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Integrated Nutrient Management on Yield, Uptake, Quality and Soil Properties of Rice in Rice-Wheat Cropping System

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Abstract

A field experiment was conducted during 2019 and 2020 at Fertilizer Research Farm Uttaripura in the jurisdiction of C. S. Azad University of Agriculture and Technology, Kanpur using rice CSR-36 variety of rice in rice-wheat cropping system. The highest plant height, number of tillers, test weight, grain yield, straw yield, protein content and protein yield of rice was recorded 124.54 cm, 58.15 hill^{-1}, 27.24 gm, 53.92 q ha^{-1}, 62.30 q ha^{-1}, 8.50 % and 441.30 kg ha^{-1} respectively with the application of 75 % RDF +25 % N as VC+PM and was recorded in control plot. The maximum uptake of N 70.6, P 25.4 and K 15.8 kg ha^{-1} in grain and N 23.6, P 4.05 and K 82.2 kg ha^{-1} in straw of rice with the application of 75 % RDF +25 % N as VC+PM followed by 75 % RDF +25 % N as FYM+PM and 75 % RDF +25 % N as PM. The 100% RDF, 75 % RDF +25 % N as FYM and 75 % RDF +25 % N as VC were at par in case of nutrient uptake. The minimum uptake of N P K in grain and straw of rice in control plot. The maximum changes in soil pH from 8.3 to 7.7, EC from 0.64 to 0.53 dSm^{-1}, organic carbon from 2.7 to 3.2 g kg^{-1}, available N from 184.7 to 198.5 kg ha^{-1}, available P from 22.6 to 23.6 kg ha^{-1} and available K from 234.4 to 243.5 kg ha^{-1} with the application of 75 % RDF +25 % N as VC+PM in comparison to other treatments.

Key words: *Integrated nutrient management, yield attributes, nutrient uptake, quality, soil properties.*

Introduction

Rice is the most important staple food for three fourth of the Indian population has become an item of commerce since last two decades. The rice production recorded such commendable growth that we achieved self sufficiency and contained imports. It is principal food and cereal crop of south eastern Asia and about 90% of all rice grown in the world is produced and consumed by Asian countries. In Asia, over two billion people obtain 60-70% of their energy intake from rice and its products. Rice is primarily high energy or high caloric food while protein content is less than wheat. The protein content of rice about 9-7% and biological value of rice proteins is high. Over increasing population of India, it is assumed that we have to produce about 140 million tones rice by 2025 AD. Owing to high grain yield, rice removers a sustainable amount of major and minor nutrient from the soil and deficiency of other nutrients reduce its grain yield. The price of input mainly inorganic fertilizers is increasing day by day, therefore, emphasis to is needed to maximize the nutrient use efficiency and grain yield and minimized the cost of production. The efficiency of nutrient use may be raised by the combined use of organic and inorganic fertilizers. Organic fertilizer not only acts as the source of nutrients but also provides micronutrient and modifies soil physical behavior as well as increase the efficiency of applied nutrients. Therefore, the present study was undertaken to effect of integrated nutrient management on yield, uptake, quality and soil properties of rice in rice-wheat cropping system.

Materials and Methods

A field experiment was conducted during 2019 and 2020 at Fertilizer Research Farm Uttaripura in the jurisdiction of C. S. Azad University of Agriculture and Technology, Kanpur using high yielding variety of rice CSR-36 in rice-wheat cropping system. The initial physico-chemical properties of soil were pH 8.3, EC 0.64 dSm^{-1}, organic carbon 2.7 g kg^{-1}. The soil was sandy loam in texture having available N 184.7 kg ha^{-1}, available P_2O_5 22.6 kg ha^{-1} and available K_2O 234.4 kg ha^{-1}. The experiment was laid out under randomize block design with three replications. The experiment consist of nine treatments viz., T_1- Control, T_2-100% RDF, T_3-75 % RDF +25 % N as FYM, T_4-75 % RDF +25 % N as VC, T_5-75 % RDF +25 % N as PM, T_6-75 % RDF +25 % N as FYM+VC, T_7- 75 % RDF +25 % N as VC+PM, T_8- 75 % RDF +25 % N as FYM+PM and T_9-75 % RDF +25 % N as FYM+VC+PM. About 25 days old seedling was uprooted carefully from the seedbed and it's transplanted in well prepared field in the first week of July. Recommended doges of fertilizers were applied through urea, DAP and muriate of potash, respectively. The half doge of N and full doges of P_2O_5 and K_2O were applied as basal and rest N applied in two equal splits at the time of tillering and ear emergence stages and attributing characteristics were recorded at the time of maturity of crop.. Agronomical operations will be applied as par requirement of crop. The potassium uptake of grain and straw were calculated from grain and straw potassium concentration by the multiplying with grain and straw yield. The chemical analysis of soil was done using the standard procedure.

