EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON THE SEQUENCE OF RICE AND MUSTARD CROPS IN MIDDLE GUJARAT'S CLAY LOAM SOIL

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Abstract

In a randomized block design, six different main plot treatments (T1: 100% RDN through inorganic fertilizer, T2: 100% RDN through FYM, T3: 75% RDN through inorganic fertilizer + Bio NPK consortium, T4: 75% RDN through FYM + Bio NPK consortium, T5: 50% RDN through FYM + 50% RDN through inorganic fertilizers, and T6) were applied to rice in the kharif season. In terms of nutrients, the soil on the experimental plot had a clay loam texture, low levels of organic carbon (0.42%) and available nitrogen (219.10 kg/ha), medium levels of available phosphorus (55.37 kg/ha), and high levels of available potassium (284.08 kg/ha). The electric conductivity of the soil was found to be around par, and its pH was tested to be 8.10.

Keywords: *Integrated Nutrient, Management, Rice and Mustard, Clay Loam Soil.*

1. Introduction

Rice is a nutritious staple meal that is high in carbohydrate and hence gives rapid energy. Protein, micronutrients, and other dietary components rely on carbohydrates as a transport medium. Rice provides 80 percent of the calories, 7 to 8 percent of the protein, 3 percent of the fat, and 3 percent of the fibre needed for the more than 2 billion people who live in Asia. Because it has no fat, cholesterol, or salt, rice is a great addition to any diet. The rice bran, which is rich in lipids like fatty acids, is often discarded during the milling process. Unsaturated fatty acids may make up as much as 80% of rice bran oil's composition. Protein-rich rice might help you feel full longer. It has a high lysine content and is easily digested because to its high protein content. Grain protein accounts for up to 8% of the total, and it contains eight of the nine necessary amino acids in just the right amounts. Micronutrients (such as magnesium, calcium, phosphorus, manganese, and 9 B-vitamins) and important amino acids (tryptophan, histidine, methionine, cysteine, and arginine) found in rice bran may act synergistically to improve health.[1-2]

In India, cropping methods date back to the beginning of farming. Farmers have been working tirelessly to maximize their production per acre and per year. In today's agricultural landscape, this struggle takes the form of cropping systems like multiple cropping, which aim to maximize yield in terms of both production and return on investment by keeping land, labour, capital, and other resources busy throughout the growing season. A agricultural system would be incomplete without a cropping system. In order to make the most effective use of the world's natural resources, cropping systems must adapt in response to factors such as climate, soil, and water. The cropping system has to provide enough food for the household, enough forage for the cattle, and enough money to cover the costs of maintaining the home and the farm. During the kharif seasons, a single crop of rice from a long-duration variety is typically sown. These days, it is common to use numerous cropping techniques and photo-insensitive plant kinds.[3-4]

Promising rice-based cropping systems, such as rice-mustard in Assam, Kashmir, Konkan, etc., in India are among the most popular options for farmers since they not only improve revenue but also make use of the soil's remaining moisture and nutrients. The multi-location experiments cropping systems research project reported on the high productivity and intensive land use of rice-based cropping systems like rice-groundnut and rice-black gram/cotton/sesame in Karnataka, Tamil Nadu, Andrapradesh, and Orissa.[5]

In India, it is cultivated as an oilseed (called brown or Indian mustard), while in China, it is cultivated as a leaf vegetable. The seeds and plant material of Indian oilseeds are rich in 3-butenyl glucosinolate, and the plant is cultivated in western nations, especially western Canada, for the manufacturing of condiments such brown and oriental mustard. Several antioxidant chemicals found in mustard seed may have a protective effect on human health. Rapeseed-mustard normally has an essential oil concentration between 36% and 45%. After the oil is removed, the leftover seed is processed into rape seed-mustard meal, which is used as a feed ingredient for livestock and poultry.[6-7]

