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Effect of integrated nutrient management on production and productivity of pearl millet

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ABSTRACT

The present study was carried in the field of Crop Research Centre – 1. ITM University, Gwalior, (M.P). The experimental site had a uniform topography and normal fertility status of the soil. There was total 10 treatments comprising of various nutrient sources and evaluated in Randomised Block Design (RBD) with three replications. The treatments consisted of T1 Control, T2 100%RDF (60:30:20 kg NPK ha^{-1}), T3 75% RDF + 25% Vermicompost, T4 75%RDF +25%FYM, T5 125%RDF, T6 100 % RDF + 25% Vermicompost, T7 100% RDF + 25% FYM , T8 50% RDF + 25% FYM + 25 % Vermicompost, T9 75% RDF + 25% Vermicompost + 25 % FYM, and T10 75% RDF +12.5% Vermicompost + 12.5% FYM. The various parameters viz., growth parameter, yield parameters, nutrient content and economics were studies in this investigation. The results showed that application of 75% RDF+25% Vermicompost +25% FYM (T9) proved higher growth, yield attributes, yield and economics as net return and B-C ratio compared to other treatments.

Key words: *Nutrient management, Fertilizers, FYM, Vermicompost, Pearl millet.*

Introduction

Sustainable agricultural practices are imperative for ensuring food security and environmental stewardship in the face of increasing global challenges. Among the diverse range of crops contributing to food security, pearl millet (*Pennisetum glaucum*) stands out as a crucial staple crop, particularly in arid and semi-arid regions, due to its resilience and adaptability (Ajeigbe *et al.*, 2017). In this context, the concept of integrated nutrient management (INM) has emerged as a promising approach to optimize nutrient availability, enhance crop productivity, and promote long-term sustainability (Das and Singh, 2018).

Integrated nutrient management involves the judicious combination of diverse nutrient sources, such as organic and inorganic fertilizers, bio-fertilizers, and soil amendments, to improve nutrient use efficiency and crop performance ((Das and Singh, 2018). As nutrient availability is a critical factor affecting crop growth and yield, especially in nutrient-deficient regions, the integration of various nutrient sources offers a comprehensive approach to address the nutritional needs of pearl millet (Kumar *et al.*, 2016).

The arid and semi-arid regions where pearl millet cultivation predominates often face challenges related to soil fertility, water scarcity, and nutrient deficiencies (Ajeigbe *et al.*, 2017). Hence, the utilization of INM practices gains significance in these areas to enhance both yield and soil health (Ragar and Meena, 2022). Research studies have explored the impact of integrated nutrient management on pearl millet, indicating the potential benefits in terms of yield improvement, soil fertility enhancement, and economic viability (Ajeigbe *et al.*, 2017; Sisodia and Meena, 2023; Kumar *et al.*, 2023). Furthermore, the use of organic resources, such as crop residues, animal manures, and composts, in combination with appropriate inorganic fertilizers and microbial inoculants, has been demonstrated to play a pivotal role in increasing soil fertility and nutrient cycling (Kumar *et al.,* 2016).

Despite the importance of INM, there is a need for comprehensive research that considers local agro-ecological conditions, nutrient dynamics, and economic viability. By critically examining a range of research articles, reviews, and case studies, this paper aims to delve into the multifaceted aspects of integrated nutrient management in pearl millet cultivation (Jain *et al.,* 2022; Kumar *et al.,* 2023; Meena and Regar, 2023). It seeks to uncover the scientific basis of INM, the interactions between different nutrient sources, and the resulting effects on yield, nutrient use efficiency, and soil health (Tiwari *et al.,* 2023). Moreover, the paper will explore the implications of adopting INM practices for sustainable agricultural production in pearl millet-based cropping systems, while considering economic and environmental aspects.

In the subsequent sections, we will explore the latest research findings regarding the impact of integrated nutrient management on pearl millet cultivation. By analysing the methodologies, outcomes, and conclusions of these studies, we aim to provide a comprehensive overview of the benefits and challenges associated with the application of INM in pearl millet production. Through this exploration, we intend to contribute to the growing body of knowledge in the realm of nutrient management strategies, with a specific focus on enhancing the sustainability and productivity of pearl millet cropping systems.

