

Original Research Article

<https://doi.org/10.20546/ijcmas.2020.906.039>

## Interaction of Potassium and Zinc on rice productivity in Iron Toxic soils of Odisha, India

Asit Kumar Pal<sup>1</sup>, Lata Mallik<sup>2</sup>, Bitish Kumar Nayak<sup>1\*</sup> and Rasmikanta Sahoo<sup>3</sup>

<sup>1</sup>Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Siksha "O" Anushandhan (Deemed to be University), Bhubaneswar-751029, Odisha, India

<sup>2</sup>Department of Soil Science and Agricultural Chemistry, OUAT, Bhubaneswar-751003, Odisha, India

<sup>3</sup>Department of Agriculture Chemistry and Soil Science Institute of Agriculture Science, University Of Calcutta -700007, Kolkata, India

\*Corresponding author

### ABSTRACT

A field experiment was conducted in Aeric Haplaquept to study the effect of Potassium and Zinc and interaction effect 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. Twelve treatments combinations, consists of four levels of K (0, 40, 80 and 120 kg ha<sup>-1</sup>) and three levels of zinc (0, 2.5 and 5 kg ha<sup>-1</sup>) were imposed on concerned plots with the recommended doses of N, P and K. The results showed that the highest rice yield of 42.2 qha<sup>-1</sup> was found in the combined treatment of 80 kg K ha<sup>-1</sup> with 5 kg Znha<sup>-1</sup> (HI 46.4) which yield (40.1 qha<sup>-1</sup>) was statistically at par with the treatment of K40kg ha<sup>-1</sup> with Zn 5 kg ha<sup>-1</sup> (HI 46.2).. The mean rice yield was increased by 22 percent over control. Hence, it may be suggested to apply K40 kg ha<sup>-1</sup> + Zn 5 kg ha<sup>-1</sup> to get economically maximum benefit. Similar trends were observed in straw also. The concentration of iron in grain and straw was decreased with the treatments whereas Zinc and potassium concentration had an little influenced on grain and straw.

### Keywords

Potassium  
and Zinc  
RBD, Jajati  
rice yield

### Article Info

Accepted:  
14 May 2020  
Available Online:  
10 June 2020

### Introduction

About 72,000 hectares of land are effected by iron toxicity problem in Odisha (Mitra *et al.*, 1990). Iron toxicity is a syndrome of disorder associated with large concentration of reduced iron (Fe<sup>+2</sup>) in soil solution, occurs in flooded soils. The appearance of iron toxicity

symptoms in rice involves an excessive uptake of Fe<sup>+2</sup> by rice roots and its acropetal translocation into leaves where an elevated production of toxic oxygen radicles can demand the cell structure and impair physiological processes. The typical symptoms are bronzing of rice leaves and substantial associated yield losses 15-30% or

complete crop failure. It is important constraint to rice production mostly micronutrient disorder in wetland rice. Agronomic management was advocated to reduce Fe<sup>+2</sup> concentration in soil or cultivars which are tolerant to excess Fe<sup>+2</sup>. The soil with acidic pH and high active iron content when get reduced toxic levels of Fe is produced (Tanaka and Yoshida,1970) A field experiments was laid to screen the scented rice varieties and found that Varieties like Acharmati, Khosakani, Thakursuna and CRM-2007-1 were most suitable for iron toxic soils (Pal *et al.*, 2011). Mohanty and Patnaik (1977) observed that K- deficiency aggravated Fe toxicity. High salt content helps in production of soluble iron through increasing solubility of iron. Sahu and Mitra (1992) observed that increasing dose of K increased the dry matter yield of rice. Application of K increases Fe excluding power of root. It depends on root permeability which increase the K deficiency. The adequate amount of K produce higher weight molecules which prevent root exudation and entry of soluble iron inside by decreasing root permeability (Benckizer, 1982). Pal *et al.*, (2020) found that application of 40 kg Kha-1 with 5 kgZnha-1 gave higher rice yield response than Press mud and Ca-silicate. Due to different amendments Fe concentration in soil was also reduced. Keeping these view, a field study was made by taking K and Zn in different doses and their interaction to increase the rice production in Iron toxic soils of Odisha.

