Effect of Foliar Application of Nano on Soil Properties of Rice (*Oryza sativa* L.) Under Western UP

ABSTRACT

An experiment was conducted during *kharif* 2022 and 2023 at the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, to study the Effect of Foliar Application of Nano on Soil properties of Rice (*Oryza sativa* L.) Under Western UP. The investigation was carried out with fourteen treatments *viz*. Control, RDF (N:P:K-120:60:40 kg ha^{-1} + 25 kg zinc sulphate), 100% RDF + Nano urea, 100% RDF + Nano potash, 100% RDF + Nano Zn, 100% RDF + Nano urea + Nano potash + Nano Zn, 75% RDF + Nano urea, 75% RDF + Nano potash, 75% RDF + Nano Zn, 75% RDF + Nano urea + Nano potash + Nano Zn, 50% RDF + Nano urea, 50% RDF + Nano potash, 50% RDF + Nano Zn and 50% RDF + Nano urea + Nano potash + Nano Zn. The nano fertilizers were applied at tillering stage. Result revealed that highest soil properties*viz.,*organic matter % (0.48 & 0.52), available nitrogen (225.6 & 228.7kg ha^{-1}), available phosphorus (19.5 & 20.7kg ha^{-1}), available potassium (235.6 & 233.8 kg ha^{-1}) and available zinc (0.80 & 0.83 g ha^{-1}) were recorded with application of 100% RDF + Nano urea + Nano potash + Nano Zn spray at tillering stage respectively, during both the years.The lowest values of these parameters were recorded under control treatment.

Key words: Nano fertilizers, Rice, Organic matter.

1. INTRODUCTION

Rice (*Oryza sativa* L.) belongs to poaceae family with chromosome number (2n = 24). It is one of the major staple foods for over half the population worldwide. Rice is a crop of wet tropical climate but also grown in humid regions of subtropics. At globe the area, production and productivity of rice during 2022-23 was 165.70 million hectares (mha), 512.98 million metric tons (mmt) and 46.20 q ha^{-1} respectively. India ranked first, in terms of area and second position in production under rice cultivation in the world with 47.83 mha area, 135.76 mmt production. This however reflects poor crop productivity being 42.60 q ha^{-1} as against world's average of 46.20 q ha^{-1}, 82.80 q ha^{-1} in United States and 70.8 q ha^{-1} in China **(USDA report, 2022-23).** There are improved technologies and various interventions which could be adapted to increase the productivity in the country. In India, Uttar Pradesh ranks first in terms of area (5.70 mha) and second in terms of production (15.27 mt), followed by West Bengal. The productivity (2679 kg ha^{-1}) of rice was found to be sixth position in UP after Punjab (4340 kg ha^{-1}), Tamilnadu (3658 kg ha^{-1}), Andhra Pradesh (3470 kg ha^{-1}), Telangana (3366 kg ha^{-1}) and West Bengal (2996 kg ha^{-1}). **(E&S Division, DA&FW, 2021-22)**.

In rice, fertilizers along with soil fertility, irrigation and quality seed are mainly responsible for increase the production as well as productivity. The nutrient requirement of the rice in general is high and inadequate supply of nutrient often leads to low productivity. The major nutrient element, which is insufficient in most of the Indian soil, plays appreciably an important role in rice**.** Continuous and sole applications of inorganic fertilizer induce the soil sickness and disturb the soil environment resulted low productivity and unsustainability. Shortage of arable land, limited water and nutrient resources, necessitates increase in resource use efficiency without sacrificing production through effective use of modern technologies**.** In the context nanotechnology, nano fertilizers holds promise and can go a long way in sustaining soil health and crop production.

As per the present context, Nanotechnology, a new and rising aspect of science and technology provides a revolutionary scope of research as far as the field of Agriculture and Biotechnology is concerned. Nano fertilizers have the potential to lower soil toxicity, increase the efficiency with which nutrients are used, and mitigate the potential drawbacks of excessive dosing, frequent application, and production costs. Due to its smaller particle size and greater surface area, nano fertilizer is easily absorbed by plants, boosting their dry matter content for photosynthesis and ultimately crop yield **(Pandey, 2018).**For nourishing the rising population, keeping in view the environmental health, soil health and economic condition of farmers, nano fertilizers may be the best substitute to traditional chemical fertilizers.

