Effect of integrated nutrient management on growth Characteristics of the soil properties of rice crops

Abstract

The field experiment was conducted at Main Experimental Station of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during the *Kharif*, 2014 to study theeffect of integrated nutrient management on soil properties, growth Characteristics of rice (*Oryzasativa*). The experiment comprised of ten treatments *viz.* T_1 (control), T_2 (100% RDF) T_3 (125% RDF), T_4 (100% RDF + FYM @ 5 t ha^{-1}), T_5 (100% RDF + Brown manuring), T_6 (100% RDF + BGA@ 10 kg ha^{-1}), T_7 (100% RDF + PSB), T_8 (Farmers practice (N_{100}:P_{40}:K_0), T_9 (100% RDF + FYM @ 5 t ha^{-1} + PSB + *Azatobacte*r + BGA) and T_{10} (100% RDF + FYM @ 5 t ha^{-1} + PSB + *Azatobacter* + Brown manuring) in Randomized Block Design with three replications with rice variety NDR-97 was taken. The experimental soil was silty loam in texture having the maximum values of pH (7.88), EC dSm^{-1}(0.32), organic carbon (0.34 %).

Keys words: RDF, FYM, PSB , Azotobacter, BGA

Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop in the world. It is a rich source of energy and contains a reasonable amount of protein (6-10%), carbohydrate (70-80%), minerals (1.2-2.0%), and vitamins such as riboflavin, thiamine, niacin, and vitamin E. Over 90% of the world's rice is grown and consumed in Asia, often referred to as the "rice bowl of the world," where 16% of the earth's population and two-thirds of the world's poor reside. Rice is the principal food for people living in the humid tropics and subtropics, and it is cultivated in tropical and subtropical regions globally.The global requirement for rice is projected to be about 880 million tonnes by 2050. According to the FAO (2014), worldwide production of rice was 719.74 million metric tonnes with an acreage of 160.6 million hectares. In India, rice is cultivated over approximately 43.9 million hectares, with an annual production of about 88.02 million tonnes. India contributes around 21% of global rice production from its 28% share of the world's rice area. Rice is a vital food for the majority of the world's population. In Uttar Pradesh, the area under rice cultivation is about 5.964 million hectares, with a production of 2.50 million tonnes and a productivity of 2358 kg per hectare (FAO 2014).The decline or stagnation in rice yield has been attributed to nutrient depletion and reduced use of organic matter (John et al., 2001). In the current scenario, where food and nutritional security are under threat, it is imperative to enhance the soil-plant-atmosphere system as a whole rather than focusing solely on crop nutrition. The combined use of organic and inorganic nutrient sources, along with biofertilizers, has proven to be more effective than using each component separately (Palanippan and Annadurai, 2007). India's population is expected to reach 1.4 billion by the year 2025, further emphasizing the need for sustainable agricultural practices.

Material and Method:

Geographical situation of experimental site:

The experiment was conducted at the Main Experimental Station of Narendra Nagar (Kumarganj), Faizabad (U.P.) during the Kharif season of 2014. This chapter describes the climatic and edaphic conditions, materials used, and methods employed during the investigation.

The Main Experimental Station of Narendra Deva University of Agriculture and Technology, located in Narendra Nagar (Kumarganj), Faizabad (U.P.), is situated on the Faizabad-Raibarely road, approximately 42 km from Faizabad. The experimental site falls under the subtropical zone of the Indo-Gangetic plains, characterized by alluvial calcareous soil. It is located between 24.440-26.560 degrees North latitude and 82.120-83.980 degrees East longitude, with an elevation of about 113 meters above mean sea level. The experimental field was well-leveled and had good irrigation and drainage facilities. The mean annual rainfall in this region is 1021.8 mm, with about 90% of it occurring during the monsoon season.

Soil characteristics:

The soil of the experimental site is part of the Indo-Gangetic plain, classified as the Eastern Plain Zone (EPZ) in the alluvial tract of Uttar Pradesh. The properties of the soil are detailed in Table 1. Soil analysis data indicate that the soil is low in available nitrogen and has medium levels of phosphorus and potassium.

