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Effect of Nutrient Optimization through Organic and Inorganic Resources on Yield, Uptake, and Soil Properties in a Rice-wheat Cropping System

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during 2017-18 to 2019-20 on a fixed layout in sodic soil at Fertilizers Research Farm, Uttaripura in the jurisdiction of C. S. Azad University of Agriculture and Technology, Kanpur using high yielding variety of rice NDR-359 and wheat PBW-343. The maximum grain, straw, and biological yield of rice were noted as 44.75, 55.93, and 99.68 q ha-1, and wheat 46.25, 56.42 and 99.97 q ha-1 with the application of 75% NPK+ two spray of 0.25% of Sagarika +25 kg/ha Sagarika granules +two spray of 2% of WSF (18:18:18), The maximum uptake of NPK in grain and straw of both rice and wheat crop with the application of 75% NPK + two sprays of 0.25% of Sagarika +25 kg/ha Sagarika granules +two spray of 2% of WSF (18:18:18) followed by75% NPK+ two spray of 0.25% of Sagarika +25 kg/ha Sagarika and minimum uptake of NPK in grain and straw with the application of 75% NPK. The basal application of Sagarika @ 25 kg ha was found superior to the foliar spray of Sagarika. The change in pH, EC, OC, available N, P, K, S, Zn, and Br ranged from 7.2 to 7.5, 0.32 to 0.34 DSM-1, 0.39 to 0.41%, 191 to 195, 15.7 to 16.8, 173.4 to 178.5, 19.4 to 19.8, 11.2 to 11.5 and 0.73 to 0.77 kg ha-1 respectively with the application of different treatments while not remarkable changes from initial values of soil properties. Application of 10 t/ha FYM was found better than other treatments during the study period.

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1. INTRODUCTION

The world agricultural cropping system is intensively using a large number 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 environmental 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 the population of beneficial organisms in the soil and on the whole soil health problems. Among the 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. Biswal et al, [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 to these problems. The use of nano-fertilizers not only causes increased use efficiency through an ultrahigh absorption of the nutrients, an increase in photosynthesis caused by an expansion in the 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 nutrient optimization through organic and inorganic resources on yield, uptake and soil properties in the rice-wheat cropping system.

2. MATERIALS AND METHODS

A field experiment was conducted during 2017-18 to 2019-20 on a fixed layout in sodic soil at Fertilizers Research Farm, Uttaripura in the jurisdiction of C. S. Azad University of Agriculture and Technology, Kanpur using a salt-tolerant and high-yielding variety of rice NDR-359 and wheat PBW-343. The initial Physico-chemical properties of soil were pH 8.20, EC 0.42 dSm-1, and organic carbon 2.6 g kg-1soil. The soil was sandy loam in texture, having available N 175.3 kg ha-1, available P2O5 19.5 kg ha-1, and available K2O 232.4 kg ha-1. The experiment was laid out under a consistent randomized block design with three replications. The experiment consisted of ten treatments-viz., T1-100% NPK (RDF), T2-75% NPK, T3-75% NPK+ two spray of 0.25% of Sagarika at tillering and pre-flowering stage. T4-75% NPK+ two spray of 0.25% of Sagarika granules at sowing, T5-75% NPK+ two spray of 2% of WSF (18:18:18) at tillering and pre-flowering stage, T6-75% NPK+ seed treatment with NPK Consortia @ 5 ml/ kg of seed. T7-75% NPK+ two spray of 0.25% of Sagarika +25 kg/ha Sagarika granules. T8-75% NPK+ two spray of 0.25% of Sagarika +two spray of 2% of WSF (18:18:18). T9-75% NPK+ two spray of 0.25% of Sagarika +25 kg/ha Sagarika granules + two spray of 2% of WSF (18:18:18) and T10-75% NPK+seed treatment with NPK Consortia @ 5 ml/ kg of seed +FYM 10 t/ha. About a 25-day-old seedling was uprooted carefully from the seedbed and transplanted carefully in a well-prepared field in the month of June and for the sowing of wheat in the month of November. Recommended doges of fertilizers were applied through urea, DAP, and muriate of potash, respectively. The half doge of N and full doges of P2O5 and K2O were applied as basal and the rest of N was applied in two equal splits at the time of tillering and ear emergence stages in both rice and wheat crops. Agronomical operations will be applied as a partial requirement of crops. The analysis works for different parameters as suggested by Jackson [2] texture.

