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Asit Kumar Pal
Professor, Department of Soil Science and Agricultural Chemistry Institute of Agricultural Sciences, Siksha "O" Anushandhan (Deemed to be University), Bhubaneswar, Odisha, India

Bitish Kumar Nayak
Department of Soil Science and Agricultural Chemistry Institute of Agricultural Sciences, Siksha "O" Anushandhan (Deemed to be University), Bhubaneswar, Odisha, India

Rasmikanta Sahoo
Department of Agriculture Chemistry and Soil Science Institute of Agriculture Science, University of Calcutta, Kolkata, West Bengal, India

Corresponding Author:
Asit Kumar Pal
Professor, Department of Soil Science and Agricultural Chemistry Institute of Agricultural Sciences, Siksha "O" Anushandhan (Deemed to be University), Bhubaneswar, Odisha, India

Impact of amendments on rice productivity in iron toxic soils of Odisha

Asit Kumar Pal, Bitish Kumar Nayak and Rasmikanta Sahoo

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Abstract
A field experiment was conducted in Aeric Haplaquept to study the effect of different amendments to increase the rice crop yield in Iron toxic soil.
The experiment was conducted in RBD with three replications by taking rice Var. Jajati as a test crop. The treatments were: T1- Control, T2- fresh cowdung @ 10 t ha-1 +Zn @ 5 kgha-1, T3- Press mud @ 10 tha-1, T4- Rice bran @ 3 tha-1, T5-Ca-silicate @ 1 tha-1, T6- Rice bran + Ca-silicate @ 1 tha-1, T7- K @40 kgha-1 (through Patent Kali) + Zn @ 5 kgha-1, T8- K @ 80 kgha-1 (40 kg through Patent Kali) and recommended doses of N, P and K. The results showed that the rice yield of 56.67 qha-1 in the treatment of 40 kg K from Patent Kali with 5 kg Znha-1 was higher followed by Pressmud 10 t ha-1, Ca- silicate 1t ha-1, fresh cowdung +Zn 5kgha-1 and others in sequence. Highest harvest index was found in the treatment receiving 40 kg K from Patent Kali with 5 kg Znha-1. It was observed that there was reduction in Fe concentration from initial value in all treatments.

Keywords: Productivity, iron toxic soils, Odisha

Introduction
Iron toxicity is a syndrome of disorder associated with large concentration of reduced iron (Fe2+) in soil solution. It may occur in flooded soils and important constraint in rice production mostly micronutrient disorder in wetland rice. Pal *et al*. (2011) [5] conducted a field experiment to screen out the rice cultivars and reported that out of 15 scented rice cultivars, only four genotypes are suitable for iron toxic soil. Around 72,000 hectares of land are affected by iron toxicity problem in Odisha due to waterlogging, acidic and reduced condition resulting yield losses of rice (Mitra *et al*., 1990) [3]. The soil with acidic pH and high active iron content when get reduced toxic level of Fe is produced (Tanaka and Yoshida, 1970) [6]. Therefore, management of these soils are highly essential to augment the production and productivity of rice. Keeping these views, a study was made by using different types of amendments in iron toxic soil to increase the crop production.

Materials and Methods
A field experiment was conducted during Kharif in iron toxic low land soil of Central research Station, OUAT, Bhubaneswar. The experiment was conducted in RBD with three replications on a typical iron toxic Aeric Haplaquept soil with recommended dose of fertilizers (N: P: K: 60: 30: 30 kgha-1) by taking rice cultivar 'Jajati' as a test crop. The treatments were: T1-Control, T2- fresh cowdung @ 10 t ha-1 +Zn @ 5 kgha-1, T3- Press mud @ 10 tha-1, T4-Rice bran @ 3 tha-1, T5- Ca-silicate @ 1 tha-1, T6- Rice bran + Ca-silicate @ 1 tha-1, T7- K @ 40 kgha-1 through Patent Kali + Zn @ 5 kgha-1, T8- K @ 80 kgha-1 (40 kg from Patent Kali). The soil of the experimental plot was sandy loam with pH 5.1, Organic carbon 4.1 gkg-1, CEC 5.0 Cmol (P+) kg-1. The available N, P2O5 and K2O were 185, 8 and 95 kgha-1, respectively. The soil had DTPA extractable Fe 400 mgkg-1 and Zn 1.82 mgkg-1. The crop was harvested at maturity. Grain and straw yield were recorded. Potassium was estimated by flame photometry method (Jackson, 1973) [1]. Harvested samples were drying in oven at 700C, then grind. The ground samples were digested with diacid 2:1 mixture of nitric and perchloric acid for chemical analysis. Zn and Fe content were analysed by Atomic absorption Spectrophotometer (Lindsay and Norvell, 1978) [2]. The post harvest soils were analysed for pH, Fe and Zn.

