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Research Article

EFFECTS OF DIFFERENT SOURCES AND LEVELS OF MANGANESE ON DRY MATTER PRODUCTION AND NUTRIENT UPTAKE BY COTTON (*Gossypium hirsutum* L.) IN SALT AFFECTED SOIL

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Abstract

The present study was aimed to establish the effects of different sources and levels of Mn on DMP and nutrient uptake by cotton in saline sodic soil. The treatments consisted of three different sources namely manganese sulphate, Mn - EDTA and Mn- humate applied at four levels Mn (0, 1.25, 2.5 and 5.0 mg kg^{-1}). A pot experiment was conducted in factorial completely randomized design with three replications. Cotton variety LRA 5166 was grown as a test crop. The dry matter production (DMP), NPK and Mn uptake were recorded at harvest in each pot separately. The results revealed that soil application of Mn significantly increased the dry matter production of the cotton. Among the three sources, Mn - humate recorded the highest DMP when compared with other two sources. Increasing the levels of Mn (0 to 5.0 mg kg^{-1}) significantly increase the uptake of NPK and Mn. The present study concluded that 2.5 mg kg^{-1} of Mn through Mn humate was the optimum dose for highest dry matter production and maximum NPK and Mn uptake by cotton.

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1. Introduction

Cotton, the king of fibre crop is the most important commercial crop in the world. Though, the quality and genetic potential of seed plays a major role in determining productivity, soil factor especially nutrient availability plays vital role in cotton production (Anonymous, 1995). Essential micronutrients like manganese play an important role in physiology of cotton crop as they are required for various biological process including photosynthesis, respiration and atmospheric nitrogen assimilation.

Nearly, 40 to 50 per cent flowers and bolls shed in cotton due to micronutrient stress in the salt affected soil. Therefore, it is necessary to supply the plant with proper quantity of micronutrients to increase the productivity of cotton. The essential mineral elements like Mn which are required in higher concentrations by the plant have major role in determining the growth and development of cotton often produces more vegetative growth, than needed for maximum boll production and yield especially when climatic condition favor vegetative growth, by directing the nutrients and photosynthates towards vegetative parts rather than reproductive parts (Radhika *et*

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al., 2013). Manganese is also involved in pollen germination, pollen tube growth, root cell elongation and resistance to root pathogens. The soil deficient in manganese, affects the crop growth, development and productivity (Constable *et al.*, 1988; Moraghan and Mascani, 1991).

In the light of the above, the present study was undertaken to assess the effect of different sources and levels of Mn on dry matter production, NPK and Mn uptake by cotton in salt affected soil.

2. Materials and Methods

A pot experiment was conducted at Pot culture yard, Faculty of Agriculture, Annamalai University during 2012 to study the effect of various levels and sources of Mn on yield and growth of cotton (*Gossypium hirsutum* L.) in a saline sodic soil. The experimental soil was sandy loam in texture (Typic haplustalf) having pH 8.7 and EC - 1.23 dSm^{-1}. The fertility status of the soil was low in nitrogen (228 kg ha^{-1}) and phosphorus (9.12 kg ha^{-1}) and medium in potassium (290 kg ha^{-1}). The Mn status of the soil is 1.90 mg kg^{-1} of soil. The experiment was laid out in factorial completely randomized block design with three replication. The treatments includes four levels of Mn (0, 1.25, 2.5 and 5.0 mg kg^{-1}) supplied through three different sources namely manganese sulphate, Mn - EDTA and Mn - humate. All treatmental pots were applied with soil test based NPK dose of 8:4:4 g kg^{-1}. The Mn-humate used in this study was prepared by adding excess of saturated Mn- sulphate solution into Na-humate at pH 5.5. The complex precipitated was first washed with Dil. HCl and later with distilled water to remove the hydroxide, if any. The Mn-humate complexes were then dried at 55 ºC. Mn content of the Mn-humate was estimated by using atomic adsorption spectrometer. Plant samples collected at different critical stages of crop growth were analyzed for Mn content, NPK content of the plant samples collected at maturity was done using standard procedure outlined by Jackson (1973). The total uptake of the NPK and Mn by the crop was computed by multiplying the respective nutrient content with DMP.

3. Results and Discussion

Dry Matter Production

The results of the observation indicated that addition of graded levels of manganese from 0 to 5 mg Mn kg^{-1} of soil through different sources significantly ($p \leq 0.05$) increased the dry matter production of cotton in saline sodic soil (Table - 1). Among the different levels of manganese, the application of 2.5 mg Mn kg^{-1} significantly registered the maximum mean dry matter production of 192 g pot^{-1}. This was found to be on par with application of 1.25 mg Mn kg^{-1} of soil and recorded the mean dry matter production of 186 g pot^{-1}. The level L_1 registered the lowest mean dry matter production of 160 g pot^{-1}.