Materials and Methods

The present study was carried in the field of Crop Research Centre – 1. ITM University, Gwalior, (M.P). The experimental site had a uniform topography and normal fertility status of the soil. There was total 10 treatments comprising of various nutrient sources and evaluated in Randomised Block Design (RBD) with three replications. The treatments consisted of T1 Control, T2 100% RDF (60:30:20 kg NPK ha-1), T3 75%RDF+25% Vermicompost, T4 75% RDF +25% FYM, T5 125% RDF, T6 100% RDF+25% Vermicompost, T7 100% RDF+25% FYM, T8 50%RDF+25% FYM+25% Vermicompost ,T9 75% RDF+25%

Vermicompost+25% FYM, and T10 75% RDF+12.5% Vermicompost + 12.5% FYM .The soil of the experimental field was clayey in texture and showed low rating for available nitrogen (163.4 kg ha^{-1}), while low rating for phosphorus (19.4 kg ha^{-1}) and high rating for available potash (416.8 kg ha^{-1}). The soil was found slightly alkaline (pH 7.93) with normal electrical conductivity (0.39 dS m^{-1}). All agronomical practices were followed during investigation period and meteorological week wise weather parameters were also observed. Pearl millet cultivar 'NBBH-20' used as experimental materials and sowing at 45×15 spacing in field. Application of fertilizer and organic manure (FYM, Vermi compost) were applied as per treatment. Five tagged plants from each plot were selected randomly for recording different observations. The collected data for various parameters were statistically analysed using Fisher's analysis of variance (ANOVA) technique and the treatments were compared at 5% level of significance.

Results and Discussion

The various parameters viz., growth parameter, yield parameters, nutrient content and economics were studies under this study and been given below.

This study revealed that the integration various types of fertilizer will help in improving the crop growth, production, and productivity. The plots applied with T9 75%RDF + 25% Vermicompost + 25% FYM showed maximum plant height (115.37 cm), Leaf Area Index (3.92), Dry matter (325.87 g) and found significantly superior over other treatment while minimum was observed in control plots (Table 1). The yield attributes *viz.,* Thickness of ear head (5.39 cm), Length of ear head (24.19 cm), grain weight per plant (31.16 g) Test weight (6.95 g) and found highest in the plots applied with T9 75%RDF + 25% Vermicompost + 25% FYM and found significant over other treatment. The lowest was recorded in control (Table 2). The similar results were observed by Ajeigbe *et al.,* (2017), Meena and Regar (2023).

The application of T9 75% RDF + 25% Vermicompost + 25% FYM proved that maize can produce significantly higher grain yield (53.26 q ha^{-1}), straw yield (76.14 q ha^{-1}) biological yield (53.26 q ha^{-1}) and harvest index (36.65 %) found significantly superior over other treatment while lowest was observed in control plots (Table 3). The protein content (12.80%) and nutrient uptake *viz.*, N uptake (155.52 kg/ha), P uptake (41.34 kg/ha), K uptake (174.04 kg/ha) found highest in the plots applied with T9 75% RDF + 25% Vermicompost + 25% FYM and found significant over other treatment. The lowest was recorded in control (Table 4). The results are in

Table 1. Effect of integrated nutrient management on Growth parameters

Treatments	Plant height(cm)	Dry matter(g)	Leaf Area Index(LAI)
T_1-Control	101.29	48.29	2.28
T_2-100%RDF	111.58	53.65	2.85
T_3-75%RDF+25% Vermicompost	125.08	58.53	3.19
T_4-75%RDF +25%FYM	120.79	57.41	3.11
T_5-125%RDF	132.55	60.89	3.40
T_6-100%RDF + 25% Vermicompost	140.64	64.72	3.70
T_7-00%RDF+25%FYM	135.94	62.78	3.52
T_8-50%RDF+25%FYM+25%Vermicompost	106.47	50.99	2.61
T_9-75%RDF+25%Vermicompost+25%FYM	149.58	69.32	3.92
T_{10}-75%RDF+12.5%Vermicompost+12.5%FYM	115.37	54.30	2.90
SE(m)±	1.690	2.28	0.07
CD(P=0.05)	5.020	4.60	0.20

Table 2. Effect of integrated nutrient management on Yield attributes

Treatments	Thickness of ear head (cm)	Length of ear head (cm)	Grain weight perplant (g)	Test weight (g)
T_1-Control	3.69	15.31	18.69	5.48
T_2-100%RDF	4.12	17.13	22.03	5.87
T_3-75%RDF+25%Vermicompost	4.49	19.53	26.45	6.26
T_4-75%RDF +25%FYM	4.41	19.01	25.89	6.18
T_5-125%RDF	4.70	20.94	27.82	6.32
T_6-100%RDF + 25%Vermicompost	5.06	22.66	29.45	6.67
T_7-00%RDF+25%FYM	4.89	21.87	28.56	6.61
T_8-50%RDF+25%FYM+25% Vermicompost	3.91	16.24	20.57	5.64
T_9-75%RDF+25% Vermicompost+25%FYM	5.39	24.19	31.16	6.95
T_{10}-75%RDF+12.5% Vermicompost+12.5%FYM	4.18	17.87	23.98	6.05
SE(m)±	0.07	0.27	0.43	0.33
CD(P=0.05)	0.20	0.81	1.27	NS