2. Literature review

Das, A. and Ghosh, P. K. (2019) Rice production, yield qualities, and nutrient absorption were studied by scientists at the Institute of Agricultural Sciences at Banaras Hindu University in Varanasi, Uttar Pradesh, during the 2011 kharif season. They found that the number of panicles per hill and the duration of the panicles were both greatly improved by using a mixture of 125% RDF and 5 t/ha vermicompost. During the 2013 kharif season, researchers looked into the effects of integrated nutrient management on soil properties, yield, and economics in the alluvial calcareous soil of the Agronomy Research Farm at Narendra Deva University of Agriculture and Technology in Kumargang, Faizabad.[8]

Jayakumar and Naveen, D.V. (2018) During the kharif season of 2000, scientists at Agricultural Farm, Pallisiksha Bhavana visva-Bharati, Sriniketan conducted a field experiment to study the effects of integrated nitrogen management on rice growth and yield. Greater numbers of grains per panicle, 1000 grain weight, and grain yield were seen when 50% N (60 kg/ha) was applied by inorganic fertiliser and 50% N (60 kg/ha) was applied via FYM, as opposed to 75% N (90 kg/ha) via inorganic fertiliser and 25% N (30 kg/ha). The highest straw yield was achieved with 75% N (90 kg/ha) from inorganic fertiliser and 25% N (30 kg/ha) from FYM, while the harvest index was highest with 50% N (60 kg/ha) from chemical fertiliser and 50% N (60 kg/ha) from FYM.[9]

Das, D. and Shahid, M. (2017) In a lab experiment conducted at the Agricultural Research Farm, Institute of Agricultural Science, Banaras Hindu University, Varanasi, rice was grown using both organic and inorganic sources of N. The results showed that RDF (120-60-60 kg NPK/ha) produced significantly higher effective tillers per metre, grains per panicle, grain and straw yields and harvest index compared to the control. Higher grain and straw yields were recorded when 40 kg N was applied through digested sludge, 40 kg N was applied via press mud, and 40 kg N was applied via carpet wastes.[10]

Jat, N.K. and Shamim, M. (2016) The impact of integrated nutrient management on soil properties, yield, and economics of rice was studied in alluvial calcareous soils at the Agronomy Research Farm of Narendra Deva University of Agriculture and Technology in Kumargang, Faizabad (UP) during the kharif season of 2013. They found that using 50% RDF + 50% FYM significantly outperformed the control and the other treatments in terms of grain production, straw yield, number of grains per panicle, and test weight.[11]

Keivanrad, S. and Zandi, P., (2015) the 25-year impact of fertilization in a rice-rice cropping system on production, nutrient absorption, economics, and soil fertility in vertisol soil. There was a statistically significant increase in yield for all experimental treatments, whether they used fertilizers alone or in conjunction with organic or bio-fertilizers, herbicides, or soil amendments. Grain and straw yields were both considerably increased by combined green manuring (6.25 t/ha) and gypsum (500 kg/ha) fertilization at a rate of 125:50:50 kg/ha.[12]

3. Methodology

To conduct the present study, a field experiment of integrated nutrient management was set up in the kharif season for rice using organic manure like FYM and bio fertilisers like Bio NPK consortium in addition to chemical fertilisers and doses of recommended fertiliser for mustard in the rabi season. For the two kharif-rabi seasons, 2018–19 and 2019–20, the experimental location will not alter the randomization process.

3.1 Experimental site

The experiment was conducted at the Main Rice Research Station of Anand Agricultural University in Nawagam, India, during the kharif (Rice) and rabi (Mustard) seasons of 2018–19 and 2019–20. There isn't a lot of variation in elevation at the testing site.

3.2 Rice (kharif)

Six different INM treatment combinations were used on the rice crop. Instructions for care are listed in Table 3.9.