Results and Discussion

Yield and quality of crop

The yield of rice and wheat were significantly influenced with the application of different treatments in rice-wheat cropping system (Table-1). The plant height, number of tillers, test weight, grain yield, straw yield, protein content and protein yield of rice varied from 94.04 to 124.54 with mean value of 118.54 cm, 45.34 to 58.15 with mean value of 54.27 $hill^{-1}$, 21.73 to 27.24 with mean value of 24.77 gm, 29.95 to 53.92 with mean value of 47.70 q ha^{-1}, 34.56 to 62.30 with mean value of 54.98 q ha^{-1}, 6.88 to 8.50 with mean value of 7.91 % and 192.29 to 441.31 with mean value of 364.47 kg ha^{-1} respectively in different treatments. The similar results were reported by [2]. The highest plant height, number of tillers, test weight, grain yield, straw yield, protein content and protein yield of rice was recorded 124.54 cm, 58.15 $hill^{-1}$, 27.24 gm, 53.92 q ha^{-1}, 62.30 q ha^{-1}, 8.50 % and 441.30 kg ha^{-1} respectively with the application of 75 % RDF +25 % N as VC+PM followed by 75 % RDF +25 % N as FYM+PM treatment due to integration of organic and inorganic fertilizers. The minimum plant height 94.04 cm, number of tillers 45.34 $hill^{-1}$, test weight 21.73 gm, grain yield 29.95 q ha^{-1} , straw yield 34.56 q ha^{-1}, protein content 6.88 % and protein 192.29 kg ha^{-1} was recorded in control plot. The similar results were also reported by many others[3].

Table 1 Effect of treatments on yield and quality parameters of rice (mean of two years)

Treatments	Plant height (cm)	No of tillers/hill	Test weight (gm)	Grain yield (q/ha)	Straw yield (q/ha)	Protein content (%)	Protein yield (kg/ha)
T_1	94.04	45.34	21.73	29.95	34.56	6.88	192.29
T_2	121.89	52.39	22.85	44.21	55.14	7.67	354.43
T_3	114.55	51.22	23.30	46.32	53.18	7.75	343.48
T_4	116.69	52.25	23.70	48.72	56.06	7.81	364.88
T_5	124.13	55.19	26.33	51.37	59.73	8.18	403.83
T_6	119.54	54.51	25.41	49.02	56.43	8.06	378.98
T_7	124.54	58.15	27.24	53.92	62.30	8.50	441.31
T_8	123.83	56.93	26.62	51.72	59.67	8.25	410.19
T_9	117.73	53.47	25.83	50.14	57.76	8.12	390.89
CD=0.05	**2.57**	**0.78**	**0.34**	**1.97**	**2.89**	**0.62**	**--**

Uptake of nutrients:

The nutrients uptake by grain and straw of rice were significantly influenced with the application of different treatments of rice in rice-wheat cropping system (Table-2). The uptake of N, P, K varied from 30.7 to 70.6 kg ha^{-1} , 0.9 to 25.4 kg ha^{-1}, 6.5 to 15.8 kg ha^{-1}, in grain and from 4.8 to 23.6 kg ha^{-1}, 0.72 to 4.05 kg ha^{-1} and 35.2 to 82.2 kg ha^{-1} in straw of rice respectively in different treatments in rice-wheat cropping system. The mean value of NPK uptake were recorded 58.34 kg ha^{-1} , 21.46 kg ha^{-1} and 31.15 kg ha^{-1} of grain and 16.95 kg ha^{-1} , 2.77 kg ha^{-1} and 67.83 kg ha^{-1} of straw respectively. The maximum uptake of N 70.6, P 25.4 and K 15.8 kg ha^{-1} in grain and N 23.6, P 4.05 and K 82.2 kg ha^{-1} in straw of rice with the application of 75 % RDF +25 % N as VC+PM followed by 75 % RDF +25 % N as FYM+PM and 75 % RDF +25 % N as PM. The 100% RDF, 75 % RDF +25 % N as FYM and 75 % RDF +25 % N as VC were at par in case of nutrient uptake[1]. The minimum uptake of N 30.7, P 9.0, K 6.5 kg ha^{-1}, in grain and N 4.8, P 0.72 and K 35.2 kg ha^{-1} in straw of rice in control plot. The similar results were also reported by past investigators[2].