Table 3. Effect of integrated nutrient management on Yield

Treatments	Grain yield (q/ha)	Straw Yield (q/ha)	Biological yield (q/ha)	H I (%)
T_1-Control	15.99	32.72	48.70	32.68
T_2-100%RDF	22.67	44.28	66.96	32.82
T_3-75%RDF+25%Vermicompost	24.61	46.75	71.36	34.48
T_4-75%RDF +25%FYM	24.39	46.62	71.01	34.34
T_5-125%RDF	27.73	49.38	77.11	35.89
T_6-100%RDF + 25%Vermicompost	29.31	50.94	80.41	36.63
T_7-00%RDF+25%FYM	27.93	49.88	77.81	35.96
T_8-50%RDF+25%FYM+25%Vermicompost	20.75	42.23	62.99	32.75
T_9-75%RDF+25%Vermicompost+25%FYM	32.19	55.69	87.87	36.65
T_{10}-75%RDF+12.5%Vermicompost+12.5%FYM	22.97	45.35	68.32	33.86
SE (m)±	0.47	0.36	0.88	1.48
CD(P=0.05)	1.40	1.08	2.62	NS

Table 4. Effect of integrated nutrient management on Nutrient uptake

Treatments	Protein (%)	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
T_1-Control	8.96	98.32	24.62	114.19
T_2-100%RDF	10.01	117.43	30.74	129.87
T_3-75%RDF+25%Vermicompost	10.81	130.50	34.29	145.41
T_4-75%RDF +25%FYM	10.55	126.58	33.89	139.97
T_5-125%RDF	11.35	137.84	36.18	152.88
T_6-100%RDF + 25%Vermicompost	12.05	147.20	39.04	164.22
T_7-00%RDF+25%FYM	11.71	142.55	37.66	158.67
T_8-50%RDF+25%FYM+25%Vermicompost	9.54	108.20	29.04	120.81
T_9-75%RDF+25%Vermicompost+25%FYM	12.80	155.52	41.34	174.04
T_{10}-75%RDF+12.5%Vermicompost+12.5%FYM	10.16	121.40	32.14	132.65
SE(m)±	0.12	1.69	0.52	2.03
CD(P=0.05)	0.37	5.03	1.53	6.02

Table 5. Effect of integrated nutrient management on Economics

Treatments	Gross Cost	Gross Income	Net Income	B-C Ratio
T_1-Control	21530.00	45590.50	24060.50	1.12
T_2-100%RDF	24730.00	60184.50	35454.50	1.43
T_3-75%RDF+25%Vermicompost	26430.00	70194.50	43764.50	1.66
T_4-75%RDF +25%FYM	28930.00	70870.50	41940.50	1.45
T_5-125%RDF	25530.00	70300.50	44770.50	1.75
T_6-100%RDF + 25%Vermicompost	27830.00	82624.50	54794.50	1.97
T_7-00%RDF+25%FYM	29730.00	82075.00	52345.00	1.76
T_8-50%RDF+25%FYM+25%Vermicompost	30630.00	67018.00	36388.00	1.19
T_9-75%RDF+25%Vermicompost+25%FYM	31430.00	95471.00	64041.00	2.04
T_{10}-75%RDF+12.5%Vermicompost+12.5%FYM	27680.00	67466.50	39786.50	1.44

line with the findings of Tiwari *et al.*, (2022), Jain *et al.*, (2022).

Considering the economic studies application of 75%RDF + 25% Vermicompost + 25% FYM (T9) resulted in maximum net return (64041.00 ha^{-1}) and Benefit to cost ratio of (2.04 Re^{-1} invested). And minimum net return (24060.50 ha^{-1}) and Benefit to cost ratio of (1.12 Re^{-1} invested) was found in control. Similar resulted were recorded by Meena and Regar (2023).

Conclusion

The results showed that application of 75%RDF+25% Vermicompost+25%FYM (T9) proved higher growth, yield attributes, yield and economics as net return and B-C ration compared to other treatments.

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