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Suitable rice varieties for iron toxic soils of Orissa

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ABSTRACT

Iron toxic soil, one of the handicapped soils of Orissa produces poor rice yield. Normal rice production in these soils by means of amelioration is costly. Considering rice genotypes to be a better option for getting expected yields, 65 genotypes were evaluated for their tolerance capacity to iron toxicity in a typical iron toxic soil of Bhubaneswar, Orissa Rice genotypes irrespective of their duration showing score value between 1 to 2 produced normal yields and those having score between 7 to 9 yielded the minimum. Genotypes Kalinga-III, Udayagiri, Konark and Panidhan under extra early, early, medium and late durations, respectively produced significantly higher yields at different score scales than their respective duration groups.

Key words: *Iron toxicity, genotypes, score scale and grain yield*

Out of 4.42 m ha of rice lands of Orissa, nearly 0.25 m ha medium and low land soils belonging to red and lateritic groups adjacent to upland plinthites suffer from iron toxicity due to deposits of soluble ferrous iron (Sahu 1993). Rice grown in these soils produce low yield due to reduced uptake of P, K, Ca, Mg, Zn and Mn (Sahu 1990).

Rice productivity in iron toxic soils can be enhanced through application of costly inputs such as lime, well decomposed organic manures, above the recommended doses of N, P, K and Zn and Mn (Nayak *et al.*, 2004). There are rice genotypes those can tolerate iron toxicity and produce normal yield with application of recommended doses of N, P, K (Sahrawat and Singh 1998). The degree of tolerance to iron toxicity varied with genotypes (Sahu *et al.*, 1990). Information regarding performances of rice genotypes in iron toxic soils of Orissa is meager for which field trials were taken up to screen out rice varieties tolerant to iron toxicity.

A typical iron toxic rice field was selected in Central Research Station of Orissa University of Agriculture and Technology, Bhubaneswar. The soil of the experimental site was sandy loam (Haplaquept) with pH 5.1, O.C. 4140 $mg^{-1}g$, CEC 5.0 cmol (p+) kg^{-1}, AB-DTPA extractable Zn 0.45 ppm, Fe 367.9 ppm, Cu 2.64 ppm and Mn 2.2 ppm. Sixty five genotypes of rice comprising eight from extra early groups (<90 days), eight from early groups (90-115 days), twelve from medium groups(116-130 days), eleven from late medium groups (131-145 days) and twenty one from long duration groups (>145 days) were grown (Table 1) in plots of 5 m^2 with three replications in RBD. The crop received N, P_2O_5 and K_2O at 80:40:40 kg ha^{-1} in the form of Urea, DAP and Murate of potash respectively. The symptoms of iron toxicity was scored after 30 days of planting in 1-9 scale (IRRI 1996). Iron contents of leave samples were determined by Atomic Absorption Spectrophotometer after digestion in diacids HNO_3: $HClO_4$ in 3:2 ratio. Rice genotypes along with their score of toxicity, grain yield and Fe content are presented in Table 1 and 2.

Tolerance of rice genotypes to iron toxicity measured by SES scale (IRRI,1996) has been rated as good tolerant with score of 1 and 2, moderately tolerant with score of 3 to 5 and susceptible with score of 6 to 9. Grain yield of genotypes varied with their duration. Extra early groups showed the minimum yields ranging from 0.77 1.99 t ha^{-1}. Kalinga III having the score 1 produced the maximum yield. Variety Sankar with a score of 7 had the minimum yield. The yields produced by the other four varieties were at par. Under early group the yields ranged from 1.57 t ha^{-1} to 2.51 t ha^{-1}. Udayagiri with score of 1 produced the maximum yield which was at par with the yield produced by Ghanteswari with score of 3. Rice genotypes under medium group showed yield range between 1.59 t ha^{-1} to 2.71 t ha^{-1}. Konark with score of 2 produced the maximum yield which was at par with the genotypes such as Sarsa, Birupa, Sarathi and Lalata which had score of 2 to 3. Other genotypes having score between 5 to 7 produced significantly lower yields. Under late medium group Jajati with score of 7 produced the minimum yield of 1.75 t ha^{-1} while Moti with score 3 produced the maximum yield of 3.21 t ha^{-1}. Genotypes such as Padmini, Gouri, Bhanja and Gajapati having score value within 2-3 could not compete with Moti, which might be due to their poor adaptability to rice environment under iron toxic situation. Other genotypes under this group having score value of 5 yielded lower than the other varieties. Genotypes under late duration group, T-1242 and SR 26B with score of 6 produced the minimum yields while Seema having score of 2 showed the maximum yield of 3.60 tha^{-1} which was at par with the yields of Mahalaxmi having the same score. Genotypes Panidhan and Basuabhog though scored 1, showed significantly lower yields than Seema which might be due to their low yielding character but high tolerance to iron toxicity. Genotypes CR-1014 and CR-1030 although had score of 5 produced 14.5% higher yields than iron toxic affected genotypes SR-26B and T-1242. The grain yield of other three genotypes having score of 2 to 4 ranged between 2.3 to 3.0 t ha^{-1}. Yield differences among the rice varieties having similar score values might be due to their genotypic characters.