Table 2 Effect of treatments on nutrients uptake kg ha^{-1} of rice (mean of two years)

Treatments	Grain			Straw		
	N	P	K	N	P	K
T_1	30.7	9.0	6.5	4.8	0.72	35.2
T_2	56.8	21.7	13.0	15.4	3.09	68.3
T_3	54.9	20.7	12.5	13.8	2.92	64.8
T_4	58.4	22.1	13.7	15.7	3.20	59.5
T_5	64.6	23.9	14.5	19.1	3.70	77.0
T_6	60.6	22.6	13.5	17.5	3.39	71.6
T_7	70.6	25.4	15.8	23.6	4.05	82.2
T_8	65.6	24.2	14.7	20.8	3.89	77.5
T_9	62.5	23.3	14.0	19.6	3.52	73.9
CD=0.05	3.25	3.28	0.82	1.02	0.33	4.51

Physico-chemical Properties of Soil

The considerable changes in physico-chemical properties of experimental soil after two year with the application of different treatments (Table 3). The maximum changes in soil pH from 8.3 to 7.7, EC from 0.64 to 0.53 dSm^{-1}, organic carbon from 2.7 to 3.2 g kg^{-1}, available N from 184.7 to 198.5 kg ha^{-1}, available P from 22.6 to 23.6 kg ha^{-1} and available K from 234.4 to 243.5 kg ha^{-1} with the application of 75 % RDF +25 % N as VC+PM followed by 75 % RDF +25 % N as FYM+PM and 75 % RDF +25 % N as PM treatment in comparison to control plot due to application of inorganic with organic fertilizers. There is not remarkable changes in 100% RDF, 75 % RDF +25 % N as FYM, 75 % RDF +25 % N as VC, 75 % RDF +25 % N as FYM+VC and 75 % RDF +25 % N as FYM+VC+PM. Treatments.

Table 3 Effect of treatments on physico-chemical properties of experimental soil after two years

Treatments	pH	EC dSm^{-1}	OC g kg^{-1}	N	P	K
				kg ha^{-1}		
T_1	8.4	0.63	2.5	175.2	21.4	224.2
T_2	8.3	0.62	2.7	179.3	22.0	228.9
T_3	8.2	0.60	2.8	181.2	22.3	231.2
T_4	8.2	0.59	2.8	184.9	22.6	235.2
T_5	7.9	0.56	3.0	190.1	23.0	238.0
T_6	8.1	0.61	2.9	187.9	22.6	236.3
T_7	7.7	0.53	3.2	198.5	23.6	243.5
T_8	7.8	0.55	3.1	195.3	23.2	240.1
T_9	8.0	0.58	2.9	188.4	22.7	236.4
Initial values	8.3	0.64	2.7	184.7	22.6	234.4

References

1. Kandeshwari, M. and Thavaprakash, N. (2016). Influence of Integrated Nutrient Management practices on yield and nutrient uptake in rice under system of rice intensification. *International Journal of Agricultural Science*, **2**(6): 123-130.
2. Lakpale, R., Shrivastva, G. K. and Tuteja, S. S. (2007). Direct and residual effect of levels of phosphorus with and without FYM and cow dung blending on productivity of spice-rice cropping system. *Environment Ecology,* **25**(4): 739-744.
3. Moe, K., Mg, K., Win, K. and Yamakawa, T. (2017). Combined effect of organic manure and Inorganic fertilizers on the growth and yield of hybrid rice. *Americon Journal of Plant Science,* 8:1022-1042.

