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AK Pal
Micronutrient Laboratory, Department of Soil Science and Agricultural Chemistry, OUAT, Bhubaneswar, Odisha, India

L Malik
Micronutrient Laboratory, Department of Soil Science and Agricultural Chemistry, OUAT, Bhubaneswar, Odisha, India

MV Singh
Micronutrient Laboratory, Department of Soil Science and Agricultural Chemistry, OUAT, Bhubaneswar, Odisha, India

Corresponding Author:
L Malik
Micronutrient Laboratory, Department of Soil Science and Agricultural Chemistry, OUAT, Bhubaneswar, Odisha, India

Screening of rice (*Oryza sativa* L.) genotypes for zinc efficiency in Inceptisols of Odisha

AK Pal, L Malik and MV Singh

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Abstract
Zinc deficiency in crop has been recognized as world wise nutritional constraint. Zinc is important micronutrient for plant growth and nutrition of human being. Short supply of zinc to crops yield results in low concentration in grain for which malnutrition of human being occurs, those depends on rice based diet mainly in developing countries. Growing zinc efficient cultivars represent long term solution for sustainable approach to crop production. Twenty diverse rice genotypes were tested in a field experiment of Inceptisols of Odisha, at three levels of Zn (0,20kgha-1 and 20kgha-1 +0.5% $ZnSO_4$ sprayed twice at pre-flowering and booting stage) with the objective of developing a screening technique to evaluate the rice genotypes for zinc use efficiency. Genotypes differed significantly in grain yield. Grain yield efficiency Index is the best tools to categorize the genotypes into efficient and non-efficient groups. The relative grain yield ie. Zn efficiency index from 96.7 to 76.2 percent and relative grain Zn uptake ie. Zn efficiency from 91.4 to 68.3% among the genotypes. On the basis of grain yield and Zn efficiency, genotypes are classified on efficient and responsive (Swarna, IR 64,Vanaprava, Lalata, Gajapati and Ranidhan), efficient and non responsive (Prachi, Samba masuri, Kharbela, Sarala, Monoswani, Swarna masuri and Jajati), Inefficient and responsive (Birupa, Banki and CR1030), Inefficient and non responsive (IR 36, Suphala, Ghanteswari and Rudra). From practical point of view, genotypes that produce high grain yield at low level of Zn and responsive well to Zn addition are most desirable because they able to express their high potential in a wide range of Zn availability.

Keywords: Zinc, rice, genotypes, grain yield, efficiency

Introduction
Zinc deficiency is widespread micronutrient deficiency and one of the major constraint in world food production. In rice production, short supply of zinc to the crop, yield often reduce (Gao *et al*. 2006) [1] and Zn mass concentration in the grains are often low (Jiang *et al*. 2007) [2] which resulted Zn malnutrition of people who depend on rice based diet.

Zinc deficiency in soils of Odisha ranges from 0 to 76 percent with a mean of 19 percent (Jena *et al*. 2008) [4]. Under submerged condition of rice cultivation, zinc (either native or applied) is changed into amorphous sesquioxide precipitates or franklinite, $ZnFe_2O_4$ (Sajwan and Lindsay, 1988) [3]. Crop products constitue the primary source of all the micronutrients for humans especially in developing countries. High consumption of cereals based food with low levels of available micronutrient may cause malnutrition in humans (San, 2006) [7]. However, the Zn concentration in cereals may be enhanced by applying Zn fertilizer directly to the soil or plant (Broadley *et al*., 2007) [5]. Zinc deficiency in the field crops is emerging nutritional problem and effect crop growth as well as yield. Therefore, an attempt were made to screen out the rice genotypes on zinc efficient and non efficient basis, and develop an alternative technology for improving sustainable solution to the problem.

