Influence of Various Nutrient Sources on Rice [*Oryza sativa* L.] Productivity and quality of under Organic Farming

ABSTRACT

The field investigation aimed to examine the impact of various organic nutrient sources on rice var. GNR-7 at the Organic Farm of ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat during the *kharif* season of 2021. The experiment was structured using a Randomized Block Design with a Factorial concept, incorporating two levels: soil application and foliar application, each comprising fourth factors.Total of twelve treatment*i.e.*, S_1:100% RDN through NADEP compost, S_2: 80% RDN through NADEP compost along with *Azospirillium* and PSB @ 2 l/ha each S_3: 60% RDN through NADEP compost along with *Azospirillium* and PSB @ 2 l/ha each and S_4:Ghan-jivamrut @ 500 kg/ha + Jivamrut @ 500 l/ha and that of foliar application were, F_0: Control, F_1: Novel organic liquid nutrient @ 1% and F_2: *Moringa leaf extract* @ 3%. The application of foliar spray was done thrice at 15, 30 and 45 days after sowing. were replicated thrice.The result revealed that S_1 treatment significantly recorded the grain yield and S_2 treatment significantly recorded the straw yield. While for foliar application, the treatment F_2 significantly recorded the highest grainand straw yield but remained at par with F_1 treatment. The mean data of quality parameters did not significantly change due to soil and foliar application of different organic nutrient sources.It can be determined that the soil application of 100 per cent RDN through NADEP compost and foliar application of either 3 per cent *Moringa leaf extract* or 1 per cent Novel organic liquid nutrient at 15, 30 and 45 DAS resulted in higher yield and also improved the quality parameters of rice under organic farm.

Keywords: NADEP compost; Ghan-jivamrut; jivamrut; biofertilizer; rice; novel organic liquid nutrient; *moringa leaf extract*; organic farming; quality parameters; yield

Introduction :

The escalating population in our country has heightened the demand for food grain, prompting Indian agriculture to embrace green revolution technology. However, the relentless pursuit of increased food grain production has resulted in the excessive use of chemical fertilizers, leading to soil degradation.The imbalanced and excessive application of agricultural chemicals, including fertilizers and synthetic pesticides, has led to soil degradation, thereby compromising the quality of farm produce. Products tainted with unnecessary chemicals pose a potential threat to consumer health. Cultivating crops through eco-friendly methods emerges as a viable solution in addressing these concerns, particularly as the demand for high-quality food continues to surge [1]. Organic farming is a production system that eschews or significantly limits the use of synthetic fertilizers, pesticides, growth regulators, genetically modified organisms, and livestock feed additives. To the fullest extent feasible, organic farming relies on practices such as crop rotations, utilization of crop residues, animal manures, legumes, green manures, off-farm organic wastes, biofertilizers, mechanical cultivation, mineral-bearing rocks, and various forms of biological control to maintain soil productivity and tilth. These natural inputs, readily accessible, facilitate slow nutrient release, supply both macro and micronutrients, and foster a conducive soil environment for microbial populations [2].

Rice *(Oryza sativa* L.) stands as the primary food source for almost half of the world's population, making it a crucial staple in Asian diets. With over 50 percent of the global population relying heavily on rice consumption, its significance extends beyond mere sustenance, impacting economies, employment, cultural practices, and historical narratives [3]. In India, rice holds the status of a staple food for nearly 65 percent of the population.Asia is commonly referred to as the 'rice bowl' of the world, as it accounts for over 90% of the global production and consumption of rice, making it the premier food crop worldwide. Following China, India holds the position of the second-largest producer of rice globally. In the year 2021-2022, India's rice cultivation covered an area of 46.38 million hectares, yielding a production of 130.29 milliontonnes with an average productivity of 2809 kg/ha. The leading rice-producing states within India include West Bengal, Uttar Pradesh, Punjab, Odisha, Andhra Pradesh, Bihar, Chhattisgarh, Tamil Nadu, and Gujarat [4].