### **Materials and Methods**

A field experiment was conducted during *Kharif* 2011 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) by

taking rice cultivar 'Jajati' as a test crop. Twelve treatment combinations, consist of four levels of K (0, 40, 80 and 120 kg ha<sup>-1</sup>) and three levels of zinc (0, 2.5 and 5 kgha<sup>-1</sup>) were imposed on concerned plots. The soil of the experimental plot was sandy loam with pH 5.1, organic carbon 4.1 gkg<sup>-1</sup>, CEC 5.0 Cmol (P<sup>+</sup>) kg<sup>-1</sup>. The available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were 185, 8 and 95 kgha<sup>-1</sup>, respectively. The soil had DTPA extractable Fe 400 mgkg<sup>-1</sup> and Zn 1.82 mgkg<sup>-1</sup>. The crop was harvested at maturity. Grain and straw yield were recorded. Potassium was estimated by flame photometry method (Jackson,1973). Harvested samples were drying in an oven at 70°C, 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).

### **Results and Discussion**

The rice grain yield varied from 27.5 to 42.2 qha<sup>-1</sup> using different treatments (Table 1). Highest significant yield of 42.2 qha<sup>-1</sup> ie. 53.6 percent increase over control was obtained with the application of K80 kgha<sup>-1</sup>+Zn 5 kgha<sup>-1</sup> (HI 46.4) which was statistically at par with the treatment of K40kgha<sup>-1</sup> +Zn 5 kgha<sup>-1</sup> (HI 46.2). The application of K40 kgha<sup>-1</sup>+Zn 5 kgha<sup>-1</sup> alongwith recommended dose of fertilizers (N, P and K) gave rice grain yield of 40.1 qha<sup>-1</sup> which was 45.8 percent over control. The effect of K had significantly increased mean yield over control whereas increasing dose of zinc also had significant effect on yield of rice. The interaction effect of K80 kgha<sup>-1</sup> + Zn 5 kgha<sup>-1</sup> had no statistical difference with K40 kgha<sup>-1</sup> + Zn 5 kgha<sup>-1</sup>. Hence, it may suggested that application of K@40 kgha<sup>-1</sup> + Zn @5 kgha<sup>-1</sup> gave better yield of rice and economically maximum benefit.

**Table.1** Effect of Potassium and zinc on yield (qha-1) of rice

Treatments	Yield of rice(qha-1)			HI(%)
	Grain	% increase over control	Straw	
T1-K0Zn0	27.5	-	34.0	44.7
T2-K0Zn2.5	32.3	17.4	38.8	45.4
T3-K0Zn5.0	34.3	24.7	40.8	45.7
T4-K40Zn0	33.4	21.3	39.9	45.6
T5-K40Zn2.5	37.0	34.5	43.5	45.9
T6-K40Zn5.0	40.1	45.8	46.6	46.2
T7-K80Zn0	34.1	24.1	40.6	45.6
T8-K80Zn2.5	38.5	40.1	45.0	45.1
T9-K80Zn5.0	42.2	53.6	48.7	46.4
T10-K120Zn0	34.4	25.1	39.4	46.6
T11-K120Zn2.5	36.1	31.2	42.4	45.9
T12-K120Zn5.0	37.0	34.5	42.9	46.3
CD (0.05)	5.89	-	5.77	-

**Table.2** Effect of Potassium and zinc on Fe, Zn (mgkg-1) and K(%) content in rice

Treatments	Fe conc.(mgkg-1)		Zn conc.(mgkg-1)		K(%)	
	Grain	straw	Grain	Straw	Grain	straw
T1-K0Zn0	82.2	237.5	24.8	34.5	0.16	0.32
T2-K0Zn2.5	66.5	120.6	25.3	33.9	0.16	.041
T3-K0Zn5.0	61.6	101.9	26.3	30.9	0.15	0.37
T4-K40Zn0	77.9	164.7	25.7	41.4	0.19	0.40
T5-K40Zn2.5	67.9	146.9	26.5	41.7	0.17	0.34
T6-K40Zn5.0	43.3	127.1	24.8	43.9	0.17	0.42
T7-K80Zn0	74.6	148.4	29.0	42.4	0.15	0.36
T8-K80Zn2.5	57.3	119.9	26.9	40.8	0.18	0.25
T9-K80Zn5.0	69.9	111.2	23.9	39.8	0.17	0.33
T10-K120Zn0	70.4	198.3	26.5	35.9	0.17	0.36
T11-120Zn2.5	60.9	98.8	26.1	34.6	0.17	0.32
T12-120Zn5.0	59.2	72.2	25.4	34.1	0.15	0.36
CD (0.05)	29.6	45.15	5.41	8.32	0.04	0.14