Materials and Method
A field experiment was conducted during kharif at central Research Farm, OUAT, Bhubaneswar, Odisha. The soil of the experimental field was sandy loam (Inceptisol) having pH 5.9, organic carbon 4.1gkg-1 soil, available SO_4-S (0.15% $CaCl_2$ extractable) was 17 mgkg-1 and DTPA extractable Zn was 0.501 mgkg-^{1}. The experiment was conducted in a strip plot design with three replication. Twenty diverse rice genotypes of 21 days old seedling was transplanted. Rice received uniform dose of N-P_2O_5-K_2O respectively through DAP, Urea and MOP. The treatment consist of three levels of Zn *viz*. T_0-low (no fertilizer Zn), T_1-20kg Zn and T_3-20kg Zn ha^{-1} + two sprays of 0.5% ZnSO4 at pre-flowering and booting stage.

Crop was harvested at maturity and grain yield was recorded. Zn content in grains were determined by drying the grain in an oven at 70 ^{0}C, then grind. Ground material was digested with diacid 2:1 mixture of nitric acid and perchloric acid for chemical analysis. Zinc content in grain was analysed by Atomic absorption spectrophotometer (Lindsay and Norvel, 1978) [8] and the following parameter was calculated (Graham, 1984) [10].

Zinc efficiency index = (Grain yield at control Zn / Grain yield at Zn treatment) x 100
Zinc efficiency = (Grain Zn uptake at control / Grain Zn uptake at Zn treatment) x 100

Result and Discussion

The grain yield of rice genotypes (Table-1) varied widely from 12 qha-^{1} for genotype suphala to 35.0 qha-1 for Jajati with an average of 27.5 qha-1(T_0). The grain yield varied from 16.0qha-1 to 51.7 qha-1 with an average of 36.2 qha-1 at the application of Zn @ 20kgha-1 with two spray of ZnSO4 @ 0.5% (T_2). The genotype Jajati produced higher mean grain yield. On an average, Zn application increased grain yield at high Zn application along with two spray of ZnSO4 might be due to partitioning of nutrients and photosynthetic between vegetative and reproductive parts in efficient genotypes. The different response of rice plants grown under Zn deficiency might be due to genotypic variation in some of the zinc affected processes as reported by Jiang (2008) [9] in aerobic rice and Kumar et al. (2018) [6] on rice under Zn stress condition. Different genotypes varied widely in their zinc content as well as response to zinc application. The data revealed that a mean increase of Zn content in rice grain ranges from 6 to 12 percent over no Zn application in rice grain of twenty diverse genotypes. Highest Zn content in grain was recorded in Swarna followed by Ranidhan while a lowest Zn content was noted in Jajati. The data showed that the application of higher dose of Zn increased Zn uptake by rice grain compared to control (no Zn application).

The pertaining to grain yield, Zn content and uptake at control, 20kg Zn and 20kg Zn ha-^{1} + two sprays of 0.5% $ZnSO_4$ did not give a clear view of Zn efficiency of the genotypes. The desired genotypes should have higher grain yield and Zn uptake to applied Zn, keeping this in view Zn efficiency index and Zn efficiency were calculated (Table-3). Zn efficiency index varied from 81.0 to 96.7% with four genotypes having Zn efficiency index >90%. Zn efficiency also varied widely among genotypes ranging from 68.3 to 91.4%. Thus genotypes with high Zn efficiency are desired as they will be efficient scavengers of Zn under low Zn supply.

To screen Zn efficient genotypes, the genotypes were classified into four groups. Fageria and Baliger (1993) [11] suggested this type of classification for the nutrient use efficiency of crop genotypes using nutrient efficiency and average yield of genotypes at low Zn supply. The first group comprise of the efficient and responsive genotypes that produced more than average yield of 20 genotypes under Zn deficiency and their Zn efficiency was also higher than average Zn efficiency. Genotypes like IR 64, Ranidhan, Swarna, Vanaprava, Gajapati and Lalata fall in this group. The second group of efficient and non-responsive genotypes produced more than average yield of 20 genotypes at low Zn level, but response to Zn application was lower than the average. These genotypes included Prachi, Samba masuri, Kharbela, Sarala, Monoswani, Swarna masuri and Jajati. The third group is inefficient and responsive genotypes produced less than average grain yield, but their response to Zn application was above the average. The genotypes that fall into this groups were Birupa, CR 1030 and Banki. The fourth group of genotypes produced less than average yield at low Zn level and less than average response to applied zinc. These genotypes were classified as inefficient and non-responsive. The genotypes fall into this groups were IR 36, Suphala, Ghanteswari and Rudra.