2. MATERIALS AND METHODS

An experiment was conducted during *kharif* 2022 and 2023 at the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, to study the Effect of Foliar Application of Nano on Soil properties of Rice (*Oryza sativa* L.) Under Western UP. The investigation was carried out on well drained sandy clay loam soil, low in organic carbon (0.45 & 0.46 %) and available nitrogen (217.2 & 220.3 kg ha^{-1}), medium in available phosphorus (17.5 & 18.1 kgha^{-1}), potassium (231.2 & 234.2 kgha^{-1}), zinc (0.70 & 0.73 ppm)and slightly alkaline pH (7.7& 7.6) in randomized block designwith 14 treatments during both the years. The area is ploughed twice—once with a moldboard plough and once with a cultivator before transplanting. After that, the plots were marked according to the layout plan and dressed properly with spade.The rice nursery 'Pusa Basmati 1637' was transplanted manually at a distance 20x10 cm. The entire amount of phosphorus, potassium, and zinc, along with 50% of the nitrogen, were given at the time of transplanting, and the remaining 50% was top-dressed in two equal portions after the first and second irrigations. Nano urea and potash (4 ml/litre of water) and nano zinc (2 ml/liter of water), were sprayed at tillering stage by mixing in 500 liters of water/ha. Experimental data were statistically analyzed by using the analysis of variance (ANOVA) as described by [4].

3. RESULTS AND DISCUSSION

3.1 Organic Carbon (%)

The data pertaining to organic carbon have been presented in Table 1.

The highest organic carbon was recorded with the application of 100% RDF + Nano urea + Nano potash + Nano Zn which remained statistically at par with 75% RDF + Nano urea + Nano potash + Nano Zn spray at tillering stage but significantly higher than rest of the treatments during both the years. The lowest organic carbon was recorded under control treatment during both the years. The increase in organic carbon due to addition of nano fertilizers along with chemical fertilizers considerably boosted nutrient uptake by rice and improved the organic carbon content, N, P, and K status of soil **Du *et al*. (2011)**and **Jhanzab*et al*. (2015).**

3.2 Soil pH

The data pertaining to soil reaction after harvest of the paddy crop have been presented in Table 1.

The soil reaction did not significantly influence by foliar application of nano fertilizers, however the maximum and minimum value of soil reaction was found under control and 75 % RDF + Nano urea + Nano potash + Nano Zn spray at tillering stage during both the years.

3.3 Electrical conductivity (dSm^{-1})

The data pertaining to electrical conductivity after harvest of the paddy crop have been presented in Table 1.

The electrical conductivity did not significantly influence by foliar application of nano fertilizers, however the maximum and minimum value of electrical conductivity was found with the application 100 % RDF + Nano urea + Nano potash + Nano Zn spray at tillering stage and under control respectivelyduring both the years.

3.4 Bulk and particle density

The data pertaining to bulk and particle density after harvest of the paddy crop have been presented in Table1 and depicted in Fig. 1.

The bulk and particle density did not significantly influence by foliar application of nano fertilizers, however the maximum and minimum value of bulk and particle density was found under control and 100 % RDF + Nano urea + Nano potash + Nano Zn spray at tillering stage during both the years.

3.5 Available nitrogen (kg ha^{-1})

The data pertaining to available nitrogen after harvest of the paddy crop have been presented in Table 2.

The maximum amount of available nitrogen was recorded with the application of 100% RDF + Nano urea + Nano potash + Nano Zn which remained statistically at par with 100% RDF + Nano urea spray at tillering stage but significantly higher than rest of the treatment during both the years whereas lowest amount of available nitrogen was recorded under control treatment.The level of accessible nitrogen after crop harvest was sustained by the addition of nitrogen using chemical fertilizers such as urea and DAP. This increase may be related to the nitrogen in the soil becoming mineralized from nano fertilizers. When compared to chemical fertilizer alone, **Jhanzab*et al*. (2015)** found that in addition of nano fertilizers along with chemical fertilizers considerably boosted nutrient uptake by rice and improved the organic carbon content, N, P, and K status.

