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EVALUATION OF ORGANIC AND NATURAL FARMING PRACTICES ON CHEMICAL PROPERTIES OF SOIL IN *JOHA* RICE

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ABSTRACT

A field experiment was conducted at Assam Agricultural University-Assam Rice Research Institute, located at Titabar (situated at 26°43' N latitude, 94°12' E longitudes and at an altitude of 86.6 m above msl), Jorhat, Assam during *sali* season of 2022. The aim of the experiment was to study the impact of organic and natural farming practices on chemical properties of soil under cultivation of *Bokuljoha* variety of rice. The layout of the experiment was based on randomized block design with three replications. Total of eight treatments were taken in the experiment. Results revealed that application of *azolla* as dual crop (400 kg/ha) + biofertilizers (*Azospirillum*, PSB and KSB mix as seedling root dip) (4 kg/ha) resulted in significantly enhanced accessible soil nitrogen (272.53 kg/ha). Also, application of vermicompost (1 t/ha), mixed inocula of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 (4kg/ha), rock phosphate (10 kg P_2O_5) recorded higher P_2O_5 content (23.28 kg/ha) and K_2O content (123.17 kg/ha). The lowest value of available nitrogen, P_2O_5 and K_2O were observed in the control treatment.

***Key words*:** Naturalfarming, nitrogen, organic carbon, phosphorus, potassium

Introduction

As rice remains a staple for a significant portion of the global population, the demand for its production continues to rise alongside the growing population. In the fiscal year 2023, India's rice production volume surpassed 130 million metric tons, marking a steady increase since fiscal year 2017. In the Indian subcontinent, there's a unique practice known as natural farming, which draws inspiration from ancient Vedic farming techniques dating back to 1800 - 1500 BCE. At the heart of this method is the Desi cow, much like in the Vedic era, where it played a central role in agriculture. Various elements of modern natural farming, such as *jeevamrit* and *beejamrit*, rely on cow dung and urine. The tradition of treating or coating seeds with these formulations before planting echoes practices from the Vedic period. While conventional farming heavily relies on chemical fertilizers for high yields, it comes at the expense of environmental degradation. Consequently, there's a growing shift towards organic and natural farming methods to minimize harmful impacts on the environment. Masanobu Fukuoka (1913-2008) pioneered natural farming, also known as "the Fukuoka method," "the natural way of farming," or "do-nothing farming." It offers an ecological approach to agriculture, which is a chemical-free adaptation of traditional farming techniques. This method is celebrated for its agroecological emphasis, promoting a diverse farming system that harmonizes crops, trees, livestock, and functional biodiversity. Natural farming is primarily focused on on-farm biomass recycling, mulching, using on-farm cow dung-urine formulations, regulating soil aeration, and excluding any synthetic chemical inputs

(Sarma *et al*., 2023). As per a survey conducted by LVC (La Via Campesina), ZBNF demonstrates effectiveness beyond just agronomic factors and financial benefits. The majority of participants reported various positive outcomes following ZBNF implementation, including increased yield, soil preservation, seed variety, product quality, household food security, income, and health improvements over time. A significant concern among Indian farmers, such as reduced farm costs and decreased reliance on borrowing, was commonly addressed through this approach (Bhati, 2017). During a field survey, farmers engaged in natural farming were asked about the agricultural yield of the main crops over the past three years. The objective was to ascertain whether there has been an increase in the yield of crops cultivated naturally. The findings revealed that the production of nearly all crops has remained fairly consistent over the last three years across all three states: Andhra Pradesh, Karnataka, and Maharashtra (Kumar *et al*., 2020). The combination of applying 75% of the recommended dose of nitrogen, along with foliar spray of *panchagavya* at 4% concentration and *jeevamrita* at 500 liters per hectare, accompanied by irrigation at 30 and 45 days after sowing, led to the highest plant height at harvest (198.62 cm), dry matter yield at harvest (85.78 g), grain yield (4393 kg/ha), and straw yield (7567 kg/ha) in pearl millet (Patel *et al*., 2021). Meanwhile, organic farming is also gaining importance at the same time. To enhance the productivity of organic crops in India, it is essential to conduct comparable research. Additionally, it's valuable to evaluate the status of organic farming across different production systems and farming environments in the country, ensuring representation from various farms to gain a comprehensive understanding and develop research programs rooted in solid scientific principles (Ramesh *et al*., 2010). Organic cultivation not only stresses ecological harmony but also aims to produce crops that are healthier and more nourishing. Organic fertilizers play a vital role in meeting the nutrient needs of crops and enhancing the activity of soil macro and microorganisms. The benefits of organic farming extend to both developed and developing nations, encompassing environmental protection, biodiversity enhancement, reduced energy consumption, and lower CO_2 emissions in developed countries. Utilizing recommended doses of nitrogen through organic manure and biofertilizers exceeded the productivity of rice by 28% compared to controls (Yadav *et al*., 2013). As the detrimental effects of chemical farming become more evident, Assam, like many other regions, is increasingly embracing organic farming methods. These measures aim to safeguard crops, soil, and ecosystems from the harms associated with inorganic farming practices. This shift towards natural and organic farming signifies a commitment to environmental protection and sustainable agriculture. Encouraging farmers to adopt organic farming methods is essential, particularly for cultivating *joha* rice, as it serves as a dependable source of nutrition while preserving soil health and ensuring the long-term sustainability of soil resources (Dutta *et al*., 2024). Consequently, a research experiment was undertaken to systematically gather empirical evidence concerning the cultivation of *Joha* rice utilizing organic and natural farming practices with relation to chemical properties of soil.