Table 3.9: Specifics of Medicated Combos (Rice) Kharif

T_1	Using just inorganic fertiliser, we have achieved a 100% RDN.
T_2	Until the end of FYM, RDN was 100%
T_3	Consortium for the Production of Inorganic and Biological NPK Fertilisers (75%)
T_4	RDN at 75% through the FYM+BioNPK Consortium
T_5	Half the RDN from FYM and the other half from inorganic fertiliser
T_6	50% RDN from inorganic fertiliser and the Bio NPK Consortium, plus 25% from FYM

3.3 Mustard (Rabi)

After applying six different treatment combinations to kharif rice, the results were measured on a rabi season mustard crop grown with three different recommended doses of fertiliser. Table 3.10 provides information on available treatments.

Table 3.10: Specifics of Drug and Procedure Pairings Mustard rabi

I.Mainplottreatment

Sixtreatmentappliedon preceding *kharif*rice	
T_1	Using just inorganic fertiliser, we have achieved a 100% RDN.
T_2	Until the end of FYM, RDN was 100%
T_3	Consortium for the Production of Inorganic and Biological NPK Fertilisers (75%)
T_4	RDN at 75% through the FYM+BioNPK Consortium
T_5	Half the RDN from FYM and the other half from inorganic fertiliser
T_6	50% RDN from inorganic fertiliser and the Bio NPK Consortium, plus 25% from FYM
II.SubplottreatmentRabi(Mustard)	
S_1	100 %RDF
S_2	75 %RDF
S_3	50 %RDF

3.4 Statistical analysis

3.4.1 Statistical analysis and interpretation of data

statistical techniques were utilised to analyse the data on the various variables. The "F" test was used to compare the outcomes of the treatments for each of the characters. Randomised Block Design was used to examine the kharif rice data, whereas Split Plot Design was used to investigate the rabi mustard data.

Wherever "F" test differences between treatments were determined to be statistically significant, the 5% critical difference (CD) was computed; otherwise, just the standard error of the mean was computed. To further measure accuracy, the co-efficient of variation was calculated for each character.

3.4.2 Pooled analysis

Under two distinct seasonal circumstances, the straightforward method of analysis of variance may not be applicable due to the presence of substantial error variances in the seasons and the interaction between treatments and seasons. Therefore, the approach was applied to a two-year pooled study of kharif rice and rabi mustard. Error variance homogeneity was assessed using Barter's test. Our goal was to determine whether there is a season-and-treatment interaction by comparing the variation seen across seasons and treatments with the variance observed across the joint estimate of error.

4. Results

study, "Effect of Integrated Nutrient Management in Rice and Mustard Cropping Sequence on Clay Loam Soil in Central Gujarat," aims to answer this question. The research was conducted throughout the kharif and rabi seasons of 2018–19 and 2019–20 at the Main Rice Research Station of Anand Agricultural University in Nawagam.

4.1 Effect of INM on growth attributes of rice

Here, we detail the experimentation's 30-day, 60-day, and harvest-time observations of several development characteristics.

At 30 days after transplanting, neither individual treatments nor the combination of treatments had a statistically significant effect on plant height (Tables 4.1). At 30 days after transplanting, the rice plants were the same height across all treatments.

Significant differences in plant height were seen between INM treatments at 60 DAT. Treatment T1 (100% RDN through inorganic fertiliser) recorded significantly higher plant height compared to the other INM treatments, while remaining on par with the other treatments, with the exception of Treatment T2 (100% RDN from FYM) in both the first year and the pooled year. However, both in the individual years and in the pooled analysis (Table 4.2), the lowest plant height was obtained under the treatment T2 (100% RDN from FYM).

It is possible that the taller plants at 60 DAT in Treatment T1 (100% RDN using inorganic fertiliser) are due to the fact that a total of nitrogen 80 kg N/ha was supplied to the plant through the basal, tillering, and panicle initiation phases. Multiple INM treatments had a dramatic effect on plant height at harvest time. Treatment T1 (application of 100% RDN through inorganic fertiliser) produced significantly taller plants, and it was on par with treatment T5 (application of 50% RDN through FYM + 50% RDN through inorganic fertiliser) in these same years.