3.6 Available phosphorus (kg ha^{-1})

The data pertaining to available phosphorus after harvest of the paddy crop have been presented in Table 2.

The maximum amount of available phosphorus was recorded with the application of 100% RDF + Nano urea + Nano potash + Nano Zn which was at par with 100% RDF + Nano urea and 100% RDF + Nano potash spray at tillering stage but higher than rest of the treatment during both the years whereas lowest amount of available phosphorus was recorded under control treatment.The production of organic acids during decomposition, which then helped in the release of native phosphorus by the solubilizing activity of these acids, could be attributed to the increase in accessible P with the application of fertilizers**Jhanzab*et al*. (2015).**

3.7 Available potassium (kg ha^{-1})

The data pertaining to available potassium after harvest of the paddy crop have been presented in Table 2.

The maximum amount of available potassium was recorded with the application of 100% RDF + Nano urea + Nano potash + Nano Zn which remained statistically at par with 100% RDF + Nano potash spray at tillering stage but significantly higher than rest of the treatment during both the years whereas lowest amount of available potassium was recorded under control treatment. Similar result was also observed by **Du *et al*. (2011)** and **Jhanzab*et al*. (2015).**

3.8 Available Zinc (kg ha^{-1})

The data pertaining to available zinc after harvest of the paddy crop have been presented in Table 2.

The maximum amount of available zinc was recorded with the application of 100% RDF + Nano urea + Nano potash + Nano Zn which remained statistically at par with 100% RDF + Nano Zn spray at tillering stage but significantly higher than rest of the treatment during 2022. Whereas during 2023 The maximum amount of available zinc was recorded with the application of 100% RDF + Nano urea + Nano potash + Nano Zn which was at par with 100% RDF + Nano Zn and 75% RDF + Nano urea + Nano potash + Nano Zn but higher than rest of the treatments. The lowest amount of available zinc was recorded under control treatment during both the years. The zinc level in soil increased due to nano zinc because it decreases their susceptibility to adsorption, fixation and precipitation in soil **Zhao *et al*. (2019).**

4. CONCLUSION

The investigation concluded that among the different foliar application of nano fertilizers, treatment T6 (100 % RDF + nano urea + nano potash + nano Zn) sprays at tillering stage @ 4 ml per liter of water nano urea and nano potash and 2 ml per liter of water nano zinc was found to be the best treatment in chemical and physical properties of soil during both the years. The lowest value of all the parameters was recorded under control treatment during both the years.

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Table 1. Effect of foliar application of nano fertilizers on physical and chemical properties of soil after harvest of paddy crop

