Original Research Article

Effect of Phosphorus and Micronutrients on Yield and Economics of Rice (*Oryza sativa* L.)

ABSTRACT

The field experiment was carried out during *Khairf* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), to study the "effect of phosphorus and micronutrients on yield and economics of rice (Oryza sativa L.)". The experiment was laid out in Randomized Block Design with ten treatments includin g control each replicated thrice. Significantly higher grain yield (6.20 t/ha) and straw yield (8.37 t/ha) were recorded in treatment 9 with application of Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2 kg/ha. Higher gross returns (1,34,890.00 INR/ha), net return (88,765,20 INR/ha) and benefit cost ratio (1.92) were obtained in the treatment of Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2 kg/ha.

Keywords: Boron, Economics, Phosphorus, Yield, Zinc.

1.Introduction

Rice (Oryza sativa L.) is one of the world's most significant staple cereal crops, providing carbohydrates to approximately one half of the world population. However, more than 90% of the world's rice is produced and consumed in Asia, where it is a staple food for the majority of people, including the region's 560 million hungry people. After China, India is the country with the largest area under rice cultivation and the second-highest production of rice (Yadav et al., 2010). The genetic classification of rice plant belongs to the genus Oryza of family Poaceae. The genus has 24 species, 22 of which are wild and two of which are cultivated. The rice species Oryza sativa L. and Oryza glaberimma are cultivated. On the continents of Asia, America, and Europe, every species is grown. Oryza sativa cultivars can be divided into the indica, japonica, and javanica subspecies. Around 90% of the world's rice production is indica, which is planted across the tropical and subtropical regions. Japonica types are distributed in the temperate zone, and Javanica is primarily farmed in Indonesia. According to Raghuveer et al. (2014), rice accounts for 40 to 43% of all food grain production in India and takes up one-fourth of the nation's total planted land. Rice is grown in 43.79 M ha in India with the production level of 112.91 M t and the average productivity is about 2578 kg/ha. Uttar Pradesh is the third largest growing state of rice after West Bengal and Punjab in the country. Paddy production in Uttar Pradesh was 15.54 M t from an area of 5.81 M ha and productivity of 2283 kg/ha in 2018-2019 (Anonymous, 2019).

Rice is primarily a high-energy food. It contains less protein than wheat, milled rice has usually 6-7% protein. The byproducts of rice milling are used for various purposes.

The greatest concern is the prevalence of broad multi-nutrient deficits, the depletion of native nutrient stores, and unbalanced fertilization, which are seriously reducing yields and the productivity of different rice ecosystems (Murthy et al., 2015). Deficiencies of P are mainly due to the increase in cropping intensity coupled with emphasis on nitrogen rather than a balance application of all macro-nutrients required for sustaining soil fertility (Patra et al., 2019). In the country's rice-growing regions today, there is a serious lack of micronutrients like zinc and boron, which has a significant negative impact on grain productivity and quality. Low yields and low-quality crops are produced in soils that are poor in micronutrients because these plants cannot be successfully fed by these soils. When it comes to crop output and seed germination, zinc and boron are two of the most crucial minerals. It plays a crucial part in the metabolism of carbohydrates and their translocation, as well as the construction of plant cell walls, the stability of plasma membranes, the expansion of pollen tubes, and the promotion of pollination and seed development. It is also required for the development of the pollen tube during flower pollination, which is essential for effective seed set and fruit development. Boron availability that is adequate promotes meristematic growth, cross-links cellulose molecules in the cell wall, stimulates enzymes by combining diol-containing groups in the cell membrane, sugar flow into budding sections of plants, pollination, and seed setting. (Singh et al. 2020). Boron is responsible for better pollination, seed setting and grain formation in rice. Boron deficiency in rice plants causes thinner stems, shorter and fewer tillers, and an inability to generate viable seeds (Lenka et al. 2019). Fertilizers, notably zinc and boron, are required in addition to the recommended dose of main elements to boost rice yield, uptake, and total content of critical nutrients (Abbas et al., 2013). **2.Material and Methods**

The experiment was conducted during the *Kharif* season (December – March, 2022), at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj Uttar Pradesh, which is located at 25°39' 42''N latitude, 81°67'56" E longitude and 98 m altitude above the mean sea level. The soil had a sandy loam texture, a pH of 7.2, organic carbon (0.72 %), nitrogen (278.48 kg ha^{-1}), phosphorus (27.80 kg ha^{-1}) and potassium (233.24 kg ha^{-1}). Seedlings of rice variety BPT-5204 were raised in nursery and were transplanted at 30 cm x 10 cm spacing in puddled conditions. Net returns and benefit cost ratio were computed based on cost of cultivation, and grain and straw yields with their prevailing market price. The data collected for different parameters were statistically analyzed using Gomez and Gomez (1984) analysis of variance for randomized block design. The results are presented at 5% level of significance (p=0.05) for making comparison among treatments.