Iron content of leaves (Table 1) at tillering stage varied between 196 ppm for Mahanadi with score of 3 to the maximum of 846 ppm for Pathara with score 7. Rice varieties tolerant or moderately tolerant to iron toxicity showed lower concentration of iron in leaves and with increase in score value, concentration of iron increased. Considering 300 ppm of Fe in rice leaf as threshold limit of toxicity (Sahrawat 2000) almost all the varieties had iron content above this value. This might be due to high concentration of available Fe in soil leading to higher absorption by mass flow (Mangel and Kirkby 1987). The variations in iron content of rice genotypes of similar duration might be due to difference in formation of oxidizing zones by the roots rhizosphere which leads to precipitation of soluble ferrousion to ferric hydroxide (Tanaka and Yoshida 1970).

Table 1. Reaction of rice genotypes towards tolerance of iron toxicity

Duration	Reaction to iron toxicity Tolerant	Moderately tolerant	Susceptible
Extraearly variety	Kalinga-III(1)	Badami(4)	Sankar(7), Heera(9), Neela(7), Vanaprabha(7), Sneha(7), Bandana(7)
Earlyvariety	Udayagiri(2)	Ghanteswari(5), Parijat(3), Lalitagiri(5), Keshari(5), Ananda(3), Khandagiri(3)	Pathara(7)
Medium variety	Sarsa(2), Konark(2), Birupa(2), IR-64(2)	Sarathi(3), IR-36(3), Lalat(4), Daya(5), Ratna(5)	Meher(6), Sebati(6), Bhoi(6)
Latemedium variety	Swarna(2), Bhanja(2), Pratap(2)	Padmini(3), Moti(3),Gouri(3), Samalai(3),Gajapati(3), Tapaswini(3), Swarnadhan(5)	Jajati(7)
Latevariety	Panidhan(1), Dharitri(2), Mahalaxmi(2), Tulasi(2), Kalashree(2), Kanchan(2), Basuabhog(2), Seema(2)	Sabita(3), Manika(3), CR-1030(5), Prachi(3), Ramachandi(4), Jagannath(3), FR-43B(4),T-141(5), Lunishree(3), Mahanadi(3), CR-1014(5)	T-1242(6), SR-26B(6)

*Figures in parenthesis indicate score scale

Table 2. Yield and Fe content of leaves of rice genotypes grown in Fe-toxic soils

Duration	Varieties	Yield t ha^{-1}	Fe content (ppm)	Duration	Varieties	Yield t ha^{-1}	Fe content (ppm)
Extra early variety	Neela	1.17	820	Late medium variety	Pratap	2.31	552
	Sneha	1.05	531		Tapaswini	2.13	491
	Heera	1.00	837		Swarnadhan	2.33	399
	Bandana	1.20	497		Jajati	1.75	601
	Kalinga III	1.99	354		Padmini	2.88	446
	Sankara	0.77	837		Moti	3.22	273
	Badami	1.67	798		Gouri	2.40	512
	Vanaprabha	1.14	578		Swarna	2.65	258
	CD P= 0.05	0.30	21		Samalai	2.72	330
					Bhanja	1.93	365
					Gajapati	2.79	439
					CD P= 0.05	0.29	16
Earlyvariety	Ghanteswari	2.30	650	Late variety	Seema	3.60	289
	Keshari	2.10	821		Dharitri	2.47	481
	Lalitagiri	1.59	527		Mahalaxmi	3.50	311
	Parijat	2.05	503		Jgannath	2.47	379
	Pathara	1.58	847		Kalashree	3.02	303
	Ananda	2.12	410		Sabita	2.70	390
	Khandagiri	1.99	425		FR-43B	2.85	351
	Udayagiri	2.51	270		T-1242	1.94	389
	CD P= 0.05	0.27	23		SR-26B	1.98	394
Medium variety	Daya	1.99	429		Ramachandi	2.33	389
	Sarsa	2.41	421		Manika	3.06	414
	Meher	1.68	487		Tulashi	3.35	301
	Birupa	2.58	413		Panidhan	3.54	294
	Sarathi	2.55	495		CR-1014	2.78	373
	IR-36	2.22	364		CR-1030	2.40	459
	Ratna	1.90	408		T-141	2.03	396
	Lalata	2.47	508		Kanchan	3.35	325
	Sebati	1.59	571		Lunishree	2.48	280
	Konark	2.71	338		Prachi	2.40	392
	Bhoi	2.15	630		Mahanadi	3.05	196
	IR-64	2.53	223		Basuabhog	3.33	295
	CD P= 0.05	0.38	15		CD P= 0.05	0.23	18

*Yield and Fe-content of rice genotypes are pooled data of two years (1999 and 2000)

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