S. No.	Treatments	Organic carbon (%)		Soil pH		EC (dSm^{-1})		Bulk density ($g\ cc^{-1}$)		Particle density ($g\ cc^{-1}$)	
		2022	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
T_1	Control	0.30	0.31	7.9	8.0	0.19	0.20	1.41	1.39	2.66	2.65
T_2	RDF (N:P:K-120:60:40 kg ha^{-1} + 25 kg zinc sulphate)	0.40	0.43	7.5	7.8	0.21	0.21	1.36	1.35	2.64	2.62
T_3	100% RDF + Nano urea	0.43	0.47	7.4	7.6	0.24	0.23	1.35	1.35	2.63	2.60
T_4	100% RDF + Nano potash	0.42	0.45	7.5	7.6	0.24	0.24	1.35	1.34	2.64	2.63
T_5	100% RDF + Nano Zn	0.43	0.46	7.4	7.6	0.23	0.25	1.35	1.34	2.62	2.60
T_6	100% RDF + Nano urea + Nano potash + Nano Zn	0.48	0.52	7.3	7.5	0.25	0.26	1.34	1.33	2.61	2.59
T_7	75% RDF + Nano urea	0.40	0.42	7.5	7.7	0.21	0.22	1.36	1.34	2.64	2.61
T_8	75% RDF + Nano potash	0.39	0.39	7.7	7.6	0.22	0.22	1.36	1.35	2.64	2.63
T_9	75% RDF + Nano Zn	0.40	0.41	7.5	7.8	0.20	0.21	1.36	1.35	2.64	2.63
T_{10}	75% RDF + Nano urea + Nano potash + Nano Zn	0.46	0.49	7.3	7.4	0.23	0.24	1.35	1.33	2.62	2.60
T_{11}	50% RDF + Nano urea	0.38	0.40	7.8	7.8	0.22	0.23	1.38	1.38	2.65	2.65
T_{12}	50% RDF + Nano potash	0.36	0.37	7.9	7.9	0.22	0.21	1.38	1.37	2.65	2.64
T_{13}	50% RDF + Nano Zn	0.38	0.37	7.8	7.8	0.21	0.21	1.38	1.36	2.65	2.64
T_{14}	50% RDF + Nano urea + Nano potash + Nano Zn	0.39	0.43	7.8	8.0	0.23	0.22	1.37	1.36	2.65	2.65
SEm±		*0.01*	*0.01*	*0.2*	*0.3*	*0.07*	*0.02*	*0.05*	*0.04*	*0.1*	*0.2*
CD (P= 0.05)		*0.03*	*0.04*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Table .2: Effect of foliar application of nano fertilizers on available N, P, K and Zn of soil after harvest of paddy crop

Symbol	Treatments	Available nutrients (kg ha^{-1})						Zinc (g ha^{-1})	
		Nitrogen		Phosphorus		Potassium			
		2022	2023	2022	2023	2022	2023	2022	2023
T_1	Control	203.3	205.3	13.2	14.4	213.1	214.4	0.61	0.63
T_2	RDF (N:P:K-120:60:40 kg ha^{-1} + 25 kg ha^{-1} zinc sulphate)	220.2	224.5	18.1	18.7	233.0	234.5	0.73	0.74
T_3	100% RDF + Nano urea	224.8	227.3	19.2	19.9	234.2	236.2	0.75	0.78
T_4	100% RDF + Nano potash	221.5	225.3	18.7	19.3	234.8	237.1	0.74	0.77
T_5	100% RDF + Nano Zn	222.7	225.8	17.8	18.4	233.5	235.6	0.78	0.82
T_6	100% RDF + Nano urea + Nano potash + Nano Zn	225.6	228.7	19.5	20.7	235.6	237.9	0.80	0.83
T_7	75% RDF + Nano urea	218.4	222.2	16.3	17.1	230.8	231.8	0.71	0.72
T_8	75% RDF + Nano potash	216.3	219.5	15.7	16.7	231.5	233.2	0.70	0.70
T_9	75% RDF + Nano Zn	217.8	220.7	15.3	16.4	230.3	231.1	0.73	0.75
T_{10}	75% RDF + Nano urea + Nano potash + Nano Zn	219.5	222.8	15.8	17.8	232.2	233.8	0.77	0.81
T_{11}	50% RDF + Nano urea	214.6	216.3	14.8	15.7	227.3	229.1	0.66	0.68
T_{12}	50% RDF + Nano potash	213.3	214.2	14.5	15.5	228.2	229.5	0.65	0.66
T_{13}	50% RDF + Nano Zn	213.8	215.8	14.1	15.2	226.6	228.2	0.68	0.69
T_{14}	50% RDF + Nano urea + Nano potash + Nano Zn	215.7	217.4	15.0	16.1	228.8	229.9	0.69	0.71
	SEm±	*0.8*	*0.9*	*0.4*	*0.6*	*0.4*	*0.5*	*0.01*	*0.01*
	CD (P= 0.05)	*2.4*	*2.7*	*1.2*	*1.7*	*1.3*	*1.5*	*0.02*	*0.04*