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Effect of Nano Nitrogen, Zinc and Copper on Yield and Nutrients Uptake in Rice- Wheat Cropping System

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Abstract

A field experiment was conducted during 2019-20 and 2020-21 at Fertilizer Research Farm Uttaripura, Kanpur. The maximum grain, straw and biological yield of rice 57.3, 72.6 and 135.3 q ha^{-1} and wheat 52.3, 69.2 and 121.5 q ha^{-1} respectively, was obtained from FFP +1 Spray of Nano N +1 Spray of Nano Zn+1 Spray of Nano Cu followed by FFP+2 Spray of Nano Zn and FFP+2 Spray of Nano Cu. The minimum grain, straw and biological yield of rice 53.6, 67.2 and 120.8 q ha^{-1} and wheat 45.6, 59.6 and 104.9 q ha^{-1} respectively, was obtained from Farmer fertilizer Practice (FFP). The maximum uptake of N 74.5, P 20.9 and K 20.6 kg ha^{-1} in grain and N 29.8, P 4.21 and K 93.8 kg ha^{-1} in straw of rice with the application of FFP +1 Spray of Nano N +1 Spray of Nano Zn+1 Spray of Nano Cu. The Cu 22.2 mg kg^{-1} in grain and 8.51 mg kg^{-1} in straw was received with treatment of FFP+2 Spray of Nano Cu. The Zn 51.2 mg kg^{-1} in grain and 29.8 mg kg^{-1} in straw was observed with the application of FFP+2 Spray of Nano Zn. The maximum uptake of N 84.8, P 26.8 and K 18.9 kg ha^{-1} in grain and N 32.6, P 4.84 and K 92.2 kg ha^{-1} in straw of rice with the application of FFP +1 Spray of Nano N +1 Spray of Nano Zn+1 Spray of Nano Cu. The Cu 22.5 mg kg^{-1} in grain and 8.48 mg kg^{-1} in straw was received with treatment of FFP+2 Spray of Nano Cu. The Zn 19.3 mg kg^{-1} in grain and 10.3 mg kg^{-1} in straw was observed with the application of FFP+2 Spray of Nano Zn.

Key words: *Yield, nutrient uptake, nano fertilizer, cropping system*

Introduction

World agricultural cropping system are intensively using large amount of fertilizers, pesticides and herbicides to achieve more production per unit area per unit time but using more doses than optimum of these chemicals and fertilizers leads to several problems like environment pollution, low input use efficiency, decreased quality of food products, increasing problems of pests, less income from the production, soil degradation, increasing incidence of multi-nutrient deficiencies in soil and plants, decreasing of population of beneficial organisms in the soil and on the whole soil health problems. Among most recent technical improvements in the field of agriculture, nanotechnology holds an eminent position in remodeling agriculture and food production to fulfill the demands in an efficient and cost-effective way [1]. Nanotechnology is a promising tool and has the potential to foster a new era of precise farming technologies and therefore, may emerge as a possible solution for these problems. The use of nano fertilizers not only causes increased use efficiency through ultrahigh absorption of the nutrients, increase in photosynthesis caused by expansion in surface area of the leaves but also reduces the toxicity generated due to over application in the soil as well as reduces the split application of fertilizers. Therefore, the present study was undertaken to effect of nano nitrogen, zinc and copper on yield and uptake in rice- wheat cropping system.

Materials and Methods

A field experiment was conducted during 2019-20 and 2020-21 at Fertilizer Research Farm Uttaripura in the jurisdiction of C. S. Azad University of Agriculture and Technology, Kanpur using high yielding variety of rice CSR-36 and wheat KRL-210 in rice-wheat cropping system. The initial physico-chemical properties of soil were pH 8.1, EC 0.65 dSm^{-1}, organic carbon 4.5 g kg^{-1}. The soil was sandy loam in texture having available N 232.5 kg ha^{-1}, available P_2O_5 19.5 kg ha^{-1} and available K_2O 210.7 kg ha^{-1}. The experiment was laid out under randomize block design with four replications. The experiment consist of five treatments viz., T_1-Farmer fertilizer Practice (FFP), T_2-PPF-50% N+2 Spray of Nano N, T_3-FFP+2 Spray of Nano Zn, T_4- FFP+2 Spray of Nano Cu and T_5- FFP +1 Spray of Nano N +1 Spray of Nano Zn+1 Spray of Nano Cu. About 25 days old seedling was uprooted carefully from the seedbed and it's transplanted in well prepared field in the first week of July and sowing of wheat in the month of November. Agronomical operations was applied as par requirement of crop. The nano fertilizers namely nano-nitrogen, copper and zinc had nutrient concentrations of 25000, 5000 and 2000 ppm, respectively. Similar method reported by [4]. Four ml of these liquid fertilizers were added in one litre of water and for one acre 500 ml of nano fertilizers were added to 125 litre of water and sprayed as per treatments. The first spray was done at 14 DAT and second 35 DAT in rice and first spray at 21 DAS and second 42 DAS in wheat. The agronomical practices were applied as per requirement of crops. The crops were harvested at full maturity and the yield data were recorded from the net plot area harvested.