3. RESULTS AND DISCUSSION

3.1 Yield of Crops

The grain, straw and biological yield of rice and wheat were significantly influenced with the application different treatments (Table 1). The ranged of grain yield from 35.40 to 44.75 q ha^{-1} with the mean value of 41.54 q ha^{-1}, straw from 44.25 to 55.93 q ha^{-1} with the mean value of 50.49 q ha^{-1} and biological from 79.65 to 99.68 q ha^{-1} with the mean value of 92.70 q ha^{-1} in rice and grain from 34.50 to 46.25 q ha^{-1} with the mean value of 42.44 q ha^{-1}, straw from 42.09 to 56.42q ha^{-1} with the mean value of 51.82 q ha^{-1} and biological from 79.59 to 99.97 q ha^{-1} with the mean value of 94.55 q ha^{-1} in wheat with the application of different treatments in rice - wheat cropping system. The data showed that the grain, straw and biological yield of both rice and wheat decreased due to reduction of 25% NPK over 100% NPK (RDF). The maximum grain, straw and biological yield of rice were noted as 44.75, 55.93 and 99.68 q ha^{-1}, and wheat 46.25, 56.42 and 99.97 q ha^{-1} with the application of

75% NPK+towsprey of 0.25% of Sagarika +25 kg/ha Sagarika granules +two sprey of 2% of WSF (18:18:18), and the minimum yield of both rice and wheat with the application of 75% NPK alone. The similar results were also reported with Kumar et al, [3]. Application of various inputs like sagarika, WSF (18:18:18) NPK consortia and FYM along with 75% NPK trended to increased grain , straw and biological yield over 75% NPK, and when they are together the yield of both rice and wheat increased over 100% NPK (RDF) Yen et al. [4].

3.2 Uptake of Nutrients

The nutrients uptake by grain and straw of rice and wheat were significantly influenced with the application of different treatments (Table 2). The uptake of N, P and K varied from 31.8 to 43.5 kg ha^{-1}, 4.92 to 9.25 kg ha^{-1} and 4.55 to 8.50 kg ha^{-1} with mean value of 38.2, 7.24 and 6.72 kg ha^{-1} respectively in grain and N from 51.3 to 63.3 kg ha^{-1}, P from 1.82 to 2.75 kg ha^{-1} and K from 81.2 to 98.5 kg ha^{-1} with mean values N 57.4, P 2.22 and K 91.6 kg ha^{-1} in straw of rice and from 56.6 to 75.1 kg ha^{-1}, 10.3 to 15.3 kg ha^{-1} and 17.5 to 22.9 kg ha^{-1} with mean value of 69.8, 12.8 and 20.6 kg ha^{-1} in grain and from 17.2 to 21.9 kg ha^{-1}, 5.57 to 6.57 kg $ha^{-1}$and 55.1 to 64.2 kg ha^{-1} with mean value 20.1, 6.03 and 60.7 kg ha^{-1} in straw of N,P and K respectively of wheat crop with the application of different treatments. The maximum uptake of NPK in grain and straw of both rice and wheat crop with the application of 75% NPK + two spray of 0.25% of Sagarika +25 kg/ha Sagarika granules +two spray of 2% of WSF (18:18:18) followed by75% NPK+towsprey of 0.25% of Sagarika +25 kg/ha Sagarik and minimum uptake of NPK in grain and straw with the application of 75% NPK. The basal application of sagarika @ 25 kg ha found superior over foliar spray of sagarika. The similar results were also reported by Bhattacharya et al, [5] and Solanki et al. [6].

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

Treatments	Rice			Wheat		
	Grain	Straw	Biological	Grain	Straw	Biological
T_1	42.00	51.24	93.24	43.55	53.13	96.68
T_2	35.40	44.25	79.65	34.50	42.09	79.59
T_3	39.20	49.00	88.2	40.20	49.04	89.24
T_4	40.50	50.63	91.19	42.48	51.82	94.30
T_5	42.80	53.5	96.30	44.35	54.11	98.46
T_6	39.45	49.31	88.76	40.47	49.37	89.84
T_7	44.50	54.62	98.12	45.35	55.33	99.98
T_8	41.75	52.19	93.94	43.35	52.88	96.23
T_9	44.75	55.93	99.68	46.25	56.42	102.97
T_{10}	43.50	54.37	97.87	44.25	53.98	98.23
CD=0.05	2.36	3.57	--	2.43	3.29	--

Table 2. Effect of treatments on nutrients uptake in rice and wheat kg ha^{-1} (mean of three years)