Among the three sources of manganese applied, lowest mean dry matter production was recorded with manganese sulphate (167g pot^{-1}), followed by Mn-EDTA which recorded the mean DMP of 179 g pot^{-1}. The manganese humate was significantly superior to other two sources of Mn in increasing mean dry matter production (192 g pot^{-1}). Interaction between the sources and levels of Mn significantly influenced the DMP of cotton. Addition of 2.5 mg Mn kg^{-1} through manganese humate recorded maximum dry matter production of 208 g pot^{-1} at harvest. This was found to be on par with application of 1.25 mg Mn kg^{-1} as manganese humate (205 g pot^{-1}).This lowest DMP of 160 g pot^{-1} was registered in control. Similar observation was reported by Dordas (2009), Zhou *et al.* (2009) and Luiz Antônio et *al.* (2010). The increase in DMP might be due to involvement of Mn in the metabolic processes such as respiration, photosynthesis, synthesis of amino acids and hormone activation (Indole acetic acid, IAA) throughout the IAA-oxidases (Burnell, 1988).

NPK Uptake

Application of manganese through different sources and levels to cotton significantly improved the uptake of NPK by cotton in saline sodic soil (Table - 2.). Irrespective of the sources, addition of graded levels Mn from 0 to 5.0 mg kg^{-1} to cotton consistently increased the NPK uptake by cotton up to 2.5 mg Mn kg^{-1}, beyond that decreased. Application of 2.5 mg Mn kg^{-1} significantly registered the highest mean NPK uptake of 2.70, 0.88, 2.26 g pot^{-1}, respectively.

Application of 1.25 mg Mn kg^{-1} of soil recorded the mean NPK uptake of 2.62, 0.86, 2.20 g pot^{-1}, respectively. This was on par with the treatment supplied with 2.5 mg kg^{-1}. The least mean NPK uptake of 2.26, 0.74, 1.89 g pot^{-1}, respectively was registered at control. All the three sources of Mn evaluated, showed a significant increase in NPK uptake by cotton over control. Application of Mn as Mn-humate significantly was superior to other two sources in increasing the NPK uptake of cotton and it recorded 2.71, 1.02 and 2.52 g pot^{-1}, respectively. This was followed by manganese EDTA which recorded the NPK uptake of 2.44, 0.98 and 2.27 g pot^{-1}, respectively and the lowest NPK uptake of 2.33, 0.94 and 2.19 g pot^{-1}, respectively by cotton was recorded in manganese sulphate applied pots.

The interaction effect due to levels and sources of Mn on NPK uptake by cotton was significant. Supply of 2.5 mg Mn kg^{-1} as manganese humate recorded the maximum of NPK uptake of 2.93, 0.96 and 2.45 g pot^{-1}, respectively. This was on par with application of 1.25 mg Mn kg^{-1} as manganese humate and it registered NPK uptake of 2.89, 0.94 and 2.42 g pot^{-1}, respectively. The increase in NPK uptake may be due to role of Mn in photosynthesis, nitrogen metabolism and nitrogen assimilation; Mn also activates decarboxylase, dehydrogenase and oxidase enzymes and increased the dry matter production which leads to increased uptake of NPK. Similar observation was made by Singh and Raina (1981) in oats. The humate ion present in Mn-humate could have complexed with NH_4^+, phosphate and K^+ ions and improved the uptake of NPK by cotton.

Manganese uptake

Application of manganese through different sources and levels to cotton significantly improved the uptake of Mn by cotton in saline sodic soil (Table - 1). Irrespective of the sources, addition of graded levels Mn from 0 to 5.0 mg kg^{-1} to cotton consistently increased the Mn uptake by cotton up to 2.5 mg kg^{-1} beyond that decreased.

Application of 2.5 mg Mn kg^{-1} significantly registered the highest mean Mn uptake of 5.94 mg pot^{-1}. Application of 1.25 mg Mn kg^{-1} of soil recorded the mean Mn uptake of ^{1}and 5.77 mg pot^{-1}. However, this was on par with the treatment supplied with 2.5 mg kg^{-1}. The least mean Mn uptake of 9.60 mg pot^{-1} was registered in L_1.

