Impact of organic and natural farming practices on growth and development ~~parameters~~ component of *joha* rice

Abstract

In pursuit of sustainable agriculture, a study was conducted on *Bokuljoha*, a variety of aromatic rice in the kharif season of 2022-23 at ARRI-AAU, Titabar on a clay loam soil (33.25 % sand, 29.25 % silt and 36.50 % clay) of very high in organic carbon (8.40 g), medium in available nitrogen (284.12 kgha^{-1}), medium in available phosphorus (22.52 kg ha^{-1}), low in available potassium (127.43 kg ha^{-1}) and of pH 5.63. From the results it was revealed that the cumulative effect of vermicompost, biofertilizers and rock phosphate were more significant than their direct and residual effects on the crop growth and development parameters, yield attributes and B:C ratio. Though there was a treatment which included natural farming practices it failed to exert any noticeable influence on the growth and development as well as in yield parameters.

Key words: organic farming, natural farming, rice, vermicompost, rock phosphate

Introduction

Rice being the staple food for a sizeable portion of the world's population has increase in demand for its production as the population is increasing day by day. In fiscal year 2023, India's estimated production volume of rice was over 130 million metric tons. There has been a gradual increase in the production of rice since fiscal year 2017 (Sandhya Keelery, 2021, statistica.com). Rice is the most common staple crop consumed all over India. Rice is mostly being produced by the application of various inorganic sources of fertilizers which in turn costs for the health of these planets. The cultivation methods of rice have a profound impact on the food security and the environmental sustainability. In recent years, there has been a growing interest in organic farming practices and natural farming practices in the Indian sub-continent as well as in the entire world to these critical concerns. Organic cultivation not only emphasizes ecological harmony but also aims to produce healthier and more nutritious crops. Organic manures have the capacity to fulfil nutrient demand of crops adequately and ~~promotes~~promote the activity of macro and micro flora in the soil (Sharma, 2005). Studies suggest that yields could be sustained without increasing the nutrient inputs by tightening the nutrient cycles through organic nutrition (Stockdale *et al.*, 2001). One such endeavour is the cultivation of *joha* rice by organic farming methods. *Joha* rice (*Oryza sativa*), a unique and aromatic variety predominantly grown in the ~~northeastern~~north-eastern region of India. Among different qualities of rice these group have high demand because of their specific aroma, superfine kernels, superior quality of cooking and superfine kernels. These group of rice is specifically used for making various dishes during separate occasions. Joha rice is grown in only about 5 percent area in Assam with an average yield of 1 to 1.5 tonnes per hectare as it takes longer time to mature (120 to 160 days). (Lakshmi Subramaniam). Proper selection of a variety and appropriate nutrient management are important in organic rice production (Manjunath *et al.*, 2009). Assam being surrounded by hills on all sides and covered by forests makes it a biodiversity rich zone thereby making it suitable for practicing organic farming as well as natural farming. Hence a study was carried out to generate scientific data on production of *joha* rice by organic and natural farming practices.