Materials and methods

A field research was conducted at Assam Agricultural University-Assam Rice Research Institute-, located at Titabar, Jorhat, India in the *kharif* season of 2022-2023. The soil was characterized as clay loam with pH value of 5.63, organic carbon content of 8.40 g, available nitrogen at 284.12 kg ha^{-1}, available P_2O_5 at 22.52 kg ha^{-1} and available K_2O at 127.43 kg ha^{-1}. The experiment was laid in a randomized block design with three replications. Total of eight treatments were taken which were as follows: T_1 [Absolute control], T_2 [(Natural farming, *Beejamrit* as root dip treatment (3%) (100 L ha^{-1}) + *Jeevamrit* as spray (3%) (100 L ha^{-1}) + *Ghanajeevamrit* as soil treatment at 100 kg (Jeevamrit and *Ghanajeevamrit* at 30, 60 and 90 DAT)], T_3 [(Enriched compost (5 t ha^{-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})], T6 [Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})], 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})] and T_8 [Vermicompost (1 t ha^{-1}), mixed inocula of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 (4kg ha^{-1}), rock phosphate (10 kg P_2O_5 ha^{-1})]. The rice variety used for the experiment was *Bokul Joha* @ 45 kg/ha. 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. For the natural farming treatments, *beejamrita* was applied to

Table 1: Mechanical composition of soil.

S.	Soil Properties	Value	Method(s) followed
1	Sand (%)	33.25	International pipette method (Piper, 1966)
2	Silt (%)	29.25	
3	Clay (%)	36.50	
4	Textural class	Clay loam	

Table 2: Initial chemical properties of soil (Before sowing).

S. No.	Chemical properties	Value	Status	Method (s) followed
1	Soil reaction (pH)	5.63	Acidic	Glass electrode method(Jackson, 1973)
2	Organic Carbon (%)	8.40	Very high	Wet digestion method(Walkley and Black, 1934)
3	Available N (kg/ha)	284.12	Medium	Alkaline potassium permanganate method (Subbiah and Asija, 1956)
4	Available P_2O_5 (kg/ha)	22.52	Medium	Bray's I Method,(Jackson, 1973)
5	Available K_2O (kg/ha)	127.43	Low	Neutral normal ammonium acetate method (Jackson,1973)

the seeds before sowing, while *jeevamrita* and *ghanajeevamrita* were used as sprays during the growth period. *Azolla* was applied at a rate of 400 kg/ha as a dual crop in a single plot (T7) for each replication, two weeks prior to transplantation. The seedlings were removed from the soil one day before transplantation, and each biofertilizer was applied at a rate of 4 kg/ha as a root dip treatment to the seedlings per treatment. Neem oil and *brahmashtra*were utilized for plant protection in the experimental plots. Soil organic carbon was estimated using the wet digestion method described by Walkley and Black (1934), while pH was measured using the glass electrode method outlined by Jackson (1973). The available nitrogen was estimated by alkaline permanganate oxidation method as outlined by Subbiah and Asija (1956). The available phosphorus was determined by Bray's I method using colorimeter (470 nm wavelength) as outlined by Jackson (1973). The available potassium was extracted with neutral normal ammonium acetate and the content of K in the solution was estimated by Flame photometry (Jackson, 1973). Data related to the experiment were analysed by ANOVA and the significance was determined by using Fisher's least significance difference (p = 0.05%).