3. Results and discussion

3.1. Yield**:** Grain yield, straw yield and harvest index were embodied in Table 1.

Significantly higher number of grain yield (6.20 t/ha) were recorded in with application of Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2kg/ha, minimum was recorded in control (5.00 t/ha) whereas with application of Phosphorus 60 kg/ha + Boron 2kg/ha (6.07 t/ha) was found to be statistically at par with the highest. Significantly higher number of straw yield (8.37 t/ha) were recorded in with application of Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2kg/ha, minimum was recorded in Phosphorus 30 kg/ha + Boron 2kg/ha (6.70 t/ha) whereas with application of Phosphorus 60 kg/ha + Boron 2kg/ha (8.17 t/ha) was found to be statistically at par with the highest. Highest harvest index was (42.64 %) recorded with application of Phosphorus 60 kg/ha + Boron 2kg/ha, minimum was recorded in Phosphorus 30 kg/ha + Zinc 5 kg/ha (39.41).

According to Meena et al. (2015), a rise in grain and straw output may be the result of increased photosynthetic activity brought on by an increase in leaf area index, which in turn stimulated the generation of dry matter and increased grain and straw yield. the availability of P influenced the uptake of other essential plants nutrients due to role of P in the rice plant roots. Significantincrease in straw and grain yield with application of zinc and boron is observed which mightbe due to the crucial role of Zn in earlier stages that promotes growth and development andprofuse tillering in rice which in turn lead to increase in photosynthetic rate and dry matter accumulation that leads to increase of straw yield.

3.2. Economics: Gross returns, Net returns and Benefit cost ratio of different treatments were embodied in Table. 2

The cost of cultivation of rice varies between (46,124.80 INR/ha) and (39,760 INR/ha),maximum cost of cultivation was reported in the treatment combination of Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2 kg/ha (46,124.80 INR/ha). Maximum gross returns (1,34,890.00 INR/ha) were recorded with the application of Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2 kg/ha and minimum gross returns were recorded with the application of Phosphorus 30 kg/ha + Zinc 5 kg/ha (1,01,485 INR/ha). Maximum net returns (88,765.00 INR/ha) were recorded with the application of Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2kg/ha and minimum gross returns were recorded with the application of Phosphorus 30 kg/ha + Zinc 5 kg/ha (56,064.00 INR/ha).Highest benefit cost ratio (1.92) was recorded with the application of Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2kg/ha and lowest was recorded with application of Phosphorus30 kg/ha + Zinc 5 kg/ha (1.23).

4. Conclusion

It can be concluded that in rice crop with application of phosphorus 60 kg/ha along with zinc 5kg/ha and boron 2 kg/ha recommended for highest yield and economic returns under eastern Uttar Pradesh Agro-Climatic conditions.

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Table 1. Influence of Phosphorus and micronutrients on yield of rice.

S. No.	Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Harvestindex (%)
1.	Phosphorus 30 kg/ha + Zinc 5 kg/ha	4.67	6.87	39.41
2.	Phosphorus 30 kg/ha + Boron 2kg/ha	4.60	6.70	40.71
3.	Phosphorus 30 kg/ha + Zinc 5 kg/ha + Boron 2kg/ha	4.97	6.93	41.76
4.	Phosphorus 45 Kg/ha + Zinc 5 kg/ha	5.10	7.23	41.35
5	Phosphorus 45 Kg/ha + Boron 2kg/ha	5.37	7.17	42.81
6	Phosphorus 45 Kg/ha + Zinc 5 kg/ha + Boron 2kg/ha	5.50	7.40	42.64
7.	Phosphorus 60 kg/ha + Zinc 5 kg/ha	5.83	7.90	42.48
8.	Phosphorus 60 kg/ha + Boron 2kg/ha	6.07	8.17	42.64
9.	Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2kg/ha	6.20	8.37	42.58
10.	120-60-60 NPK kg/ha (Control)	5.00	7.00	41.68
	F-Test	S	S	NS
	SEm (±)	0.07	0.15	2.03
	CD (5%)	0.23	0.45	-

Table 2. Influence of Phosphorus and micronutrients on economics of rice.

S. No.	Treatments	Cost of Cultivation (INR/ha)	Gross Returns (INR/ha)	Net Returns (INR/ha)	Benefit Cost Ratio
1.	Phosphorus 30 kg/ha + Zinc 5 kg/ha	45,420.40	1,01,485.00	56,064.60	1.23
2.	Phosphorus 30 kg/ha + Boron 2kg/ha	44,970.40	1,02,555.00	57,584.60	1.28
3.	Phosphorus 30 kg/ha + Zinc 5 kg/ha + Boron 2kg/ha	45,720.40	1,09,235.00	63,514.60	1.39
4.	Phosphorus 45 Kg/ha + Zinc 5 kg/ha	45,619.60	1,12,750.00	67,130.40	1.47
5	Phosphorus 45 Kg/ha + Boron 2kg/ha	45,169.60	1,16,445.00	71,275.40	1.58
6	Phosphorus 45 Kg/ha + Zinc 5 kg/ha + Boron 2kg/ha	45,919.30	1,19,540.00	73,620.00	1.60
7.	Phosphorus 60 kg/ha + Zinc 5 kg/ha	45,824.80	1,27,040.00	81,215.20	1.77
8.	Phosphorus 60 kg/ha + Boron 2kg/ha	45,374.80	1,31,960.00	86,585.20	1.91
9.	Phosphorus 60 kg/ha + Zinc 5 kg/ha + Boron 2kg/ha	46,124.80	1,34,890.00	88,765.20	1.92
10.	120-60-60 NPK kg/ha (Control)	40,360.00	1,10,000.00	69,640.00	1.73