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Materials and Methods

Field experiment were conducted at the research farm of Assam Rice Research Institute-Assam Agricultural University, Titabar, Jorhat, India during the kharif season of 2022-2023 The soil was clay loam with pH 5.63, organic carbon 8.40 g, available nitrogen 284.12 kg ha -1, available P_2O_5 22.52 kg ha^{-1} and available K_2O 127.43 kg ha^{-1}. The number of treatments used were eight in total including control which were T_1 [Absolute control], T_2 [(Natural farming, *Beejamrit* as root dip treatment (3%) (100 litres ha^{-1}) + *Jeevamrit* as spray (3%) (100 litres ha^{-1}) + *Ghanajeevamrit* as soil treatment at 100 kg (*Jeevamrit* and *Ghanajeevamrit* at 30, 60 and 90 DAT)], T_3 [(Enriched compost (5 tha^{-1}) + Biofertilizer (*Azospirillum*, PSB as seedling root dip) (4 kg ha^{-1})], T_4 [Enriched compost (5 t ha^{-1})], T_5 [Vermicompost (5 t ha^{-1})], T_6 [Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})], T_7 [Fresh *azolla* as dual crop (400 kgha^{-1}) + Biofertilizers (*Azospirillum*, PSB and KSB mix as seedling root dip) (4 kgha^{-1})] and T_8 [Vermicompost (1 tha^{-1}), mixed inocula of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 (4kgha^{-1}), rock phosphate (10 kg P_2O_5ha^{-1})]. The experiment was laid in a randomized block design with three replications. The variety used for the experiment was *Bokul Joha*. The seedlings were transplanted after 30 days age with spacing of 20 x 15 cm with 2-3 seedlings per hill. Hand weeding was done as and when required. The organic manures and fertilizers were incorporated 2 weeks before transplantation as per the treatment requirement. In case of the natural farming treatments *beejamrita* was used as a seed treatment before sowing of the seeds where as *jeevamrita* and *ghanajeevamrita* were used as spray. The experimental plot received plant protection by application of neem oil and *brahmashtra*. For the determination of plant height, dry matter content, number of tillers, leaf area index five samples were collected from each plot, the data was averaged out and used for interpretation. The yield attributing characters were determined by randomly selecting five samples from each plot as well and the average value was used for interpretation. In case of the grain ad straw yield determination, it was recorded as per m2 from each plot and later converted to quintals per hectare. Data related to the experiment were analysed by ANOVA and the significance was determined by using Fisher's least significance difference (p = 0.05%).

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Results and Discussions

The application of several organic nutrient sources led to notable changes in growth and yield components. The organic inputs had a favourable impact on the growth and yield-attributing metrics compared to the control. Plants that were noticeably taller were observed with application of vermicompost (1 tha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4 kg ha^{-1}), rock phosphate (10 kg P_2O_5) i.e., at 45 DAT (81.78 cm), 90 DAT (128.15 cm) and at harvest (145.71 cm) followed by fresh *azolla* application as dual crop (400 kg ha-1) + biofertilizers (*Azospirillum*, *PSB* and *KSB* mix as seedling root dip) (4 kg ha-1) (Table 1). At harvest, the other inputs, which also included natural farming inputs, did not exhibit a discernible difference in height. Biologically, hereditary elements that are less susceptible to extrinsic influences control plant height. However, the use of vermicompost, rock phosphate, and biofertilizers may have increased the availability of nutrients, which may have contributed to the increase in height. The highest number of tillers at 45 DAT (8.31m^{-2}), at 90 DAT (13.79 m^{-2}) and at harvest (10.40 m^{-2}) was found in vermicompost (1 tha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4 kg ha^{-1}), rock phosphate (10 kg P_2O_5 ha^{-1}) at booting stage (Table 2).

Table 1. Effect of organic and natural inputs on plant height (cm) of rice

Treatments ~~Treatments~~	**45 DAS**	**90 DAS** ~~90 DAS~~	**At harvest** ~~At harvest~~
T_1: Absolute Control	~~45 DAS~~ 63.06	89.35	109.59
T_2: NF, *Beejamrit* as root dip treatment (3%) (100 litres ha^{-1}) + *Jeevamrit* as spray (3%) (100 litres ha^{-1}) + *Ghanajeevamrit* as soil treatment at 100 kg (*Jeevamrit* and *Ghanajeevamrit* at 30, 60 and 90 DAT)	70.06	104.56	112.95
T_3: Enriched compost (5 t ha^{-1}) + Biofertilizer (Azospirillum, PSBas seedling root dip) (4 kg ha^{-1})	76.31	119.55	139.92
T_4: Enriched compost (5 t ha^{-1})	73.32	115.21	135.07
T_5: Vermicompost (5 t ha^{-1})	74.15	112.99	134.21
T_6: Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})	75.45	113.65	137.75
T_7: Fresh a*zolla* as dual crop (400 kg ha^{-1}) + Biofertilizers (Azospirillum, PSB and KSB mix as seedling root dip) (4 kg ha^{-1})	77.88	122.89	141.10
T_8: Vermicompost (1 t ha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kg ha^{-1}), rock phosphate (10 kg P_2O_5)	81.38	128.15	145.71
Sem (±)	4.25	6.06	5.68
CD (p=5%)	12.84	18.21	17.06