Table 1 Initial Analysis of Experimental Soil

S. No.	Properties	Values	Method Employed
A. Physical properties			
1.	Bulk density	1.36	Core method (undisturbed sample) Black, 1965
2.	Texture		
i)	Sand (%)	24.15	Hydrometer method (Bouyoucos, 1936)
ii)	Silt (%)	56.68	

S. No.	Properties	Values	Method Employed
iii)	Clay (%)	19.17	
iv)	Textural class	Silt loam	Triangular method
B. Chemical properties			
1.	pH 1:2.5	7.90	Glass electrode pH meter (Jackson, 1973)
2.	EC dSm-1 at 25°C	0.38	Conductivity meter (Jackson, 1973)
3.	Organic carbon (%)	0.30	Walkley & Black's rapid titration method (1934)
4.	Available N (kg ha-1)	130.96	Alkaline permanganate method (Subbiah and Asija, 1956)
5.	Available P (kg ha-1)	16.90	Olsen's method (Olsen et al., 1954)
6.	Available K (kg ha-1)	220.75	Flame photometer (Jackson, 1973)
7.	Available Zn (ppm)	0.49	Extraction with DTPA solution (Lindsay & Norvell, 1978)

Treatmentsdetails:T1: Control, **T2**: 100% RDF, **T3**: 125% RDF, **T4**: 100% RDF + FYM @5 t ha-1, **T5**: 100% RDF + Brown manuring, **T6**: 100% RDF + BGA @10 kg ha-1, **T7**: 100% RDF + PSB, **T8**: Farmers practice (N100:P40), **T9**: 100% RDF + FYM @5 t ha-1 + PSB + Azotobacter + BGA, **T10**: 100% RDF + FYM @5 t ha-1 + PSB + Azotobacter + Brownmanuring.

Layout Details:

Design: Randomized Block Design (RBD), Number of replications**: 3,** Number of treatments: 10, Total number of plots**:** 30, Net plot size**:** 3.2 × 4 = 12.8 m², Gross plot size**:** 4 × 5 = 20 m², Spacing: 20 cm × 10 cm, Variety: NDR-97

Result and Discussion

The data on plant height as influenced by integrated nutrient management are presented in Table 2. Significant differences in plant height were observed due to the application of various organic, inorganic, and biofertilizer treatments. Treatments included different levels of RDF: 100% RDF alone, 125% RDF alone, 100% RDF combined with FYM @ 5 t ha-1, Brown manuring, BGA @ 10 kg ha-1, PSB, and combinations of 100% RDF with FYM @ 5 t ha-1 + PSB + Azotobacter + Brown manuring or BGA @ 10 kg ha-1. The highest plant height was recorded in the treatment with 100% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter + Brown manuring. The increase in plant height can be attributed to better nourishment, which enhances beneficial effects such as an accelerated rate of photosynthesis, assimilation, cell division, and vegetative growth. These results align with the findings of Lin and Lin (1985), Priyanka *et al.* (2013), and Sujatha *et al.* (2014).

Number of tillers m^{-2}:

The number of tillers per square meter is a crucial growth attribute influenced by organic, inorganic, and biofertilizers. The maximum number of tillers was recorded with treatment T10, which included 100% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter + Brown manuring substituted by organic application. The increased number of tillers per square meter can be explained by the balanced nutrient supply that encouraged vegetative growth through the combined use of inorganic, organic, and biofertilizer sources. Organic manures and biofertilizers improved soil fertility, enhancing nutrient availability and, consequently, the number of tillers per square meter. This improved nutrient availability ultimately leads to higher crop yields. These results are consistent with the findings of Azad and Lehria (2001), Satsangi et al. (2002), Jagdish and Yadav (2008), Lin and Lin (1985), and Dutt and Chauhan (2010).

Dry Matter Production

The increase in dry matter production was observed at different growth stages due to the application of organic, inorganic, and biofertilizer treatments. Various levels of RDF were applied: either 100% RDF alone, 125% RDF alone, or 100% RDF in combination with FYM @ 5 t ha-1, Brown manuring, BGA @ 10 kg ha-1, PSB, or combinations of 100% RDF with FYM @ 5 t ha-1 + PSB + Azotobacter + Brown manuring or BGA @ 10 kg ha-1. The maximum dry matter production was recorded in the treatment with 100% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter + Brown manuring, followed by the treatment with 100% RDF + FYM @ 5 t ha-1 + PSB + Azotobacter + BGA.