Results and Discussions

The organic and natural farming inputs had no significant effect on the pH of the soil. The pH of the soil was in the range of 5.60 and 5.83. The application of vermicompost (1 t/ha), mixed inocula of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 (4kg/ha), rock phosphate (10 kg P_2O_5) resulted in the highest soil pH and the lowest was observed in control. It is most likely caused by organic inputs due to release of various organic acids from them. The organic carbon content was found to be non-significant among all the treatments. These could be the result of the organic matter taking time to build up; therefore, the OC content might not vary significantly in a year. Applying organic and natural farming inputs was found to enhance the amount of available nitrogen. Application of *azolla* as dual crop (400 kg/ha) + biofertilizers (*Azospirillum*, PSB and KSB mix as seedling root dip) (4 kg/ha) resulted in significantly enhanced accessible soil nitrogen (272.53 kg/ha). The control treatment recorded the lowest value (262.78 kg/ha). The increased availability of nitrogen in soil may be mainly due to incorporation of *azolla* and other organic sources of nutrients as observed by Bharadwaj *et al.*,

Table 3: Effect on Organic Carbon, available N, P_2O_5 and K_2O in soil.

Treatments	Organic Carbon (g)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
T_1: Absolute Control	8.0	262.78	19.03	118.26
T_2: NF, *Beejamrit* as root dip treatment (3%) (100 L ha^{-1}) + *Jeevamrit* as spray (3%) (100 L ha^{-1}) + *Ghanajeevamrit* as soil treatment at 100 kg (Jeevamrit and *Ghanajeevamrit* at 30, 60 and 90 DAT)	8.3	263.39	19.26	119.71
T_3: Enriched compost (5 t ha^{-1}) + Biofertilizer (*Azospirillum*, PSB as seedling root dip) (4 kg ha^{-1})	8.4	265.03	21.36	122.66
T_4: Enriched compost (5 t ha^{-1})	8.5	264.56	20.48	121.12
T_5: Vermicompost (5 t ha^{-1})	8.8	263.87	20.12	120.23
T_6: Enriched compost (2.5 t ha^{-1}) + Vermicompost (2.5 t ha^{-1})	8.7	264.89	21.06	121.32
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})	8.3	272.53	21.63	123.01
T_8: Vermicompost (1 t ha^{-1}), mixed inocula of *Azospirillumamazonense* A-10 and *Bacillus megaterium* P-5 (4 kg ha^{-1}), rock phosphate (10 kg P_2O_5)	8.2	268.09	23.28	123.17
Sem (±)	0.82	1.13	0.35	0.38
CD (p=5%)	NS	3.40	1.08	1.16

Here, T= Treatment, PSB = Phosphate Solubilizing Bacteria, KSB=Potassium Solubilizing Bacteria, DAT = Days After Transplanting and NF=Natural Farming.

(1994), Mahmoud *et al.*, (2012) and Mandal *et al.*, (1999).

Available phosphorus was found to be increased with application of organic farming inputs. Significantly higher available soil phosphorus was recorded with application of vermicompost (1 t/ha), mixed inocula of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 (4kg/ha), rock phosphate (10 kg P_2O_5), (23.28 kg/ha). The lowest was found in control (19.03 kg/ha).A significant change in the available phosphate content was observed due to the application of various inputs over the control. The application of organic amendments, which released organic acids as a result of microbial breakdown, may be responsible for the increase in the amount of accessible phosphorus. Additionally, the addition of rock phosphate, *Azospirillum*, and PSB improved the chemical characteristics of the soil. Both Akande *et al*., (2005) and Sharma and Mittra (1989) observed similar findings. The same treatment has also resulted in highest K_2O content (123.17 kg/ha) of soil over all other inputs. The lowest was found in control (118.26 kg/ha). The higher availability of potassium in soil may be due to beneficial effect of KSB and other organic inputs on reduced potassium fixation. Similar observations were recorded by Reddy and Reddy, (1998) and Sharada *et al*., (2018)

Conclusion

Combined application of vermicompost (1 t/ha) along with inocula of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 (4kg/ha) and rock phosphate (10 kg P_2O_5) can enhance the presence of organic matter, phosphorus and potassium in the soil. Also, growth of *azolla* as dual crop has the ability to increase the nitrogen content in the soil. Thus, enhancing crop productivity in *joha* rice while providing sufficient nutrition to soil, preserving soil health, enriching soil microorganisms with the long-term sustainability of soil resources.

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