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T_1: Absolute Control	2.95	9.72	7.99
T_2: NF, *Beejamrit* as root dip treatment (3%) (100 litres ha^{-1}) + *Jeevamrit* as spray (3%) (100 litres ha^{-1}) + *Ghanajeevamrit* as soil treatment at 100 kg (*Jeevamrit* and *Ghanajeevamrit* at 30, 60 and 90 DAT)	5.53	10.59	8.77
T_3: Enriched compost (5 t ha^{-1}) + Biofertilizer (Azospirillum, PSBas seedling root dip) (4 kg ha^{-1})	6.78	11.85	9.80
T_4: Enriched compost (5 t ha^{-1})	5.37	11.64	9.12
T_5: Vermicompost (5 t ha^{-1})	4.89	10.64	9.02
T_6: Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})	6.07	9.33	9.22
T_7: Fresh *azolla* as dual crop (400 kg ha-1) + Biofertilizers (Azospirillum, PSB and KSB mix as seedling root dip) (4 kg ha-1)	7.03	12.05	10.17
T_8: Vermicompost (1 t ha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kg ha^{-1}), rock phosphate (10 kg P_2O_5)	8.31	13.79	10.40
Sem (±)	0.40	0.53	0.36
CD (p=5%)	1.23	1.63	1.10

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Table 2.Effect of organic and natural inputs on number of tillers/ m^2 of rice

Because it is correlated with the number of final productive tillers at harvest, tiller output is crucial for rice. As a result, it might be seen as an additional benefit of using organic inputs to increase yield through changed canopy growth. The dry weight was found to be significantly enhanced in vermicompost (1 tha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kgha^{-1}), rock phosphate (10 kg P_2O_5 ha^{-1}) at the booting stage i.e., at 45 DAT (29.34 gm $plant^{-1}$), 90 DAT (79.11 gm $plant^{-1}$) and at harvest (92.29 gm$plant^{-1}$) (Table 3). These might be due to the adequate absorption of nutrients by the roots. Phosphorus being a root growth enhancer helped in gaining dry matter content and the other sources of nutrient proved to be efficient. The leaf area index (LAI) collected at four different time points, namely 45 (3.44), 60 (4.47), 75 (4.17) and 90 DAT (4.03) were discovered to be highest in vermicompost (1 tha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4 kg ha^{-1}), rock phosphate (10 kg P_2O_5 ha^{-1}) at all the points under observation (Table 4). The LAI was discovered to be at its highest at the panicle initiation stage, and it reduced during the later growth phases because of the loss of rice leaves caused by panicle emergence. Likewise, vermicompost (1 tha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kgha^{-1}), rock phosphate (10 kg P_2O_5 ha^{-1}) produced highest number of panicles (346.67 m^{-2}), filled grains (256.42 $panicle^{-1}$) over the control. The number of unfilled grains was found to be significantly highest in control (20.81 $panicle^{-1}$) and the change in test weight was found to be non-significant (Table 5). Thus, it is seen that application of the above-mentioned nutrient sources showed overall superiority over the other organic and natural farming inputs in influencing the growth parameters. Similar findings were also observed by Boral *et al*. (2014), Hassanuzaman *et al*. (2010) and Kavitha and Subramanian (2007).