In organic farming, composting, particularly the NADEP method, presents an environmentally friendly solution. Cow-based organic manures such as jivamrut, bijamrut, and panchgavya serve as excellent alternatives to chemical fertilizers, playing a pivotal role in organic farming [5]. Biofertilizers containing nitrogen-fixing and phosphate-solubilizing microorganisms enhance soil health by accelerating specific microbial processes, thereby increasing the availability of nutrients in a form readily assimilated by plants [6]. Moringa leaf extract, acting as a bio-stimulant with zeatin, efficiently enhances crop growth, reducing reliance on chemical fertilizers [7]. Enriched banana pseudo-stem sap serves as a remedy for the harmful effects of inorganic farming. This value-added product, known as "NOVEL-Liquid Organic Nutrient," developed by the Banana Pseudo-stem Processing Unit at Navsari Agricultural University, Navsari, Gujarat, contains essential macro and micronutrients, plant growth regulators, and beneficial microbes, thus promoting crop growth and protecting against pests [8]. These organic practices, addressing both the environmental and economic burdens of chemical fertilizers, are in line with the growing global trend towards sustainable agriculture. As awareness grows, integrating these methods can ensure a healthier and more environmentally friendly future for pulse cultivation, thereby contributing to both food security and sustainable agriculture [9]. Given the importance and anticipated increase in demand for quality food, this study proves invaluable in addressing these challenges.

2. Materials and Methods

The field experiment took place at the Organic Farm of ASPEE College of Horticulture, Navsari Agricultural University, Navsari during the *kharif* season of 2021, focusing on ricevar. GNR-7. It was structured using a Randomized Block Design with a Factorial concept (FRBD), with two factors: soil application and foliar application, each having fourth levels and replicated thrice. The fourth levels of soil application included: S_1:100% RDN through NADEP compost, S_2: 80% RDN through NADEP compost along with *Azospirillium* and PSB @ 2 l/ha each S_3: 60% RDN through NADEP compost along with *Azospirillium* and PSB @ 2 l/ha each and S_4: Ghan-jivamrut @ 500 kg/ha + Jivamrut @ 500 l/ha and that of foliar application were, F_0: Control, F_1: Novel organic liquid nutrient @ 1% and F_2: *Moringa leaf extract* @ 3%. Foliar spraying was carried out thrice at 15, 30, and 45 days after sowing. Twenty-one days old seedlings were transplanted at the spacing of 20 cm row to row and 15 cm plant-to-plant distance. Two to three seedlings per hill were transplanted.The experimental field's soil had a clayey texture (57.20%) with high organic carbon content (0.77%) and medium levels of available K_2O (495.52 kg/ha), available N (266.8 kg/ha), and available P_2O_5 (60.52 kg/ha). Favorable weather conditions prevailed throughout the cropping period, facilitating optimal crop growth and development.

Table 1. Treatment details

Factor I: Soil application (S)

S_1:100% RDN through NADEP compost

S2:80% RDN through NADEP compost along with*Azospirillum* andPSB @ 2 lit/ha each

S_3:60% RDN through NADEP compost along with*Azospirillum* andPSB @ 2 lit/ha each

S_4:Ghan-jivamrut @ 500 kg/ha + Jivamrut @500 lit/ha

Factor II: Foliar application (F)

F_0:Control

F_1:Novel Organic liquid nutrient @ 1%

F_2:*Moringa* leaf extract @ 3%

Quality content

Starch content (%) The estimation of starch by anthrone reagent. The sample is treated with 80% alcohol to remove sugars and then starch is extracted with perchloric acid [10.]Amylose content (%)A method for the determination of the amylose content in starch has been developed which is based on the colorimetric measurement of the iodine complexes formed with amylose and amylopectin. The method requires measurement at only one wavelength and avoids the use of harsh dispersants for the starch [11].Amylopectin content (%) Amylopectin content was determined as the difference between the total starch content and amylose content and expressed as the percentage of starch.Amylose-amylopectin ratio: Amylose-amylopectin ratio is the main factor for classifying rice into waxy and non-waxy. Amylose-amylopectin ratio of rice samples was estimated as per the method suggested [12].