Table 1: Effect of different levels of zinc application on grain and grain Zn content on diverse rice genotypes

Rice Variety	Grain Yield(q/ha)				Zinc concentration in grain(mgkg-1)			
	T_0	T_1	T_2	Mean	T_0	T_1	T_2	Mean
Prachi	39.3	40.7	42.0	40.7	25.0	30.6	34.8	30.1
Samba masuri	30.3	32.7	35.7	32.9	24.6	29.2	29.6	27.8
IR64	29.0	29.3	30.7	29.7	27.1	28.4	29.0	28.2
IR36	24.3	26.7	44.7	31.9	31.6	33.1	34.2	32.9
Kharbela	28.7	35.7	41.0	35.1	28.2	28.5	29.2	28.6
Ranidhan	34.7	41.0	47.0	40.9	36.7	37.7	36.8	37.0
Swarna	33.7	34.7	40.3	36.2	36.3	37.2	38.5	37.3
Vanaprava	30.3	34.0	34.7	33.0	31.2	32.3	33.5	32.3
Sarala	28.3	32.3	41.0	33.9	26.8	27.1	29.1	27.7
Gajapati	29.0	29.8	44.7	34.5	27.0	27.4	28.8	27.7
Monoswani	27.7	32.0	39.3	33.0	23.5	25.7	28.9	26.0
Suphala	12.0	15.3	16.0	14.4	30.0	31.9	32.4	31.4
Ghanteswari	14.7	17.0	22.3	18.0	26.8	27.9	30.3	28.4
Rudra	21.3	24.3	28.7	24.8	27.6	31.4	33.9	31.0
Swarna masuri	28.7	31.3	37.7	32.6	25.3	30.0	28.1	27.8
Lalata	27.7	29.3	37.0	31.3	27.1	27.3	31.5	28.6
Birupa	26.7	27.7	30.0	28.1	24.9	26.0	27.5	26.1
CR1030	22.3	26.0	28.0	25.4	30.6	30.8	33.1	31.5
Banki	25.7	27.7	31.0	28.1	30.2	31.8	35.3	32.4
Jajati	35.0	41.3	51.7	42.7	24.9	25.8	26.7	25.8
Mean	27.5	30.4	36.2		28.3	30.0	31.6	
CD(p=0.05)	Zn-NS;var.-7.35; Zn x var.-NS				Zn-NS; Var.-3.24; Zn x Var.-NS			

Table 2: Effect of different levels of zinc application on grain Zinc uptake(gha-1) on diverse rice genotypes

Rice variety	Zinc uptake in Grain(gha-1)			
	T0	**T1**	**T2**	**Mean**
Prachi	98.2	124.5	146.3	123.0
Samba masuri	74.7	95.4	105.6	91.9
IR64	78.7	83.4	89.0	83.7
IR36	76.8	88.2	152.6	105.9
Kharbela	80.8	101.8	119.8	100.8
Ranidhan	127.1	154.4	173.0	151.5
Swarna	122.3	128.9	155.1	135.4
Vanaprava	94.6	109.7	116.0	106.8
Sarala	76.0	87.7	119.4	94.4
Gajapati	78.2	81.8	128.5	96.2
Monoswani	65.1	82.1	113.7	87.0
Suphala	36.0	48.9	51.8	45.6
Ghanteswari	39.4	47.4	67.7	51.5
Rudra	58.9	76.4	97.2	77.5
Swarna masuri	72.5	94.0	105.9	90.8
Lalata	74.9	80.0	116.4	90.4
Birupa	66.4	71.9	82.5	73.6
CR1030	68.3	80.0	92.8	80.3
Banki	77.6	88.1	109.3	91.7
Jajati	87.2	106.5	138.0	110.5
Mean	77.7	91.6	114.0	

