quality of scented rice. Assam can earn good revenue by promoting joha rice to the national and global market as it fetches high premium price for its high standard quality traits (Das *et al.* 2010). It has tremendous potential to grow crops organically and can lead as a main supplier of organic products in the world's organic market. However, study on different organic inputs and their role in yield improvement in scented rice is very scanty in Assam. In the light of these problems, the present investigation was designed to generate scientific information on organic cultivation of scented rice under Assam condition. There is huge scope of converting the north-east region of India including Assam to an organic hub of the country with aromatic rice by following organic management system. Considering all the above facts, and based on the importance of the location specific research in present day context, the experiment was designed.

MATERIALS AND METHODS

The field experiment was conducted in organic block on experimental farm of AAU-Assam Rice Research Institute, Assam Agricultural University, Titabar, Assam during *kharif* season of 2019 and 2020 under rainfed medium land situation. The site is situated at 26°35′N latitude, 28°10′E longitude having an ele-

Table 1. N, P, K composition of the organic inputs.

Input	N percentage	P percentage	K percentage
Enriched compost	0.7	0.7	0.6
Green manure (*Sesbania rostrata*)	2.0	0.4	0.5
Vermicompost	1.2	0.6	0.2
Azolla	3.0	1.0	1.2
Rock phosphate	-	26	-

vation of 99.4 meter above mean sea level. The soil of the experimental site was sandy loam in texture with pH 5.4, low in available nitrogen (224.50 kg/ha), medium in available phosphorus (17.31 kg/ha) and available potassium (136 kg /ha) and medium in organic carbon (0.59%). The P and K requirement of the crops were not applied separately. There were seven treatment combinations in the experiment and one control viz., T_1- Enrich compost (5 t/ha) + Biofertilizer consortium as root dip (4 kg/ha seedling) T_2- Green manure (2.5 t/ha) +Azolla (20 kg/ha) + Biofertilizer consortium as root dip (4 kg/ha seedling) + Rock phosphate (17 kg/ha), T_3- Green manure (5 t/ha) +Azolla (20 kg/ha)+Biofertilizer consortium (4 kg/ha seedling) as root dip + Rock phosphate (17 kg/ha), T_4- Vermicompost (2.5 t/ha) + Azolla (20 kg/ha) +Biofertilizer consortium as root dip (4 kg/ha seedling) +Rock phosphate (17 kg/ha), T_5- Vermicompost (5 t/ha)+Azolla (20 kg/ha)+Biofertilizer consortium as root dip (4 kg/ha seedling)+Rock phosphate (17 kg/ha), T_6- Green manure (2.5 t/ha)+ Vermicompost (2.5 t/ha) + Biofertilizer consortium as root dip (4 kg/ha seedling) + Rock phosphate (17 kg/ha)+Azolla (20 kg/ha), T_7- Vermicompost (2.5 t/ha)+ Neem cake (300 kg/ha, half basal and half top dressed)+ Biofertilizer consortium as root dip (4 kg/ha seedling) and T_8-Control.

Randomized Block Design (RBD) was laid out for the experiment. The organic guidelines of Assam Agricultural University, Jorhat were followed for the production of different organic inputs used in the experiment. The nitrogen, phosphorus and potassium composition of each organic inputs utilized in the experiment were analyzed and presented in Table 1. The seeds of scented rice variety Keteki joha were collected from organic block of AAU-Assam Rice Research Institute, Assam Agricultural University,

Table 2. Nursery management practices for seedling vigour and pest/disease incident in scented rice (*Oryza sativa* L.), Var Keteki joha.

Treatment	Vigour index	Disease/Pest
T_1 : Seed bed amended with vermicompost @ 4 kg/bed (10 m×1.25 m)	85.80	No pest incident
T_2 : Seed bed amended with vermicompost @ 4 kg/bed+seed treatment with fresh cow urine @ 200 ml/liter (10 m×1.25 m)	87.37	No pest incident
T_3 : Seed bed as untreated (10 m×1.25 m)	57.05	14% thrips incident