Cooking quality

Gel consistency (mm) Gel consistency is a measure of the flow characteristics of milled rice (100 mg) in 2.0 ml 0.2N KOH and is indexed by the length of cold horizontal gel in mm in 13 x 100 mm test tube. Gel consistency test together with the amylose test is a good index of cooked rice texture [13].Paste clarity (Transmittance %) The procedureswith slight modifications were used for determination of starch clarity. 1% dry basis aqueous dispersions of starch were boiled at 100 ℃ for 30 min at constant stirring, and then transferred to plastic tubes and stored at 4 ℃ for 4 weeks. The transmittance was measured at 620 nm using a spectrophotometer every week, obtaining triplicate readings per sample [14].

3. Results and Discussion

3.1 Productivity

3.1.1 Grain yield

Based on the results, it was concluded that the grain yield was significantly influenced by the soil application and foliar application of the organic nutrient sources (Table 2).The S_1 (100% RDN through NADEP compost) treatment recorded significantly higher grain yield of 3749 kg/ha and it remained at par with S_2 (80% RDN through NADEP compost alongwith *Azospirillum* and PSB @ 2 l/ha each) treatment which recorded 3538 kg/ha grain yield.The result revealed that the foliar application of *Moringa leaf extract* @ 3 per cent *viz*., F_2 treatment recorded significantly higher grain yield of 3312 kg/ha but was statistically similar with F_1 treatment where, Novel organic liquid nutrient @ 1 per cent was sprayed and it recorded 3257 kg/ha grain yield.The F_0 treatment, which served as the control with no spray applied, recorded the lowest grain yield at 2959 kg/ha. The influence of the interaction effect of soil and foliar application on grain yield was found to be statistically non-significant, with no observed variation in grain yield. Analysis of grain yield data indicated that the combination of soil application of organic nutrient sources and foliar spray of liquid organic sources significantly influenced seed production, as evident from the substantial variation detected, which positively impacted yield.The higher seed yield attributed to *Moringa leaf extract* may be attributed to its capacity to enhance the loading and unloading of assimilates across membrane boundaries of vascular tissues, thereby increasing yield. Additionally, cytokinins present in *Moringa leaf extract* are known to promote carbohydrate metabolism and establish new source-sink relationships, further contributing to increased crop yield.These findings align with previous studies by Sahare and Mahanpatra[15] in rice, Ghube*et al*. [16] in organic rice, Jhilik*et al*. [17] in wheat, Biswas *et al*. [18] in maize.

3.1.2 Straw yield

The results revealed that the application of $S_2$80% RDN through NADEP compost alongwith *Azospirillum* and PSB @ 2 l/ha each significantly recorded the highest straw yield *i.e*. 5442 kg/ha. While the S_4 treatment where Ghan-jivamrut @ 500 kg/ha + Jivamrut @ 500l/ha was applied recorded the lowest straw yield of 4329 kg/ha. The foliar spray of 3 per cent *Moringa leaf extract* (F_2 treatment) resulted in significantly higher straw yield (5265 kg/ha) and was statistically similar with foliar spray of 1 per cent Novel organic liquid nutrient (F_1 treatment) which recorded 5117 kg/ha straw yield. While the F_0 treatment as control where no foliar application was given recorded the lowest grain yield *i.e*. 4605 kg/ha (Table 2).The statistically non-significant result was obtained for the straw yield due to the interaction effect between the soil and foliar application of various nutrient organic sources.The findings of the present research work were closely related to previous experiment results observed by Parmar *et al*.[19] in maize,Abusuwar and Abohassan [20] in cereals forages, Safiullah *et al*. [21] in sweet corn.

3.1.3 Harvest index

The results indicated that the harvest index did not exhibit significant differences due to the influence of soil application and foliar application of various organic nutrient sources. Numerically, the S_1 treatment exhibited the highest harvest index at 40.9%, followed by S_2 and S_3 treatments at 39.4% and 37.9%, respectively. Regarding foliar application, the F_0 treatment (Control) showed the highest numerical harvest index of 39.1%, compared to the F_1 treatment and F_2 treatment, which recorded harvest indices of 38.7% and 38.5%, respectively (Table 2).The interaction between soil and foliar application of various organic nutrient sources did not significantly affect the harvest index, and the result was statistically insignificant.