Treatments	Rice						Wheat					
	Grain			Straw			Grain			Straw		
	N	P	K	N	P	K	N	P	K	N	P	K
T_1	38.6	6.85	6.35	55.4	2.25	91.5	71.4	12.7	21.2	19.5	6.15	60.5
T_2	31.8	4.92	4.55	51.3	1.82	81.2	56.6	10.3	17.5	17.2	5.57	55.1
T_3	36.2	5.80	5.65	53.2	1.85	86.5	67.5	11.9	19.3	18.3	5.25	57.9
T_4	36.8	5.93	5.42	54.7	2.05	92.1	69.2	12.1	20.1	20.3	6.05	59.6
T_5	37.3	7.14	6.82	56.3	2.15	95.2	72.2	13.5	21.3	21.2	6.25	61.3
T_6	37.5	6.20	6.25	53.7	1.95	85.9	68.3	12.1	19.9	18.5	5.75	58.2
T_7	42.3	9.15	8.15	63.2	2.50	97.5	74.5	14.5	22.4	21.3	6.45	65.3
T_8	39.5	8.90	7.32	61.2	2.25	93.1	71.3	12.9	21.1	21.1	5.95	62.4
T_9	43.5	9.25	8.50	63.3	2.75	98.5	75.1	15.3	22.9*	21.9	6.57	64.2
T_{10}	38.5	8.35	8.20	62.1	2.65	94.5	72.3	13.2	21.2	20.8	6.29	63.1
CD=0.05	2.31	1.47	1.43	2.37	1.62	156	2.34	1.39	1.52	2.42	1.47	1.58

Table 3. Effect of treatments on physico-chemical properties of experimental soil after three year

Treatments	pH	EC	OC	Available nutrients (kg ha^{-1})					
		(dSm^{-1})	(%)	N	P	K	S	Zn	B
T_1	7.3	0.33	0.41	192	16.5	177.5	19.5	11.5	0.75
T_2	7.4	0.34	0.40	190	15.8	175.5	19.6	11.3	0.74
T_3	7.3	0.33	0.40	193	15.7	174.5	19.5	11.3	0.75
T_4	7.2	0.32	0.39	192	15.9	175.5	19.7	11.2	0.75
T_5	7.3	0.33	0.41	194	16.5	178.2	19.4	11.4	0.77
T_6	7.2	0.34	0.41	191	16.6	177.5	19.5	11.5	0.73
T_7	7.3	0.33	0.40	192	16.3	175.5	19.6	11.6	0.74
T_8	7.4	0.34	0.40	193	16.2	174.5	19.7	11.2	0.74
T_9	7.3	0.33	0.41	194	16.5	173.4	19.8	11.3	0.75
T_{10}	7.2	0.32	0.42	195	16.8	178.5	19.8	11.4	0.73
Initial status	7.4	0.34	0.39	189	15.5	175.5	19.5	11.2	1.50

3.3 Physico-chemical Properties of Soil

Application of various treatments slightly improved the physic-chemical properties of soil while pH and EC trended to decrease however; there are no significant effect of various treatments on soil properties, (Table 3). The changed of pH, EC, OC, available N, P, K, S, Zn and Br were ranged from 7.2 to 7.5, 0.32 to 0.34 dSm^{-1}, 0.39 to 0.41%, 191 to 195, 15.7 to 16.8, 173.4 to 178.5, 19.4 to 19.8, 11.2 to 11.5 and 0.73 to 0.77 kg ha^{-1} respectively with the application of different treatments while not remarkable changes from initial values of soil properties. Application of 10 t/ha FYM found better from other treatments regarding various soil properties during the study period.

4. CONCLUSION

The present study revealed that the field experiment was conducted during 2017-18 to 2019-20 as a fixed layout in sodic soil at Fertilizers Research Farm, Uttaripura in the jurisdiction of C. S. Azad University of Agriculture and Technology, Kanpur using salt tolerant and high yielding variety of rice NDR-359 and wheat PBW-343. The maximum grain, straw and biological yield of rice were noted as 44.75, 55.93 and 99.68 q ha^{-1}, and wheat 46.25, 56.42 and 99.97 q ha^{-1} and the maximum uptake of NPK in grain and straw of both rice and wheat crop with the application of 75% NPK + two spray of 0.25% of Sagarika +25 kg/ha Sagarika granules +two spray of 2% of WSF (18:18:18), and the minimum yield of both rice and wheat with the application of 75% NPK alone. Application of 10 t/ha FYM found better from other treatments regarding various soil properties during the study period.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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