Titabar, Assam. For raising of healthy seedling in nursery three nursery management practices were followed. The reaction to pests/disease in nursery and main field and seedling vigor were determined as suggested by Abdul Baki and Anderson (1973) in each management practices (Table 2). Seedlings from the best nursery management practices, viz., Seed bed amended with vermicompost @ 4 kg/bed + seed treatment with fresh cow urine @ 200 ml/liter were utilized for transplanting in the main field. The plant protection measures were not applied to facilitate the effectiveness of the organic treatment against insects and diseases in the nursery and in main field. Not a single organic inputs was applied in control plot and treated as organic with native fertility and biological make up. Seed treatment was carried out by soaking the seeds 12 hrs with a solution of *Pseudomonas fluoroscense* @ 10 g/ liter of water per kg of seed. Dhaincha (*Sesbania rostrata*) as green manure crops was grown for both the years using 50 kg seed /ha in the month of May in separate plot till 60 days. After harvesting, it was weighted, chopped and incorporated as per treatments one week before transplanting of rice. Enriched composed was prepared by taking ordinary compost prime with microbial consortia @ 1%, mixed with 1% rock phosphate (17 kg per 100 kg compost and cure for 15-20 days). Enriched compost was applied one week before transplanting of rice. Root dip treatment with consortium was carried out one day prior to transplanting as per the treatment. Enriched compost and vermicompost were applied one week before transplanting of rice on dry weight basis. Root dip treatment with consortium was given one day prior to transplanting as per the treatment.

Table 3. Influence of organic treatments on specific leaf weight (mg/cm^2) and leaf area index (LAI) on scented rice (*Oryza sativa* L.), Var Keteki joha. *Treatments details are given in materials and methods. *DAT-Days after transplanting.

Treatment	Specific leaf weight (mg/cm^2)				Leaf area index (LAI)			
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT
T_1	2.16	4.32	6.31	3.20	1.63	2.06	3.89	1.45
T_2	2.26	5.39	7.14	3.70	2.03	2.47	4.11	1.76
T_3	2.37	5.91	7.17	3.80	2.07	2.68	4.26	1.82
T_4	2.04	4.24	5.33	3.20	1.49	2.01	3.61	1.35
T_5	2.17	4.69	6.54	3.50	1.83	2.13	3.92	1.65
T_6	3.05	6.17	8.56	4.30	2.15	2.89	4.32	1.86
T_7	1.90	4.15	5.14	3.20	1.61	1.71	3.11	1.30
T_8	1.79	3.47	4.95	2.60	1.41	1.60	2.96	1.18
CD (p=0.05)	0.231	0.249	0.058	0.277	0.585	0.036	0.022	0.023

The treatment was carried out with Biofertilizer consortium @ 4 kg/ha of seedling for overnight before transplanting to enable the roots to get inoculums of the biofertilizers. Consortium is a specific formulation of *Azospirillum*, *Azotobacter*, PSB and *Rhizobium*. Azolla was applied seven days after transplanting (DAT) of rice as per treatment. After formation of a thick mat, the azolla was applied through incorporation into the soil. Each of the organic inputs applied were analyzed for quantify the N, P and K content and presented in Table 1. Observations were recorded on the 10 randomly selected plants of each plot on the incidence of disease, stem borer causing dead hearts (DH) and white ear head (WEH). Gall midge causing silver shoot and leaf folder incidence ((% DL)) by using standard methods. The leaf area index (LAI) and the specific leaf weight (SLW) were recorded at subsequent growth stages of the crop. Leaf area index (LAI), and specific leaf weight (SLW) were estimated following formula used by Yoshida *et al.* (1976) and Pearce *et al.* (1969), respectively. The yield and yield determining characters were recorded following standard procedures (Kumar *et al.* 2017). The data collected from field observations and those recorded in laboratory were subject to statistical analysis by standard analysis of variance techniques (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Growth parameters