All the three sources of Mn evaluated showed a significant increase in Mn uptake by cotton over control. Application of Mn as Mn-humate significantly was superior to other two sources in increasing Mn uptake by cotton and it recorded 5.63 mg pot^{-1}. This was followed by manganese EDTA which recorded the Mn uptake of 5.24 mg $pot^{-1}$and the lowest Mn uptake (4.84 mg pot^{-1}) by cotton was recorded in manganese sulphate applied pots.The interaction effect due to levels and sources on Mn uptake by cotton was significant. Supply of 2.5 mg Mn kg^{-1} as manganese humate recorded the highest of Mn uptake of 6.45 mg pot^{-1}. This was on par with application of 1.25 mg Mn kg^{-1} as manganese humate and it registered Mn uptake of 6.36 mg pot^{-1}. This was followed by the application of 2.50 mg Mn kg^{-1} as Mn-EDTA (5.95 mg pot^{-1}). The increase in Mn uptake in Mn fertilized pots may be due to positive influence on dry matter production as well as greater availability of Mn in soil.

4. Conclusion

The present study established that the application of Mn humate would maximize the dry matter production, NPK and Mn uptake by cotton in saline sodic soil. Application of 2.5 mg kg^{-1} of Mn as Mn humate recorded the highest DMP, NPK and Mn uptake. However1. 25 mg kg^{-1} of Mn as Mn humate was onpar with above treatment. The present study concluded that application of 1.25 mg kg^{-1} as Mn humate improved the nutrient uptake (NPK and Mn) and Dry matter of cotton in saline sodic soil.

Table - 1: Effect of soil application of different Mn source and levels on dry matter production and Mn uptake by cotton in saline sodic soil.

Levels / Sources	Dry matter production (g pot^{-1})					Mn uptake (mg pot^{-1})				
	L_1	L_2	L_3	L_4	Mean	L_1	L_2	L_3	L_4	Mean
S_1	160	166	175	165	**167**	3.68	5.15	5.43	5.12	**4.84**
S_2	160	187	192	178	**179**	3.68	5.80	5.95	5.52	**5.24**
S_3	160	205	208	195	**192**	3.68	6.36	6.45	6.05	**5.63**
Mean	**160**	**186**	**192**	**179**		**3.68**	**5.77**	**5.94**	**5.56**	

	SE_D	CD($P \leq 0.05$)	SE_D	CD($P \leq 0.05$)
S	2.99	6.20	0.05	0.12
L	3.14	6.50	0.09	0.20
LX S	4.10	8.50	0.13	0.28

S_1 – Mn sulphate, S_2 - Mn EDTA S_3 - Mn humate, L_1 - 0 mg Mn kg^{-1} of soil , L_2 - 1.25 mg Mn kg^{-1} of soil , L_3 - 2.5 mg Mn kg^{-1} of soil and L_4 - 5.0 mg Mn kg^{-1} of soil .

Table – 2: Effect of soil application of different Mn source and levels on NPK uptake of cotton in sodic soil

Levels / Sources	Nitrogen (g pot^{-1})					Phosphorus (g pot^{-1})					Potassium (g pot^{-1})				
	L_1	L_2	L_3	L_4	Mean	L_1	L_2	L_3	L_4	Mean	L_1	L_2	L_3	L_4	Mean
S_1	2.26	2.34	2.47	2.33	**2.35**	0.74	0.76	0.81	0.76	**0.77**	1.89	1.96	2.07	1.95	**1.96**
S_2	2.26	2.64	2.71	2.51	**2.53**	0.74	0.86	0.88	0.82	**0.82**	1.89	2.21	2.27	2.10	**2.12**
S_3	2.26	2.89	2.93	2.75	**2.71**	0.74	0.94	0.96	0.90	**0.88**	1.89	2.42	2.45	2.30	**2.27**
Mean	**2.26**	**2.62**	**2.70**	**2.53**		**0.74**	**0.86**	**0.88**	**0.82**		**1.89**	**2.20**	**2.26**	**2.12**	

	SE_D	CD($P \leq 0.05$)	SE_D	CD($P \leq 0.05$)	SE_D	CD($P \leq 0.05$)
S	0.02	0.06	0.004	0.01	0.02	0.05
L	0.03	0.08	0.009	0.02	0.02	0.06
LX S	0.05	0.11	0.014	0.03	0.04	0.10

S_1 – Mn sulphate, S_2 - Mn EDTA S_3 - Mn humate, L_1 - 0 mg Mn kg^{-1} of soil, L_2 - 1.25 mg Mn kg^{-1} of soil , L_3 - 2.5 mg Mn kg^{-1} of soil and L_4 - 5.0 mg Mn kg^{-1} of soil.

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