The treatment T1 (100% RDN through inorganic fertiliser) resulted in much taller plants. This may be attributable to the rice's efficient usage of nitrogen during its most formative phases of development. However, under treatment T2 (application 100% RDN via FYM), plant height was observed to be lower at 91.10, 103.16, and 97.13 cm at the harvest stage in 2018, 2019, and on a pooled basis, respectively (Table 4.3).

Table 4.1: The effects of 30 days after transplant on rice plant height in response to INM treatments

Treatments		Plantheight30DAT(cm)		
		2018	2019	Pooled
T_1	100%RDNthroughinorganicfertilizer	72.73	69.30	71.01
T_2	100%RDNthroughFYM	62.63	56.76	59.70
T_3	75%RDNthroughinorganicfertilizer+ BioNPKConsortium	65.50	59.36	62.43
T_4	75%RDNthroughFYM+BioNPK consortium	64.76	58.89	61.83
T_5	RDN provided by FYM and inorganic fertiliser each equals 50%	67.23	71.43	69.33
T_6	50% RDN from inorganic fertiliser + Bio NPK consortia + 25% RDN from FYM	64.40	68.14	66.27
S.Em.±		4.27	3.75	2.77
C.D. at 5%		NS	NS	NS
C.V.(%)		11.17	10.15	10.70
Interaction (YxT)		-	-	NS

Table 4.2: The effects of 60 days after transplant on rice plant height in response to INM treatments

Treatments		Plantheight60DAT(cm)		
		2018	2019	Pooled
T_1	100%RDNthroughInorganic fertilizer	104.18	106.00	105.10
T_2	100%RDNthroughFYM	82.68	95.56	89.12
T_3	75%RDNthroughInorganicfertilizer +BioNPKConsortium	101.42	100.12	100.77
T_4	75%RDNthroughFYM+BioNPK Consortium	95.73	97.78	96.76
T_5	Using 50% RDN from FYM and 50% RDN from Inorganic Fertilizer	102.47	103.76	103.12

T_6	50% RDN from inorganic fertilizer and the Bio NPK Consortium, plus 25% from FYM	100.69	96.03	98.36
S.Em. ±		4.26	4.81	3.16
C.D. at 5%		13.41	NS	9.21
C.V.(%)		7.53	8.35	7.96
Interaction (YxT)		-	-	NS

Table 4.3: Variation in rice plant height as a result of INM treatments

Treatments		Plantheightatharvest(cm)		
		2018	**2019**	**Pooled**
T_1	100%RDNthroughInorganicfertilizer	121.16	124.80	122.98
T_2	100%RDNthroughFYM	91.10	103.16	97.13
T_3	75%RDNthroughInorganicfertilizer+ BioNPKConsortium	105.90	112.43	109.17
T_4	75%RDNthroughFYM+BioNPK Consortium	103.63	105.93	104.78
T_5	Fifty percent of the RDN from FYM and fifty percent from inorganic fertiliser	116.23	121.50	118.87
T_6	50% RDN from inorganic fertiliser and the Bio NPK Consortium, plus 25% from FYM	106.13	108.65	107.39
S.Em.±		4.66	4.68	3.07
C.D. at 5%		14.67	14.76	8.93
C.V.(%)		7.51	7.20	7.35
Interaction(Yx T)		-	-	NS

Table 4.4 details the bio-metric observations made throughout 2018–19 and 2019–20, as well as in pooled analysis, with regard to growth variables including periodic plant stand reported at 15 DAS and at harvest, plant harvest height and harvest branch density. We show and analyse in detail the findings obtained as a consequence of the influence of integrated nutrition management treatment to preceding rice and direct application of fertilisation treatments on mustard.

The characteristics of a mustard plant are mostly dependent on its height. The harvest height measurements from 2018–19 and 2019–20 are shown in Table 4.4, together with the effects of INM treatments, RDF treatments, and their interactions.

Table 4.4 shows that there was no statistically significant difference in plant height measured at harvest between the two integrated nutrition management treatments in either the 2018–19 or 2019–20 trial years.