The experimental data presented in Table 3 clearly showed that different organic treatments could bring significant differences in leaf area index (LAI) during different stages of growth in scented rice. At all stages of growth, T_6- Green manure (2.5 t/ha) + Vermicompost(2.5 t/ha)+ Biofertilizer Consortium (4 kg/ha seedling) as root dip +Rock phosphate (17 kg/ha) + Azolla (20 kg/ha), recorded the highest leaf area index and T_8 (Control) recorded the lowest leaf area index. At 90 DAT, highest leaf area index was observed at T_6 (4.32) followed by T_3 and T_2 with (4.26) and (4.11) respectively, and the lowest observed at control treatment (2.96). It might be for better physiological growth of plants as organic matter by ameliorating the micronutrients deficiencies and by increasing the cation exchange capacity of soil, improved nutrients availability and enhance growth. Different nitrogen sources increased the growth and quantity of leaves per hill leading to higher leaf area index. The availability of nitrogen from organic imputes helps in vigorous growth of leaves and expanded leaf blades are produced, hence leaf area index also increase. These results are in accordance with Sarmah *et al.* (2022). The macro and micro nutrients in different organic sources provided adequate nutrition for leaf growth and expansion. It resulted more photo-assimilates and dry matter production. Sufficiency of nitrogen promotes vigorous growth of foliage with more number of leaves with expanded leaf blades which resulted in higher LAI. Green manuring with Sesbania slowly but continuously maintained nitrogen supply during the growing period and thereby helped in enhancing the LAI. These results were supported by the findings of Pradhan and Moharan (2017), Pathak *et al.* (2022). The experimental data clearly showed that different organic treatments could bring significant

Table 4. Incidence of insect pest and diseases as influenced by different organic management practices in scented rice (*Oryza sativa* L.) Var Keteki joha. *Treatments details are given in materials and methods. DH-Dead heart, WEH- White ear head, DL-Dead leaf.

Treatment	Sheath rot (% of disease severity)	Stem borer DH%	Stem borer WEH %	Gall midge (silver shoot %)	Leaf folder (% DL)
T_1	6.90 (14.89)	5.40	6.70	3.50	4.50
T_2	6.25 (14.42)	4.80	5.30	4.10	5.20
T_3	5.75 (13.81)	4.50	4.80	5.20	4.50
T_4	8.45 (16.85)	5.20	4.30	3.70	5.00
T_5	8.70 (17.15)	5.30	5.70	4.20	4.50
T_6	3.25 (10.30)	3.40	3.80	3.00	3.70
T_7	8.80 (17.26)	4.90	5.50	3.50	3.40
T_8	14.33 (22.53)	14.30	13.70	12.50	13.20
CD (p=0.05)	2.25	1.29	1.34	1.45	1.37

differences in specific leaf weight during different stages of growth in rice. At all stages of growth T_6- Green manure (2.5 t/ha)+ Vermicompost (2.5 t/ha)+ Biofertilizer consortium (4 kg/ha seedling) as root dip +Rock phosphate (17 kg/ha) + Azolla (20 kg/ha) recorded the highest specific leaf weight. At 90 DAS, highest specific leaf weight was observed at T_6 (8.56), followed by T_3 (7.17 mg/cm^2) and T_2 (7.14 mg/cm^2), whereas control plants showed the minimum with T_8 (4.95 mg/cm^2). Specific leaf weight increased considerably up to 90 days after planting. This stage was corresponding to the booting phase of the crop at which the demand for quantum was very high. At this stage these were found to be highly efficient for their production of assimilates per unit leaf area basis. These results were in close conformity with the findings of Kumari *et al.* (2014).

Insects and disease incidence

Observations on incidence of pests and disease were recorded and the mean values of 2 years data were reported (Table 4). Stem borer damage ranged from 3.40% to 5.40% (dead hearts) during the vegetative stage and 3.80% to 6.70% (white ears) in the pre-harvest stage whereas in control plot dead heart and white ear head recorded 4.30 and 13.70, respectively. Gall midge damage ranged from 3.00% to 5.20% (silver shoots) in different organic treatments and in control plot it was recorded 12.50%. Leaf folder damage ranged from 3.40% to 20% and significant differences were not observed between different organic treatments. No major disease incidence was observed except sheath blight which recorded in range of 10.30% to 17.26% disease incidence in different organic treatments throughout the experiment and in control plant it was recorded 22.53%. In comparison, the plants treated with a suitable amount of organic manure showed a better capability of disease resistance and grew healthier. It was also reported by Xue-Feng and Fan (2015). Lower infestation of stem borer in organic treatments was also reported by Surekha *et al.* (2010). Heavy infestation of stem borer in rice crop was reported to be low with organics compared to synthetic inorganic fertilizers by Paramasiva *et al.* (2020). In comparison, the plants treated with a suitable amount of organic manure showed a better capability of disease resistance and grew healthier.