Result and Discussion

The rice grain yield varied from 45.0 to 56.67 qha-1 due to different types of amendments (Table 1). Highest significant yield of 56.67 qha-1 ie. 25.9 % increase in yield over control was obtained in the treatment receiving 40 kg K from Patent Kali with 5 kg Znha-1 (T7) may be due K and Zn which increases the root oxidation power and convert soluble Fe2+ to insoluble Fe3+ in rhizospere (Tanaka and Yoshida, 1970). It was statistically at par with all other treatments except rice bran. The percent increase in rice grain yield were in the order of 24.8, 21.5, 20, 11.5, 8.9 and 0.73 in respect of T3, T5, T2, T6, T8 and T4, respectively. Highest harvest index was found in the treatment receiving 40 kg K from Patent Kali with 5 kg Znha-1 (T7). It was found that 40 kg K from Patent Kali with 5 kg Znha-1 (T7) was best treatment followed by Pressmud 10tha-1, Ca- silicate 1 tha-1, fresh cowdung +Zn 5kgha-1 and others in sequence. Similarly, straw yield varied from 64.67 to 83.33 qha-1 due different treatments. Highest straw yield of 83.33 qha-1 was obtained in the treatment of Ca silicate @ 1 tha-1. Similar observation made by Nayak and sahu (2008) [4], found that K @ 80 kgha-1 was the best treatment followed by lime, fresh cow dung, fly ash and others in sequence.

Table 1: Effect of amendment on grain and straw yield (qha-1) of rice

Treatments	Yield(qha-1)		% yield Increase	HI (%)
	Grain	straw		
T1-Control	45.00	71.33	-	38.7
T2- fresh cowdung@10 tha-1 +Zn@5 kgha-1	54.00	77.33	20.0	41.1
T3-Press mud@10tha-1	56.17	76.00	24.8	42.5
T4- Rice bran @ 3tha-1	45.33	76.67	0.73	37.1
T5- Ca silicate@1 tha-1	54.67	83.33	21.5	39.6
T6-Rice bran +Ca silicate	50.17	64.67	11.5	43.7
T7-K@40kgha-1 through PK+Zn @ 5kgha-1	56.67	68.00	25.9	45.5
T8-K@80kgha-1(addition 40kg through PK)	49.00	65.33	8.9	42.8
CD (0.05)	8.39	NS		

The content of Zn, Fe (mgkg-1) and K(%) in grain and straw of rice are presented in Table-2. It was found that highest grain Fe concentration of 114 mgkg-1 was observed in control plot. Fe concentration in rice grain gradually decreased to various degrees due to different amendments. Lowest Fe concentration of 26.3 mg kg-1 in rice grain was observed in the treatment of K@80 kgha-1 (40 kg through Patent Kali). This may be due to Patent Kali contain K alongwith S and Mg. Presence of Mg decreased Fe solubility thereby reducing Fe concentration in soil, therefore less Fe uptake by rice. In case of straw, Fe concentration varied from 212.0 to 431.7 mgkg-1. The Zn concentration in grain varied from 12.7 to 16.9 mgkg-1 whereas in straw, it varied from 13.2 to 64.9 mgkg-1. Like that K concentration in grain varied from 0.26 to 0.83 percent with different amendments whereas in straw, it varied from 1.5 to 2.5 percent.

Table 2: Effect of treatments on Fe, Zn concentration (mgkg-1) and K (%) in rice grain and straw

Treatments	Fe (mgkg-1)		Zn(mgkg-1)		K(%)	
	Grain	straw	Grain	straw	Grain	straw
T1-Control	114.9	343.4	15.1	28.0	0.26	2.4
T2- fresh cowdung@10 tha-1 +Zn@5 kgha-1	46.3	386.4	16.9	64.9	0.83	2.5
T3-Press mud@10tha-1	71.1	242.8	15.4	13.2	0.26	1.2
T4- Rice bran @ 3tha-1	65.9	235.8	14.3	36.3	0.79	2.2
T5- Ca silicate@1 tha-1	45.9	367.2	15.4	17.8	0.26	2.3
T6-Rice bran +Ca silicate	47.1	431.7	12.8	37.5	0.80	2.2
T7-K@40kgha-1 through PK+Zn @ 5kgha-1	50.8	212.0	15.9	38.4	0.27	1.9
T8-K@80kgha-1(addition 40kg through PK)	26.3	259.1	12.7	29.4	0.77	1.5

Post harvest soil analysis (Table 3) revealed that there was reduction in Fe concentration from initial value of 400 mgkg-1 in all treatments, whereas pH and Zn concentration were considerably increased from initial value with different treatments.

Table 3: Effect of amendment on post harvest soil

Treatments	pH	mgkg-1	
		Fe	Zn
T1-Control	5.30	326.6	3.4
T2- fresh cowdung@10 tha-1 +Zn@5 kgha-1	4.67	226.3	6.2
T3-Press mud@10tha-1	5.18	243.7	3.2
T4- Rice bran @ 3tha-1	4.62	247.5	3.6
T5- Ca silicate@1 tha-1	5.13	237.6	3.1
T6-Rice bran +Ca silicate	5.93	222.7	3.9
T7- K@40kgha-1 through PK+Zn @ 5kgha-1	4.69	250.3	2.8
T8-K@80kgha-1(addition 40kg through PK)	4.48	234.0	4.8
Initial	4.1	400.0	1.8

Conclusion

From the study, It was concluded that 40 kg K from Patent Kali with 5 kg Znha- 1 was best treatment followed by Pressmud 10tha-1, Ca silicate 1 tha-1, fresh cowdung +Zn 5kgha-1 and others in sequence for amelioration of acidic iron toxic soil and to increase the production of rice. Post harvest soil study indicated that application of amendments were also reduced the iron content of soil.

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