Theme 2
Sustainable soil management for food security and better nutrition

Manganese management in different soils in relation to its availability to manganese efficient and inefficient wheat genotypes

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INTRODUCTION

Manganese (Mn) deficiency limits wheat productivity on sandy loam, calcareous and alkaline soils cropped with rice.

Cultivation of Mn tolerant wheat genotype in deficient soil and sustainable Mn fertilizer management strategy reduces the risk of yield loss and produces a higher return to the farmer and maintains the soil Mn pools.

The study aims to optimise the Mn fertilizer dose and methods in different Mn containing soils regarding its availability to manganese efficient and inefficient wheat genotype.

METHODOLOGY

Two season greenhouse pot (10 kg soil) experiment was carried out using Mn efficient (HD-2967) and inefficient (HW-4065A) wheat genotypes, selected from the screening experiment, in three types of Inceptisols having low (2.87 mg kg-1), medium (4.36 mg kg-1) and high (8.86 mg kg-1 Mn) DTPA-Mn content (Table 1) with 6 different Mn management treatments:

Treatments details

T1: Control
T2: $MnSO_4$ (20 mg Mn kg^{-1})
T3: Foliar application with $MnSO_4$ (0.5% solution)
T4: Foliar application with $MnSO_4$ (1% solution)
T5: Foliar application gewith $MnSO_4$ (1% solution) + lime (0.1% $Ca(OH)_2$)
T6: Manganese mobilizing microorganism (*Piriformospora indica*)

Replication: 3
Growth stage: 2 (Onset of flowering, Maturity)
Design: Factorial CRD

Table.1. Initial soil properties of pot experiment

Soils	pH_2	EC_2	OC(g kg^{-1})	CEC (cmol kg^{-1})	DTPA-Mn (mg kg^{-1})	Clay (%)	Silt(%)	Sand (%)	USDA Texture	$CaCO_3$ (%)
InL	**8.44**	0.30	3.2	03.64	**2.87**	10.72	10.00	79.28	**Sandy loam**	0.48
InM	**8.31**	0.38	3.4	04.46	**4.36**	15.48	22.28	62.24	**Sandy loam**	1.50
InH	7.55	0.75	3.1	21.05	**8.86**	35.48	40.28	24.24	Clay loam	1.03

InL: Inceptisol with low Mn Content, InM: Inceptisol with medium Mn Content, InH: Inceptisol with high Mn content

RESULTS

The chlorophyll meter reading was more in HD-2967 (303.67) than HW-4065A (265.40) wheat genotypes. With spray of 1% $MnSO_4$ solution with lime (T5), chlorophyll reading significantly increased to 31.50% and 4.12% for HD-2967 and to 39.82% and 7.63% for HW-4065A over control and soil application method, respectively (Table 2).

Table.2. Effect of Mn application methods on chlorophyll meter reading (1000 scale) of Mn efficient (HD-2967) and inefficient (HW4065A) wheat genotypes grown in Inceptisols having different Mn content

Tr.	Mn efficient genotype (HD-2967)				Mn inffiicient genotype (HW4065A)			
	InL	InM	InH	Mean	InL	InM	InH	Mean
T1	221.17	227.33	337.00	261.83	183.33	199.17	276.33	219.61
T2	279.33	294.33	429.67	**334.44**	238.17	244.00	365.00	**282.39**
T3	260.00	286.17	381.33	309.17	234.83	262.17	305.83	267.61
T4	261.83	301.50	392.50	318.61	252.17	269.50	343.00	288.22
T5	290.84	301.17	392.83	**328.28**	256.33	274.50	355.50	**295.44**
T6	225.33	230.67	353.00	269.67	211.00	217.67	288.67	239.11
Mean	256.42	273.53	381.06	**303.67**	229.31	244.50	322.39	**265.40**
LSD,5%	Tr	5.56	T*S	9.64	T*V	7.87		
	Soil	3.93	Genotype 9.74		V*S	5.56	T*S*V	13.63

No visual symptoms of deficiency appeared at low Mn containing Inceptisol (InL) in both Mn efficient and inefficient wheat genotypes throughout the growing period, but number of tiller and greenness was high in Mn efficient (HD-2967) than Mn inefficient (HW4065A) wheat genotype (Plate 1).