Table 3: Zinc index efficiency and Zinc efficiency of rice genotypes

Rice variety	Zinc index efficiency			Zinc efficiency		
	T1	**T2**	**Mean**	**T1**	**T2**	**Mean**
Prachi	96.7	93.6	95.2	78.9	67.1	73.0
Samba masuri	92.8	85.0	88.9	78.3	70.8	74.5
IR64	98.9	94.6	96.7	94.4	88.4	91.4
IR36	91.2	54.5	72.8	87.1	50.3	68.7
Kharbela	80.4	69.9	75.2	79.4	67.4	73.4
Ranidhan	84.6	73.8	79.2	82.3	73.5	77.9
Swarna	97.1	83.5	90.3	94.9	78.8	86.9
Vanaprava	89.2	87.5	88.3	86.2	81.5	83.9
Sarala	87.6	69.1	78.4	86.7	63.6	75.2
Gajapati	97.2	64.9	81.1	95.6	60.9	78.2
Monoswani	86.5	70.4	78.4	79.3	57.3	68.3
Suphala	78.3	75.0	76.6	73.5	69.4	71.4
Ghanteswari	86.3	65.7	76.0	83.0	58.1	70.5
Rudra	87.7	74.4	81.0	77.1	60.6	68.9
Swarna masuri	91.5	76.1	83.8	77.2	68.5	72.8
Lalata	94.3	74.8	84.6	93.6	64.3	79.0
Birupa	96.4	88.9	92.6	92.3	80.5	86.4
CR1030	85.9	79.8	82.8	85.3	73.6	79.5
Banki	92.8	82.8	87.8	88.1	71.0	79.5
Jajati	84.7	67.7	76.2	81.8	63.2	72.5
Mean	90.0	76.6		84.8	68.4	

Conclusion

From practical point of view, the efficient and responsive group of genotypes that produce high grain yield at low level of Zn and responsive well to Zn addition are most desirable because they able to express their high potential in a wide range of Zn availability. The second most desirable group is efficient and non-responsive that can be planted under low Zn level and procured more than average yield. The inefficient and responsive genotypes can used in breeding programme for their Zn responsive characteristics. The most undesirable genotypes are the inefficient and non-responsive.

References

1. Gao XP, Zou CQ, Fan XY; Zhang FS, Hoffland E. 'From Flooded to aerobic conditions in rice cultivation' consequences for zinc uptake'. Plant and soil. 2006; 280:41-47.
2. Jiang N, Struik PC, Jin LN, Van Keuler H, Zhao M, Stomph TJ. 'Uptake and distribution of root applied or bfoliar applied ^{65}Zn after flowering in aerobic rice'. Annals of Applied Biology. 2007; 150:383-391.
3. Sajwan KS, Lindsay WL. 'Effect of redox, zinc fertilization and incubation time on DTPA extractable Zn, Fe and Mn'.Commun. Soil Sci. Plant Anal. 1988; 19:1-11.
4. Jena D, Singh MV, Patnaik MR, Nayak SC. Technical Bulletin-1, AICRP on Micro and Secondary nutrient and Pollutant elements in soils and Plants, OUAT, Bhubaneswar, 2008.
5. Broadley MR, White JP, Hammond JP, Zelko I, Lux A. Zinc in plants. New Phytologist. 2007; 173:677-702.
6. Kumar V, Laik R, Singh SK. 'Screening of rice (*Oryza Satva* L.) genotypes for Zn efficiency under zinc stress condition. Journal of Pharmacognosy and Phytochemistry. 2018; SPI:281-283.
7. San ZF. Trace elements and human healt. Stud Trace Elem Health. 2006; 23(3):66-67.
8. Lindsay WL, Norvel WA. Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of American Journal. 1978; 42:421-428.
9. Jiang WZ. 'Mn use efficiency in different wheat cultivars. Environmental Exp Botany. 2008; 57:41-50.
10. Graham RD. Breeding for nutritional characteristics in cereals. In: Tinker PB, Lauchi A (eds) Advances in plant nutrition, Praeger Publishers, New York, 1984, 57-102.
11. Fageria NK, Baligar VC. Screening crop genotypes for mineral stresses. In: Proceeding of the workshop on adaptation of plants to soil stress (INTSORMIL Publication No 94-2). University of Nebraska, Lincoln, 1993, 142-159.