Results and Discussion

Yield of crops

The yield of rice and wheat were significantly influenced with the application of different treatments in rice-wheat cropping system (Table-1). The yield of grain, straw and biological varied from 53.6 to 57.3 with mean value of 55.1 q ha^{-1} , 67.2 to 72.6 with mean value of 69.1 q ha^{-1} and 120.8 to 135.3 with mean value of 125.2 q ha^{-1} in rice and 45.6 to 52.3 with mean value of 48.6 q ha^{-1} , 59.3 to 69.2 with mean value of 63.7 q ha^{-1} and 104.9 to 121.5 with mean value of 112.5 q ha^{-1} in wheat respectively in different treatments. The maximum grain, straw and biological yield of rice 57.3, 72.6 and 135.3 q ha^{-1} and wheat 52.3, 69.2 and 121.5 q ha^{-1} respectively, was obtained from FFP +1 Spray of Nano N +1 Spray of Nano Zn+1 Spray of Nano Cu followed by FFP+2 Spray of Nano Zn and FFP+2 Spray of Nano Cu due to foliar spray of nano fertilizers. The minimum grain, straw and biological yield of rice 53.6, 67.2 and 120.8 q ha^{-1} and wheat 45.6, 59.6 and 104.9 q ha^{-1} respectively, was obtained from Farmer fertilizer Practice (FFP). The similar trend of data with was reported in past also[4].

Table 1 Effect of treatments on yield of rice and wheat q ha^{-1} (mean of two years)

Treatments	Rice			Wheat		
	Grain	Straw	Biological	Grain	Straw	Biological
T_1	53.6	67.2	120.8	45.6	59.3	104.9
T_2	54.1	67.6	121.7	47.8	61.7	109.5
T_3	55.8	70.4	126.2	49.7	65.6	115.3
T_4	54.7	67.5	122.2	48.1	63.1	111.2
T_5	57.3	72.6	135.3	52.3	69.2	121.5
CD=0.05	2.16	3.07	--	2.53	3.27	--

Uptake of Nutrients in Rice

The nutrients uptake by grain and straw of rice and wheat were significantly influenced with the application of different treatments in rice-wheat cropping system (Table-2). The uptake of N, P, K. Cu and Zn varied from 69.7 to 74.5 kg ha^{-1} , 18.2 to 20.9 kg ha^{-1}, 17.2 to 20.6 kg ha^{-1}, 15.5 to 22.2 mg kg^{-1} and 42.4 to 51.2 mg kg^{-1} in grain and from 26.9 to 29.8 kg ha^{-1}, 3.82 to 4.21 kg ha^{-1}, 87.4 to 93.8 kg ha^{-1}, 5.98 to 8.51 mg kg^{-1} and 20.2 to 29.8 mg kg^{-1} in straw of rice respectively in different treatments in rice-wheat cropping system. The maximum uptake of N 74.5, P 20.9 and K 20.6 kg ha^{-1} in grain and N 29.8, P 4.21 and K 93.8 kg ha^{-1} in straw of rice with the application of FFP +1 Spray of Nano N +1 Spray of Nano Zn+1 Spray of Nano Cu. The Cu 22.2 mg kg^{-1} in grain and 8.51 mg kg^{-1} in straw was received with treatment of FFP+2 Spray of Nano Cu. The Zn 51.2 mg kg^{-1} in grain and 29.8 mg kg^{-1} in straw was observed with the application of FFP+2 Spray of Nano Zn due to application of nano fertilizers. The similar observations reported by [3]. The minimum uptake of N 69.7, P 18.2, K 17.2 kg ha^{-1}, Cu 15.5, Zn 42.4 mg kg^{-1} in grain and N 26.9, P 3.82 and K 87.4 kg ha^{-1}, Cu 5.98 and Zn 20.2 mg kg^{-1} in straw of rice in Farmer fertilizer Practice treatment.