3.2 Quality content

3.2.1 Starch content

The statistically non-significant result was obtained for the starch content. It was noted that S_1 treatment recorded numerically the higheststarch content of 76.5%and foliar application of F_2 treatment *Morigna leaf extract*recorded numerically the higheststarch content of 76.4%but, slightly lowest starch content observed in S_3 and F_0 (Fig. 1). The interaction effect of soil and foliar application of various organic nutrient sources showed non-significant result for the starch content.

3.2.2Amylose content

The soil and foliar application of the organic sources failed to influence of the amylose content and the obtained result was statistically non-significant. Numerically the highestamylose content was recoded the $S_2$80% RDN through NADEP compost along with *Azospirillum* and PSB @ 2 l/ha eachtreatment *i.e*. 21.4% and foliar application of F_1*i.e*. Novel Organic liquid nutrient @ 1% (21.5%), but slightly lowest amylose content observed in S_3 and F_0(Fig. 1).The interaction effect of soil and foliar application of various organic nutrient sources showed non-significant result for the amylose content.

3.2.3Amylopectincontent

The statistically non-significant result was obtained for the amylopectin content. The result showed that thenumerically the highest amylopectin content was recoded the S_1*i.e.*100% RDN through NADEP compost of 55.2% and foliar application of F_2*i.e.Morigna leaf extract* @ 3% 55.8% but, slightly lowest amylopectin content observed in S_3 and F_0: *i.e.*control.The interaction effect of soil and foliar application of various organic nutrient sources showed non-significant result for the amylopectin content.

3.2.4. Amylose-amylopectin ratio

The soil and foliar application of the organic sources failed to influence of the amylose-amylopectin ratio and the obtained result was statistically non-significant (Fig. 1). The result showed that numerically the highest amylose-amylopectin ratio was recoded the $S_2$80% RDN through NADEP compost along with Azospirillum and PSB @ 2 l/ha eachtreatment *i.e.* 0.40 and foliar application of Novel Organic liquid nutrient @ 1% (F_1) 0.40, but lowest amylose-amylopectin ratio observed in S_4 and F_0 control. The interaction effect of soil and foliar application of various organic nutrient sources showed non-significant result for the amylose-amylopectin ratio.

3.3 Cooking quality

3.3.1. Gel consistency

The data pertaining to gel consistency (mm) of rice as influenced by different organic nutrient source presented in Fig 2. The result showed that soil application of $S_2$80% RDN through NADEP compost along with *Azospirillum* and PSB @ 2 l/ha each was recorded numerically higher gel consistency (75.22 mm) and foliar application of F_1Novel Organic liquid nutrient @ 1% (75.08 mm), while numerically lowest gel consistency observed in S_4 and F_2. The interaction effect of soil and foliar application of various organic nutrient sources showed non-significant result for the gel consistency.

3.3.2. Paste clarity (Transmittance%)

The data pertaining to paste clarity (transmittance %) of rice as influenced by different organic nutrient source was presented in Fig. 1. The result showed that soil application of S_1*i.e.*100% RDN through NADEP compost was recorded numerically higher paste clarity 1st week (36.81%), 2^{nd} and 3^{rd} week (27.72%, 7.68%) was recorded with S_4*i.e.*Ghan-jivamrut @

500 kg/ha + Jivamrut @ 500 l/ha and 4th week (4.61%) recorded with S_3: i.e., 60 % RDN through NADEP compost along with *Azospirillum* and PSB @ 2 l/ha each. Foliar application result showed that numerically higher paste clarity 1st week and 4th week (36.77 %, 4.58 %) was recorded with F_2*i.e*. *Moringa leaf extract* @ 3%, 2nd week (27.63%) recorded with F_1*i.e*.Novel Organic liquid nutrient @ 1% and 3rd week (7.63%) with F_0*i.e*. control. The interaction effect of soil and foliar application of various organic nutrient sources showed non-significant result for the paste clarity (Transmittance%).

