Original Research Article

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

ABSTRACT

The field experiment was conducted during *Khairf* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.72 %), available N (278.48 kg/ha), available P (27.80 kg/ha) and available K (233.24 kg/ha). The experiment was laid out in Randomized Block Design with ten treatments including 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 most important staple cereal crops in the world and it is one of the main source of carbohydrates for nearly one half of the world population. However, more than 90% of the rice is produced and consumed in Asia, where it is a staple for a majority of the population, including the regions 560 million hungry people. India has a long history of rice cultivation and stands first in rice area and second in rice production, after China (Yadav et al., 2010). The genetic classification of rice plant belongs to the genus Oryza of family Poaceae. The genus includes 24 species of which 22 are wild and two are cultivated species. Oryza sativa L. and Oryza glaberimma are cultivated. All species are cultivated in Asia, America, and Europe continents. The cultivated varieties of Oryza sativa grouped into three sub species, indica, japonica and javanica. Where indica are grown throughout the tropical and subtropical region, indica rice are grown in around 90% of world rice area, and Japonica varieties are grown throughout the temperate zone and javanica are grown mainly in the part of Indonesia. 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 highenergy food. It contains less protein than wheat, milled rice has usually 6-7% protein. The byproducts of rice milling are used for various purposes.

Now a days micronutrients deficiency such as zinc and boron is widespread in rice growing areas of country that leads to substantial loss in yield and quality of grains. Soils deficient in micronutrients are not capable of nourishing crop plant successfully and therefore low yield and quality of crops are obtained. Among the micronutrients, zinc and boron play an important role in seed setting and yield of crops. It is important for carbohydrate metabolism and their translocation and also plays an indispensable role in plant cell-wall formation, integrity of plasma membranes, pollen tube growth and increases pollination and seed development. It is also needed for the growth of the pollen tube during flower pollination and is therefore important for good seed set and fruit development. Suitable boron availability augments meristematic growth, cross links cellulose molecules in cell-wall, stimulates enzymes by combining diol comprising groups in cell membrane, movement of sugar into budding parts of plants, pollination and setting of seeds. (Singh et al. 2020). Boron is responsible for better pollination, seed setting and grain formation in rice. Deficiency of boron in rice plant results in thinner stems, shorter and fewer tillers and failure to produce viable seeds (Lenka et al. 2019). Fertilizers particularly zinc and boron in addition to recommended dose of major nutrients is needed to increase yield, uptake and total content of essential nutrients in rice (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).

Increase in grain and straw yield might be due to higher photosynthetic activity because of increased leaf area index, which ultimately promoted dry matter production resulting higher grain and straw yield (Meena *et al*. 2015). the availability of P influenced the uptake of other essential plants nutrients due to role of P in the rice plant roots. Significant increase in straw and grain yield with application of zinc and boron is observed which might be due to the crucial role of Zn in earlier stages that promotes growth and development and profuse 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