Table 2 Effect of treatments on nutrients uptake in rice (mean of two years)

Treatments	Grain					Straw				
	kg ha^{-1}			mg kg^{-1}		kg ha^{-1}			mg kg^{-1}	
	N	P	K	Cu	Zn	N	P	K	Cu	Zn
T_1	69.7	18.2	17.2	15.5	42.4	26.9	3.82	87.4	5.98	20.2
T_2	70.9	19.4	18.9	16.3	48.2	27.8	3.93	88.5	6.15	21.5
T_3	73.7	20.6	20.1	17.3	51.2	29.6	4.12	93.6	6.34	29.8
T_4	71.2	19.7	19.1	22.2	47.1	27.0	3.78	87.7	8.51	24.5
T_5	74.5	20.9	20.6	21.7	50.7	29.8	4.21	93.8	7.69	28.7
CD = 0.05	2.38	1.37	1.46	1.54	2.15	2.11	1.62	3.07	3.84	2.27

Uptake of Nutrients in Wheat

The uptake of N, P, K. Cu and Zn varied from 75.6 to 84.8 kg ha^{-1} , 23.1 to 26.8 kg ha^{-1}, 15.8 to 18.9 kg ha^{-1}, 15.8 to 22.5 mg kg^{-1} and 18.3 to 19.3 mg kg^{-1} in grain and from 23.5 to 32.6 kg ha^{-1}, 3.72 to 4.84 kg ha^{-1}, 87.4 to 93.8 kg ha^{-1}, 5.93

to 8.48 mg kg^{-1} and 09.2 to 10.3 mg kg^{-1} in straw of wheat respectively in different treatments in rice-wheat cropping system (Table-3). The maximum uptake of N 84.8, P 26.8 and K 18.9 kg ha^{-1} in grain and N 32.6, P 4.84 and K 92.2 kg ha^{-1} in straw of rice with the application of FFP +1 Spray of Nano N +1 Spray of Nano Zn+1 Spray of Nano Cu. The Cu 22.5 mg kg^{-1} in grain and 8.48 mg kg^{-1} in straw was received with treatment of FFP+2 Spray of Nano Cu. The Zn 19.3 mg kg^{-1} in grain and 10.3 mg kg^{-1} in straw was observed with the application of FFP+2 Spray of Nano Zn due to application of nano fertilizers.. The minimum uptake of N 75.6, P 23.1, K 15.8 kg ha^{-1}, Cu 15.8, Zn 18.3 mg kg^{-1} in grain and N 23.5, P 3.72 and K 82.6 kg ha^{-1}, Cu 5.98 and Zn 10.3 mg kg^{-1} in straw of wheat in Farmer fertilizer Practice treatment. The similar results were reported by many others [2,3].

Table 3 Effect of treatments on nutrients uptake in wheat (mean of two years)

Treatments	Grain					Straw				
	kg ha^{-1}			mg kg^{-1}		kg ha^{-1}			mg kg^{-1}	
	N	P	K	Cu	Zn	N	P	K	Cu	Zn
T_1	75.6	23.1	15.8	15.8	18.3	23.5	3.72	82.6	5.93	09.2
T_2	79.5	24.9	17.3	16.7	18.6	27.4	4.15	84.5	6.12	09.5
T_3	83.7	26.2	18.4	17.8	19.2	31.7	4.63	90.1	6.28	10.2
T_4	80.3	25.0	17.6	22.5	18.4	28.3	4.22	85.7	8.48	09.4
T_5	84.8	26.8	18.9	21.2	19.3	32.6	4.84	92.2	7.65	10.3
CD = 0.05	2.32	1.35	1.47	1.44	2.10	2.13	1.53	2.67	3.64	2.21

References

1. Biswal, S. K., Nayak, A. K., Parida, U. K. and Nayak P.L. (2012). Application of nanotechnology in agriculture and food sciences. *International Journal Science Innovation and Discoveries*, **2**(1): 21-36.
2. Bhattacharya, P., Chakraborty, A., Chakrabarty, K. and Tripathy, S. (2006). Copper and zinc uptake by rice and accumulation in soil amended with municipal solid waste compost. *Environment geology,* **49**(7): 1064-1070.
3. Kumar, Y. , Tiwari, K. N., Nayak, R. K., Rai, A., Singh, S. P., Singh, A. N., Kumar, Y., Tomar, H., Singh, T. and Ralia, R. (2020). Nanofertilizers for increasing nutrient use efficiency, yield and economic returns in important winter season crops of Uttar Pradesh. *Indian Journal of Fertilizers,* **16**(8): 772-786.
4. Kumar, Y. , Tiwari, K. N., Singh, T., Saini, N. K. Laxmi, S., Verma, R., Sharma, G.C. and Ralia, R. (2020). Nanofertilizers for enhancing nutrient use efficiency, crop production and economic retures in winter season crops of Rajasthan. *Annals of Plant and Soil Research,* **22**(4): 324-335.