Treatments	45 DAS	90 DAS	At harvest

T_1: Absolute Control	15.83	60.31	76.09
T_2: NF, *Beejamrit* as root dip treatment (3%) (100 litres ha^{-1}) + *Jeevamrit* as spray (3%) (100 litres ha^{-1}) + *Ghanajeevamrit* as soil treatment at 100 kg (*Jeevamrit* and *Ghanajeevamrit* at 30, 60 and 90 DAT)	22.34	61.60	81.33
T_3: Enriched compost (5 t ha^{-1}) + Biofertilizer (Azospirillum, PSBas seedling root dip) (4 kg ha^{-1})	25.49	70.15	88.26
T_4: Enriched compost (5 t ha^{-1})	21.93	64.56	86.17
T_5: Vermicompost (5 t ha^{-1})	20.72	58.50	85.03
T_6: Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})	23.70	69.18	87.05
T_7: Fresh *azolla* as dual crop (400 kg ha-1) + Biofertilizers (Azospirillum, PSB and KSB mix as seedling root dip) (4 kg ha^{-1})	26.12	71.07	90.14
T_8: Vermicompost (1 t ha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kg ha^{-1}), rock phosphate (10 kg P_2O_5)	29.34	79.11	92.29
Sem (±)	0.60	1.25	0.67
CD (p = 5%)	1.82	3.79	2.03

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Table 3. Effect of organic and natural inputs on dry weight (gm/plant) of rice

Treatments	45 DAT	60 DAT	75 DAT	90 DAT
T_1: Absolute Control	2.30	3.50	3.52	2.99
T_2: NF, *Beejamrit* as root dip treatment (3%) (100 litres ha^{-1}) + *Jeevamrit* as spray (3%) (100 litres ha^{-1}) + *Ghanajeevamrit* as soil treatment at 100 kg (*Jeevamrit* and *Ghanajeevamrit* at 30, 60 and 90 DAT)	2.40	3.90	3.56	3.11
T_3: Enriched compost (5 t ha^{-1}) + Biofertilizer (Azospirillum, PSBas seedling root dip) (4 kg ha^{-1})	2.93	4.15	3.97	3.82
T_4: Enriched compost (5 t ha^{-1})	2.73	4.12	3.83	3.61
T_5: Vermicompost (5 t ha^{-1})	2.66	4.14	3.81	3.56
T_6: Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})	2.87	4.13	3.96	3.81
T_7: Fresh *azolla* as dual crop (400 kg ha-1) + Biofertilizers (Azospirillum, PSB and KSB mix as seedling root dip) (4 kg ha^{-1})	3.12	4.19	4.01	3.84
T_8: Vermicompost (1 t ha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kg ha^{-1}), rock phosphate (10 kg P_2O_5)	3.44	4.47	4.17	4.03
Sem (±)	0.10	0.08	0.04	0.03
CD (p = 5%)	0.31	0.22	0.13	0.11

Table 4. Effect of organic and natural inputs on Leaf Area Index (LAI) of rice

Table 5. Effect of organic and natural inputs on yield attributing characters of rice

Treatments	Panicles/m^2	Filled grains	Unfilled grains	Test weight (g)
T_1: Absolute Control	266.33	160.73	20.81	11.01
T_2: NF, *Beejamrit* as root dip treatment (3%) (100 litresha^{-1}) + *Jeevamrit* as spray (3%) (100 litres ha-1) + *Ghanajeevamrit* as soil treatment at 100 kg ha^{-1} (*Jeevamrit* and *Ghanajeevamrit* at 30, 60 and 90 DAT)	292.33	181.06	14.63	11.02
T_3: Enriched compost (5 tha^{-1}) + Biofertilizer (Azospirillum, PSBas seedling root dip) (4 kgha^{-1})	326.67	228.16	10.84	11.31
T_4: Enriched compost (5 t ha^{-1})	316.33	214.39	10.54	11.08
T_5: Vermicompost (5 t ha^{-1})	310.67	211.03	11.82	11.12
T_6: Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})	320.67	225.90	8.39	11.07
T_7: Fresh *azolla* as dual crop (400 kgha^{-1}) + Biofertilizers (Azospirillum, PSB and KSB mix as seedling root dip) (4 kg ha^{-1})	339.01	237.85	8.27	11.38
T_8: Vermicompost (1 t ha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kg ha^{-1}), rock phosphate (10 kg P_2O_5)	346.67	256.42	8.01	11.45
Sem (±)	1.84	5.78	2.37	0.08
CD (p = 5 %)	5.60	17.54	7.19	NS