Based on the findings of the above study, it is concluded that adopting soil application of 100% RDN through NADEP compost, along with foliar application of either 3% *Moringa leaf extract* or 1% Novel organic liquid nutrient at intervals of 15, 30, and 45 days after sowing, is recommended for achieving higher yields and enhancing quality content for rice cultivation under organic farming practices.

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Table 2: Effect of different organic nutrient sources on yield of rice var. GNR-7

Treatments	**Grain yield (kg/ha)**	**Straw yield (kg/ha)**	**Harvest index (%)**
Factor I: Soil application (S)			
S_1 - 100% RDN through NADEP compost	3749	5437	40.9
S_2 - 80% RDN through NADEP compost along with *Azospirillum* and PSB @ 2 l/ha each	3538	5442	39.4
S_3 - 60% RDN through NADEP compost along with *Azospirillum* and PSB @ 2 l/ha each	2908	4774	37.9
S_4 - Ghan-jivamrut @ 500 kg/ha + Jivamrut @ 500 l/ha	2511	4329	36.8
SEm±	96	149	0.9
CD at 5%	281	437	2.8
Factor II: Foliar application (F)			
F_0 – Control	2959	4605	39.1
F_1 - Novel Organic liquid nutrient @ 1%	3257	5117	38.7
F_2 - *Moringa* leaf extract@ 3%	3312	5265	38.5
SEm±	83	129	0.8
CD at 5%	243	378	NS
Interaction			
S×F	NS	NS	NS
CV (%)	9.0	8.9	7.1