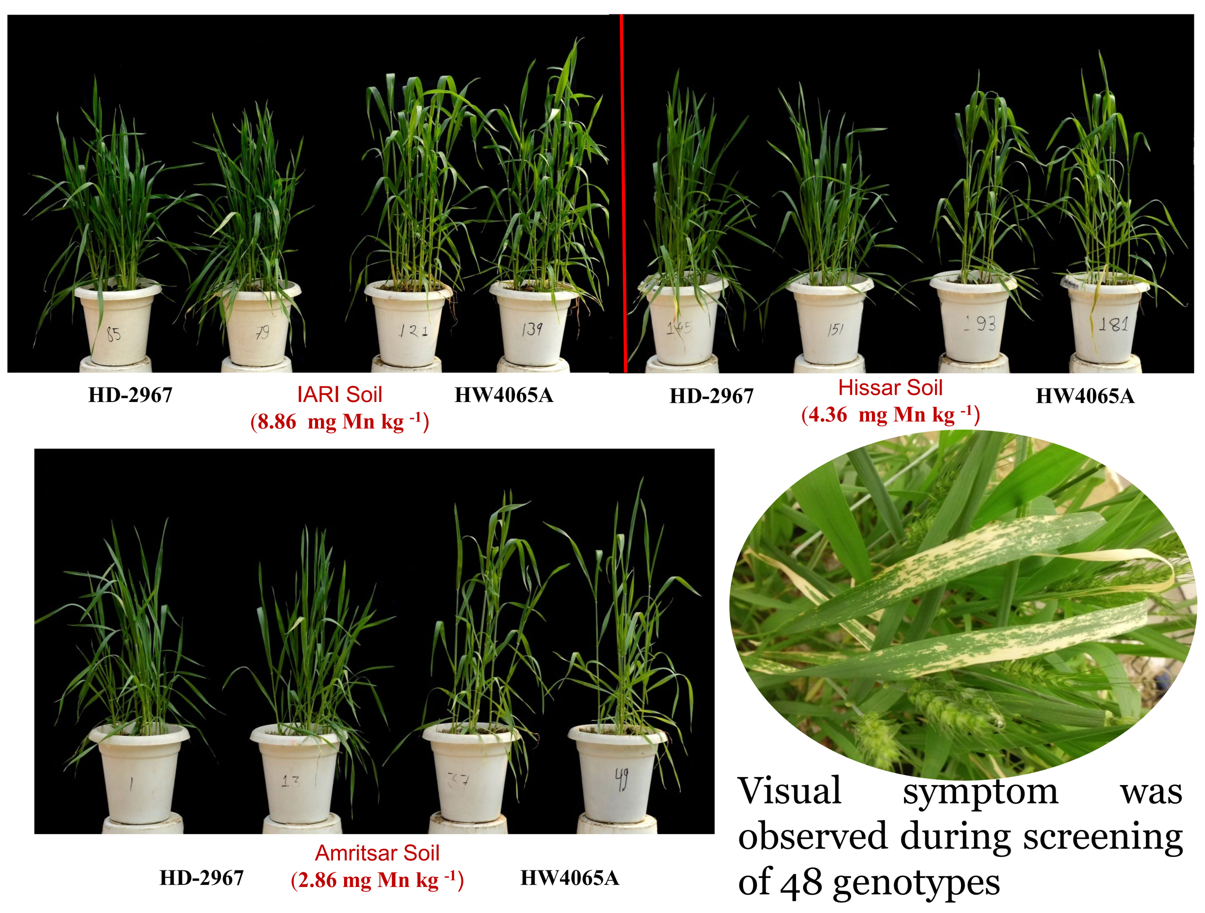

Plate.1. General appearance of Mn efficient and inefficient wheat genotypes in different soil Mn content of Inceptisols

Mn uptake increased by 58% in grain of HD-2967 than HW-4065A genotype. The increase of Mn uptake in grain was 2.2 times higher in Mn efficient genotype than inefficient genotype in Mn deficient soil, whereas the corresponding value was 1.5 and 1.4 times higher, respectively, for medium and high Mn containing soil (Table 3).

Table.3. Effect of Mn application methods on Mn uptake in grain (µg pot^{-1}) of Mn efficient (HD-2967) and inefficient (HW4065A) wheat genotypes grown in Inceptisols having different DTPA-Mn content

Tr.	Mn efficient genotype (HD-2967)				Mn inffiicient genotype (HW4065A)			
	InL	InM	InH	Mean	InL	InM	InH	Mean
T1	101.50	104.72	233.26	146.49	41.56	63.09	176.71	93.79
T2	184.16	167.68	310.30	**220.71**	78.30	114.16	253.33	**148.60**
T3	217.49	215.44	388.16	273.70	108.10	125.79	257.91	163.93
T4	292.67	286.85	523.53	367.68	143.17	197.50	329.20	223.29
T5	292.85	308.33	512.42	**371.20**	136.87	209.09	375.45	**240.47**
T6	131.96	135.39	276.34	181.23	59.33	95.63	202.91	119.29
Mean	**203.44**	203.07	374.00	**260.17**	**94.55**	134.21	265.92	**164.89**
LSD,5%	Tr	5.56	T*S	9.64	T*V	7.87		
	Soil	3.93	Genotype 9.74		V*S	5.56	T*S*V	13.63

Foliar application with 1% $MnSO_4$ increased Mn uptake in grain by 35 and 67% over foliar application with 0.5% $MnSO_4$ and soil application method, respectively, in Mn efficient genotype, whereas in inefficient genotype, the corresponding values were 41 and 56%, respectively (Table 3). Mn mobilizing fungus increased the Mn uptake by 24% in grain of HD-2967 over control, whereas the corresponding value was 27% in HW-4065A.

Table.4. MLR equations relating Mn content in wheat (mg kg^{-1}) with % decrease of soil Mn fractions

Soils	Multiple regression equation	R^2	F
InL	Mn content in wheat = 15.145 + 0.077 (WSPEXMn) + 1.161 (CBMn) – 0.458 (FeOxBMn) + 0.503 (ORBMn) – 3.143 (RESMn)	0.84	6.16*
InM	Mn content in wheat = 11.183 + 0.428 (WSPEXMn) – 0.399 (CBMn) – 0.971 (FeOxBMn) + 0.712 (ORBMn) – 0.242 (RESMn)	0.89	10.15*
InH	Mn content in wheat = 8.62 + 0.38 (WSPEXMn) – 0.528 (CBMn) – 1.374 (FeOxBMn) + 0.638 (ORBMn) - 0.785 (RESMn)	0.21	0.32^{NS}

The water soluble and exchangeable fraction and organically bound Mn contributed positively towards Mn uptake by wheat crop in all the soils, while, manganese and iron oxide bound, residual fraction have negative impact on uptake of Mn by wheat crop in all soils (Table 4).

CONCLUSIONS

This study clearly showed that greenness index, Mn uptake in wheat grain and wheat yield could be maintained in Mn deficient soil by the selection of suitable Mn management practices and Mn efficient genotype. The lead observed in this investigation requires further systematic testing under field conditions.

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