Table shows that differing fertiliser levels had a major impact on plant height measured at harvest in 2018–19, 2019–20, and on a pooled basis. Plant height measured 163, 173, and 168 cm for Treatment S1 (100% RDF) in 2018–19, 2019–20, and on a pooled basis, respectively, and measured 163, 173, and 168 cm for Treatment S2 (75% RDF) in both experimental years.

Table4.4:Mustard plant height in relation to postharvest INM levels and fertilizer application.

Treatment		Plantheight(cm)atharvest		
		2018	2019	Pooled
Mainplottreatment(*Kharif*Rice)				
T_1	Fertiliser made out of 100 percent RDN	158	169	164
T_2	100%RDNthroughFYM	164	169	167
T_3	75%RDNthroughinorganicfertilizer+ BioNPKConsortium	152	169	161
T_4	75%RDNthroughFYM+BioNPK Consortium	155	170	162
T_5	Half the RDN from FYM and the other half from inorganic fertiliser	162	172	167
T_6	25 percent RDN from FYM, 50 percent from inorganic fertiliser, and 5 percent from bio-NPK	153	166	159

	S.Em. ±	4.72	4.99	3.44
	C.D. at 5%	NS	NS	NS
	CV(%)	9.01	8.85	8.93
Subplottreatment(*Rabi*Mustard)				
S_1	100 %RDF	162	173	168
S_2	75 %RDF	157	169	163
S_3	50 %RDF	152	166	159
	S.Em. ±	2.05	1.39	1.24
	C.D. at 5%	5.99	4.06	3.52
	CV(%)	5.53	3.49	4.55
Interaction(TxS)		NS	NS	NS

Table 4.5's data also showed that different concentrations of fertilizer had an effect on rice equivalent yield. Treatment S1 (100% RDF) had the highest rice equivalent yield of the rice mustard cropping sequence in the first year and on a pooled basis (9314 and 10013 kg/ha, respectively), while in the second year, the same treatment had the highest crop equivalent yield (10712 kg/ha), which was on par with treatment S2 (75% RDF).

Table 4.5:Influence of INM treatments and fertilizer levels on rice equivalent production from a rice-mustard cropping cycle

Treatment		REY(kg/ha)		
		2018	2019	Pooled
Mainplottreatment(*Kharif*Rice)				
T_1	Fertiliser made out of 100 percent RDN	10033	10899	10466
T_2	Until the end of FYM, RDN was 100%	9578	11458	10518
T_3	75%RDNthroughinorganicfertilizer +BioNPKConsortium	7903	9046	8475
T_4	75%RDNthroughFYM+BioNPK Consortium	8542	10177	9360
T_5	Half the RDN from FYM and the other half from inorganic fertiliser	10235	11533	10884
T_6	25 percent RDN from FYM, 50 percent from inorganic fertiliser, and 5 percent from bio-NPK	8174	9370	8772

	S.Em. ±	225	414	236
	C.D. at 5%	709	1306	696
	CV(%)	3.36	3.31	3.33
Subplottreatment(*Rabi*Mustard)				
S_1	100 %RDF	9314	10712	10013
S_2	75 %RDF	9135	10495	9815
S_3	50 %RDF	8784	10036	9410
	S.Em. ±	60	84	52
	C.D. at 5%	176	244	147
	CV(%)	3.99	3.93	3.96
Interactioneffect(TxS)		NS	NS	NS

5. Conclusion

Both 50% RDN via FYM + 50% RDN through inorganic fertilizer, and 100% RDN via inorganic fertilizer, enhanced the growth and yield characteristics of kharif rice. The best rice equivalent yields were obtained using a crop rotation that alternated between rice and mustard, with 50% RDN via FYM + 50% RDN through inorganic fertilizer recorded to rice, and 100% RDF to mustard. Using 100% RDN with inorganic fertilizers yielded the best nett financial returns, followed by 50% RDN with FYM + 50% RDN with inorganic fertilizer to rice, and finally 100% RDF rabi mustard, followed by 75% RDF, according to the system economic analysis.

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