The increase in dry matter production with these treatments can be explained by the balanced nutrient supply, which enhances better translocation of photosynthates from source to sink. The significant improvement in dry matter production is attributed to the various levels of RDF and their combined application. Treatments with Brown manuring showed relatively higher dry matter production compared to those with BGA. While the use of inorganic fertilizers alone also contributed to dry matter production, the extent was not as significant as when combined with organic and biofertilizers.

The increased dry matter production at different stages under various treatments was due to the increased availability of nutrients in adequate amounts during different growth stages of rice. These results are corroborated by the findings of Begum et al. (2009), Hasan et al. (2012), Priyanka et al. (2013), and Mhalevilie et al. (2013), who also reported significant increases in dry matter production of rice with RDF and its combination with BGA, PSB, or Brown manuring. The variation in dry matter production among different treatments was due to differences in nutrient availability in the soil at respective growth stages.

Table-2. Effect of integrated nutrient management on plant height (cm) and Number of tillersm^{-2} at various growth stages of rice crop

Treatments	Plant height (cm)				Number of tillers m^{-2}			
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest
T_1- Control	30.21	55.07	68.96	70.85	128.44	290.22	299.48	298.48
T_2- 100% RDF	33.52	68.97	79.74	81.28	136.39	338.01	345.68	346.12
T_3- 125% RDF	33.96	70.35	83.02	82.72	140.88	349.13	359.78	360.60
T_4 - 100% RDF + FYM @5 t ha^{-1}	33.74	69.57	82.98	84.10	139.20	344.94	362.78	360.00
T_5- 100% RDF+ Brown manuring	33.50	69.12	82.22	83.52	138.78	343.90	356.56	357.12
T_6- 100% RDF + BGA@10 kg ha^{-1}	33.57	68.25	81.10	82.65	138.10	342.21	358.78	359.90
T_7- 100% RDF +PSB	33.46	67.92	80.02	81.99	136.69	338.68	346.01	345.68
T_8- Farmers practice(N_{100}:P_{40}:K_0)	32.06	62.10	77.20	79.00	132.55	329.11	333.17	333.17
T_9- 100% RDF+ FYM @5 t ha^{-1}+PSB+*Azotobacter*+BGA	35.16	73.20	84.98	85.11	153.00	366.11	375.78	376.12
T_{10}- 100%RDF+FYM @5 t ha^{-1}+PSB+*Azotobacter*+Brown manuring	35.68	74.65	85.08	86.95	154.70	368.06	376.12	376.28
SEm±	2.06	2.25	2.56	2.96	1.64	3.29	3.96	4.51
CD (P= 0.05)	NS	6.66	7.76	8.08	4.90	9.86	12.10	13.76

Table-3.Effect of integratednutrient management on dry matter production (g m^{-2}) at various growth stages of rice crop

Treatments	Dry matter production (g m^{-2})			
	30 DAT	60 DAT	90 DAT	At harvest
T_1- Control	48.97	77.53	119.78	135.84
T_2- 100% RDF	68.69	114.29	238.70	270.71
T_3- 125% RDF	74.94	129.70	260.44	295.37
T_4 - 100% RDF + FYM @5 t ha^{-1}	73.05	124.16	258.56	294.09
T_5- 100% RDF+ Brown manuring	70.62	122.52	256.49	292.90
T_6- 100% RDF + BGA@10 kg ha^{-1}	72.96	123.42	257.20	292.78
T_7- 100% RDF +PSB	69.56	115.76	242.35	272.77
T_8- Farmers practice(N_{100}:P_{40}:K_0)	58.12	93.78	141.19	196.98
T_9- 100% RDF+ FYM @5 t ha^{-1}+PSB+*Azotobacter*+BGA	86.52	138.96	274.66	314.76
T_{10}- 100%RDF+FYM @5 t ha^{-1}+PSB+*Azotobacter*+Brown manuring	89.00	140.17	275.12	316.05
SEm±	2.10	3.04	4.17	5.89
CD (P= 0.05)	3.60	9.12	12.17	17.64

Conclusion:

The results obtained in this experiment, it can be conclusively stated that the application of FYM at 5 t/ha, along with PSB, Azotobacter, and brown manuring, proved to be the most effective approach for enhancing growth characteristics. Additionally, this combination significantly contributed to maintaining soil health, thereby promoting sustainable rice production.

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