Similar trends were observed in case of straw. The findings made by Nayak and sahu (2008), found that K @ 80 kgha-1 was the best treatment followed by lime, fresh cowdung, fly ash and others in sequence. Pal *et al.*, (2020) was obtained similar results with the application of K 40 kg ha-1 through Patent kali +Zn 5 kgha-1 to rice yield may be due to K and Zn which increases the root exudation and convert soluble Fe+2 to insoluble Fe+3 in

rhizosphere (Tanaka and Yoshida,1970). Adequate quantity of K prevents root exudation and entry of soluble iron inside by decreasing root permeability (Benckizer 1982).

The content of Fe, Zn (mgkg-1) and K(%) in grain and straw are presented in Table 2. It was found that Fe content in grain and straw varied from 43.3 to 82.2 mgkg-1 and 72.2 to

237.5 mgkg<sup>-1</sup>, respectively. Highest Fe content of 82.2 mgkg<sup>-1</sup> in grain and 237.5 mgkg<sup>-1</sup> in straw was observed in control. Gradually it was decreased with the treatments. Lowest Fe content of grain (43.3 mgkg<sup>-1</sup>) was observed in the treatment of K@40Kgha<sup>-1</sup> + Zn@ 5kgha<sup>-1</sup> may be due to K and Zn decreased the solubility of Fe concentration in soil, as a result less Fe uptake by rice. Zinc content in grain ranged from 23.9 to 29.0 mgkg<sup>-1</sup> whereas in straw it varied from 30.9 to 43.9 mgkg<sup>-1</sup>. The potassium percentage in grain and straw varied from 0.15 to 0.19 and from 0.25 to 0.42 percent, respectively. It was found that with increasing level of K, Fe content in grain was decreased, further decreased was noticed with the addition of zinc.

From the study, it may be concluded that the application of K @40 kgha<sup>-1</sup> and Zn@ 5 kgha<sup>-1</sup> was the best treatment to enhance better grain yield of rice and gave economically maximum benefit in iron toxic soil.

## References

Benckizer G; Ottow JCG; Santiago S and Watanabe I.(1982) Physiochemical characteristics of Iron toxic soils in some Asian countries. IRRI Res. Paper series-85, IRRI, Manila, Philippines.  
Jackson ML(1973) ;Soil Chemical Analysis. Prentice Hall of India (Pvt) Ltd. New

Delhi

- Lindsay WI and Norvel WA (1978). 'Development of DTPA soil test for Zinc, iron, Manganese and copper'. *Soil Science Am.J.* 42: 421- 448.
- Mitra GN; Sahu S and Dev G (1990). 'Potassium chloride increases rice yield and reduce the symptom of iron toxicity'. *Better crops Inter*, 12: 14-15.
- Mohanty SK and Patnaik S (1997). Effect of submergence on the chemical changes in different rice soils. The kinetics of K, Ca and Mg. *Acta Agronomica, Acad.Sci. hungary*, 26: 187- 192.
- Nayak RK and Sahu SK (2008). 'Studies on Iron toxicity in relation to rice nutrition in soils of Orissa'. Ph.D thesis submission to santiniketan, W.B.
- Pal AK ; Nayak BK and sahoo RK (2020). 'Impact of different amendments on rice productivity in iron toxic soils of Odisha'. *International J. chemical studies* 8(3) : 490- 492.
- Pal AK ; Nayak RK and Acharya R (2011). 'Screening of scented rice genotypes under Iron toxic soil'. *J.Res. Orissa Univ. Agric. Tech. special issue* 1(1): 164-167.
- Sahu SK and Mitra GN (1992). 'Iron – Potassium interaction of nutrient balance in rice'. *J.Potassium Res.* 8(4): 311-319.
- Tanaka A and Yoshida S (1970). 'Nutrient disorder of rice plant in Asia' Bull. No. 10, IRRI, Manila, Philippines.

## How to cite this article:

Asit Kumar Pal, Lata Mallik, Bitish Kumar Nayak and Rasmikanta Sahoo. 2020. Interaction of Potassium and Zinc on rice productivity in Iron Toxic soils of Odisha, India. *Int.J.Curr.Microbiol.App.Sci.* 9(06): 303-306. doi: <https://doi.org/10.20546/ijcmas.2020.906.039>