Table 5. Yield attributes and grain yield of scented rice (*Oryza sativa* L) Var Keteki joha as influenced by different organic management treatments. *Treatments details are given in materials and methods. *DAT-Days after transplanting.

Treatment	Yield (t/ha)	Number of panicle/m^2	Panicle weight (g)	Spikelet/Panicle
T_1	3.30	257.8	2.71	22.80
T_2	3.67	251.5	2.70	23.80
T_3	3.63	248.8	2.31	24.80
T_4	3.01	259.2	2.56	21.30
T_5	3.23	241.3	2.53	22.00
T_6	3.80	276.3	3.37	25.50
T_7	3.19	251.5	2.45	19.00
T_8	2.30	215.0	2.09	17.50
CD (p=0.05)	0.54	19.14	0.503	4.60

Yield and yield attributing parameters

Perusal of data (Table 5) reveals that the number of panicles/m^2 of aromatic rice was significantly influenced by different organic nutrient treatments. All the organic nutrient management treatments produced significantly higher panicles/m^2 compared to the control. The highest number of panicles/ m^2 (276.3) was recorded under the T_6- Green manure (2.5 t/ha)+ Vermicompost (2.5 t/ha) + Biofertilizer consortium (4 kg/ha seedling) as root dip 4+Rock phosphate (17 kg/ha)+Azolla (20 kg/ha), treatment which was found to be statistically at par with T_4 and T_1 treatments. The production of effective tillers depends on nutrient availability during tiller bud initiation stage. During the tiller bud initiation stage, competition for nutrients is very high. A nutrient in adequate quantity and readily available form increases the number of panicles/ hill. All the organic nutrient management treatments created more conducive growth conditions by providing the plant nutrients to the crop right from early vegetative stage. The lower panicles/ m^2 in control plots might be due to lower levels of nutrient supply resulting death of tillers. These results are in close conformity with those reported by Mahore (2016).

The data presented in Table 5 revealed that all the nutrient management practices produced significantly heavier panicle as compared to the control. The heaviest panicles (3.37 g) were recorded in the T_6 treatment, the lowest panicle weight (2.09 g) was found in control plot. Spikelet number per panicle increased due to different organic treatments. Highest spikelets per panicle recorded by organic treatment T_6- Green manure (2.5 t/ha) + Vermicompost (2.5 t/ ha) + Biofertilizer consortium (4 kg/ha seedling) as root dip 4 + Rock phosphate (17 kg/ha) + Azolla (20 kg/ha).

The highest grain yield (3.80 t/ha) was recorded with recorded by the organic treatment T_6- Green manure (2.5 t/ha) + Vermicompost (2.5 t/ha) + Biofertilizer consortium (4 kg/ha seedling) as root dip 4 + Rock phosphate (17kg/ha) + Azolla (20 kg/ha) which was found statistically at par with T_1 , T_2 and T_3 treatment. The increased grain yield recorded with the T_6 treatment might be due to the significantly higher yield attributes recorded under this treatment. Green manuring followed by vemicompost application and root dip treatment with biofertilizer consortium resulted maximum availability of nutrients which maintained a favorable soil physical, chemical and biological environment. The biofertilizers applied through the root dip treatment increased the uptake of major as well as minor nutrients. *Azospirillium* colonizes in the root mass and fixes appreciable amount of nitrogen. The PSB increases the solubility of insoluble phosphorus through the production of organic acids, citric acids, malic acid and propionic acids. These acids facilitate mobilization of soil phosphorus and increased phosphorus availability. The organic inputs as a whole improved the soil support system and ensured nutrient availability which was ultimately reflected in yield performance of the crop. Similar observation on yield improvement under organic systems was also observed by Kumar *et al.* (2017) and Kaur *et al.* (2022).

CONCLUSION

From the present investigation, conclusion may be drawn that organic nutrient management practices can increase the yield potential of scented rice, variety, keteki joha under rainfed situation. From the experimented different organic practices, the combination of organic inputs as T_6. Green manure (2.5 t/ha) + Vermicompost (2.5 t/ha) + Biofertilizer consortium (4 kg/ha seedling) as root dip + Rock phosphate (17 kg/ ha) + Azolla (20 kg/ha) produced highest grain yield (3.80 t/ha) by attributing improved yield attributing parameters. The incidence of pests and disease under the organic management treatments was significantly lower compared to control plot.

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