Application of various bio-inputs significantly influenced *j oha* rice grown organically. In control, the joha rice production is incredibly low and it is not sufficient to meet the national and global need from limited organic area of Assam. However, an overall increase (0.27 t ha-1) caused by the addition of bio-inputs under the same organic system clearly justifies the search for effective organic input for yield manipulation. The application of vermicompost (1 tha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kg ha-1), rock phosphate (10 kg P_2O_5 ha^{-1}) resulted noticeable change in grain (34.62 qha^{-1}) and straw (70.30 q ha^{-1}) yield (Table 6). It was followed by fresh *azolla* as dual crop (400 kgha^{-1}) + biofertilizers (*Azospirillum*, *PSB* and *KSB* mix as seedling root dip) (4 kg ha^{-1}) (Table 6). The improved availability of nutrients, which eventually preserved a favourable soil physical, chemical, and biological environment may be responsible for the higher grain and straw production using vermicompost, rock phosphate, and biofertilizers.

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Table 6. Effect organic and natural inputs on grain yield, straw yield and harvest index

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)
T_1: Absolute Control	15.50	28.01	35.63
T_2: NF, *Beejamrit* as root dip treatment (3%) (100 litres ha^{-1}) + *Jeevamrit* as spray (3%) (100 litres ha^{-1}) + *Ghanajeevamrit* as soil treatment at 100 kg (*Jeevamrit* and *Ghanajeevamrit* at 30, 60 and 90 DAT)	19.47	35.71	35.31
T_3: Enriched compost (5 t ha^{-1}) + Biofertilizer (Azospirillum, PSBas seedling root dip) (4 kg ha^{-1})	28.50	55.90	33.77
T_4: Enriched compost (5 t ha^{-1})	25.30	48.33	34.38
T_5: Vermicompost (5 t ha^{-1})	24.52	46.36	34.62
T_6: Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})	27.07	52.21	34.15
T_7: Fresh *azolla* as dual crop (400 kg ha^{-1}) + Biofertilizers (Azospirillum, PSB and KSB mix as seedling root dip) (4 kg ha^{-1})	31.12	61.58	33.60
T_8: Vermicompost (1 t ha-1), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4kg ha^{-1}), rock phosphate (10 kg P_2O_5)	34.62	70.30	32.99
Sem (±)	0.55	0.87	-
CD (p = 5 %)	1.69	2.64	-

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Discussion

Under organic situation the availability of essential nutrients is lower at initial stages but organic sources such a vermicompost, enriched compost can provide sustained release of nutrients over the entire crop growth period though at a slower rate than chemical fertilizers. Similar observation on yield improvement under organic systems was also observed by Banerjee *et al.*, (2013), Rualthankhuma and Sarkar (2011), and Surekha *et al.*, (2010).

The highest benefit-cost ratio (3.16) was reorded in vermicompost (1 tha^{-1}), mixed inocula of *Azospirilluma mazonense* A-10 and *Bacillus megaterium* P-5 (4 $kgha^{-1}$), rock phosphate (10 kg P_2O_5 ha^{-1}). Application of vermicompost (5 tha^{-1}) recorded lowest benefit-cost ratio (0.68).

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Conclusion

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The use of organic source of nutrients influenced the physical, chemical, and biological processes in the soil thereby making the nutrients available for the crop. Therefore, the current study suggested that the cultivation of *joha* rice under organic farming system can have significant impact on the growth characteristics, yield attributing characteristics and yield. The use of chemical fertilizers can be replaced with organic fertilizers for the increase in productivity. Thus, organic farming should be promoted among the farmers fraternity as a reliable source for cultivation of *joha* rice which provides adequate nutrition by maintaining the soil health and long-term sustainability of soil resources.

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