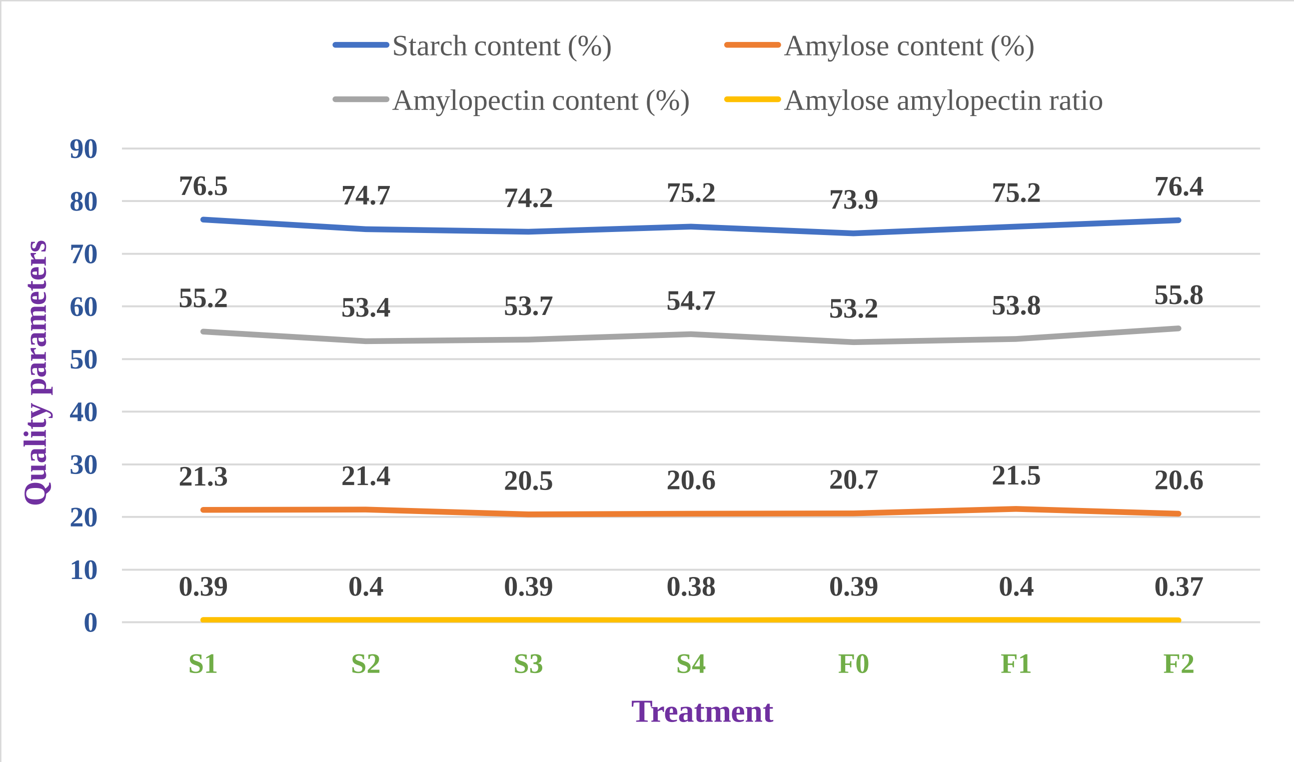

Fig. 1. Effect of different organic nutrient sources on starch, amylose, amylopectin content and amylose-amylopectin ratio

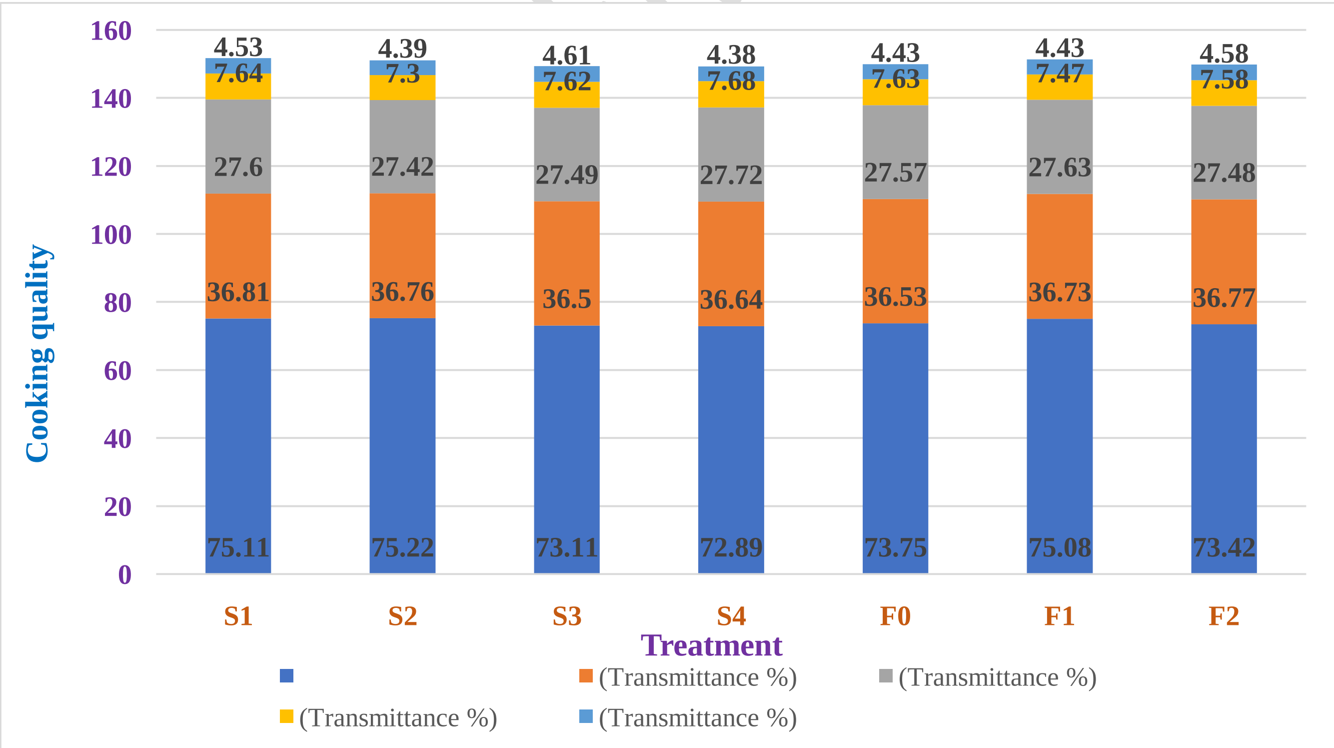

Fig. 2. Effect of different organic nutrient sources on gel consistency and paste clarity (Transmittance %)