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The Proceedings of the International Plant Nutrition Colloquium XVI

Title

Effect of application of molybdenum in maize-niger cropping System grown on acid soils of high altitude zone of Andhra Pradesh in India

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Publication Date

2009-05-21

Peer reviewed

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Introduction

Molybdenum is the only deficient element in acid soils. 56 percent of the soils in high altitude areas of Srikakulam and Vizianagaram districts are acidic and 49 percent of soils in these districts are deficient in molybdenum. Pot culture studies conducted on response of soybean to molybdenum application in acid soils indicated an increase in yield and uptake by the plant (Ebhin Masto *et. al*., 2004).

Materials and Methods

Location of the experiment

The experiment was conducted at two different sites for two years in a molybdenum deficient soil (0.29mg kg $^{-1}$& 0.15) having pH (5.9 & 5.4) and electrical conductivity (0.15 dS m^{-1} & 0.19 dS m^{-1}) at Regional Agricultural Research Station, Chintapally, located in high altitude zone of Andhra Pradesh in India with maize (var Ashwini) and niger (var.KGN2) crops in the cropping system.

Treatment details

The experiment was carried out with fourteen treatments and three replications laid out in a randomized block design. The treatments consists of Soil Application of 0.25, 0.5, 0.75, 1.0 kg ha^{-1} Sodium molybdate to maize, soil Application of 0.25 kg ha^{-1} Sodium molybdate to both maize and niger, soil Application of 0. 5 kg ha^{-1} Sodium molybdate to maize + 0.25 kg ha $^{-1}$ Sodium molybdate to Niger, soil Application of 0.25 kg ha^{-1} Sodium molybdate to maize + 0.5 kg ha^{-1} Sodium molybdate to Niger, seed treatment with 0.5 g kg^{-1} seed to both maize and niger, foliar Spray of 0.1% Sodium molybdate to maize and niger,75% lime Requirement + soil Application of 0.25 kg Sodium molybdate ha^{-1} to maize and niger,75% lime requirement + foliar Spray of 0.1% Sodium molybdate to maize and niger, lime requirement, FYM @ 5t ha^{-1}, control (Recommended dose of NPK only).

Plant and soil analysis

Index leaf samples were collected at knee height stage in maize and at flowering stage in niger crop. Yields (grain and stover in maize and pod and straw yields in niger) were recorded. Whole plant samples were collected at harvest. Post harvest soils samples were also collected after the harvest of these crops. The samples collected were analysed for molybdenum. The information regarding the yield and uptake of molybdenum by the Maize and niger crops is given in tables 1 and 2.

Results

Direct effect of Molybdenum on maize yield

Soil application of molybdenum as Sodium molybdate (0.50, 0.75 and 1.0 kg ha^{-1}) significantly increased the maize cob yield over control and the yield difference between treatments beyond 0.5 kg ha^{-1} molybdenum through soil application were not

significant and were on par. The increase in yield with seed treatment of maize with 0.5 kg ha^{-1} sodium molybdate was not significant when compared to control. Liming also had significant effect on increasing the maize cob yield. Foliar spray of 0.1 percent sodium molybdate after liming the soil had recorded significantly maximum yield (92.0 q ha^{-1}) with 43.7 percent yield response (Table 1).

After liming the soil, the yields obtained with the treatments of soil application of 0.25 kg/ha^{-1} sodium molybdate and 0.1 percent foliar spray were on par. Significant yield increase occurred when sodium molybdate @ 0.25 kg ha^{-1} was applied after liming the soil over the soil application of sodium molybdate @ 0.25 kg ha^{-1} alone.

Residual effect of molybdenum on niger yield

Residual effect of molybdenum was seen on the succeeding crop of niger after maize crop in the maize – niger cropping system, but the residual effect was significant only in the treatment where soil application of 0.75 and 1.0 kg sodium molybdate $ha^{-1}$was applied initially to maize crop when compared to 0.25 and 0.5 kg sodium molybdate ha^{-1} and the yield response was 17.1 percent with 1 kg sodium molybdate application.

Sodium molybdate when applied at different doses to second crop of niger also had significantly increased yield over control; but with a non-significant difference in yield with other initial soil applied sodium molybdate treatments to maize. Molybdenum applied either through soil (0.25 kg sodium molybdate ha^{-1}) or foliar spray (0.1 %) after liming the soil to the extent of 75% of lime requirements had significant effect on yield over all other treatments in the second crop of niger with the maximum yield of 6.5 q ha^{-1} with 31.7 percent yield response. Seed treatment of molybdenum and application of FYM @ 5 t ha^{-1} have not resulted in significant increase in niger yield (Table 1).

Table 1: Effect of molybdenum on maize and niger yield in maize-niger system

Treatments	Maize		Niger	
	Yield (q ha^{-1})	% Response	Yield (q ha^{-1})	% Response
T_1-0.25 kg ha^{-1} SM to maize	70.7	10.5	4.8	4.6
T_2-0.50 kg ha^{-1} SM to maize	77.7	21.4	5.0	9.0
T_3-0.75 kg ha^{-1} SM to maize	81.0	26.6	5.3	14.9
T_4-1.0 kg ha^{-1} SM to maize	84.5	32.0	5.3	17.10
T_5-0.25 kg ha^{-1} SM to maize and niger	71.0	10.9	5.3	15.7
T_6-0.5 to maize+0.25 kg ha^{-1} SM to niger	77.3	20.7	5.3	16.8
T_7-0.25 to maize+0.50 kg ha^{-1} SM to niger	71.5	11.7	5.5	21.7
T_8-seed treatment 0.5g /kg to both crops	66.0	3.1	4.8	5.26
T_9- FS (0.1%) SM	79.5	24.2	5.2	14.5
T_{10}-75%Lime requirement + 0.25 kg ha^{-1} SM to maize and niger	84.2	31.5	6.5	42.9
T_{11}-75%LR+FS (0.1%) SM to maize and niger	92.0	43.7	6.0	31.7
T_{12}-LR	82.0	28.2	5.6	22.1

T_{13}- FYM 5t/h	64.3	0.5	4.9	7.45
T_{14}- Control	64.0	-	4.7	-
CD (P=0.05)	**11.0**		**0.7**	**-**

Similar results were also reported by Laltlanmawia *et al (2004)* in soybean on acid soils of Nagaland and Kamalakar (2005) in cauliflower grown on *Alfisols* of Southern Telangana zone of Andhra Pradesh. Singh (1979) observed an average direct response of 364 kg ha^{-1} and residual response of 140 kg ha^{-1} in rice- wheat cropping system grown on alluvial soils of New Delhi.

Effect of molybdenum on the molybdenum content of index leaves

All the molybdenum application treatments had significantly increased the molybdenum content in the index leaves both in the direct and residual crops. In the direct crop of maize the content varied from 0.26 mg kg^{-1} (control) to 0.96 mg kg^{-1} (soil application of 1.0 kg sodium molybdate) while in the residual crop, variation is from 0.24 (control) to 0.60 mg kg^{-1}. Significant variation observed in molybdenum content both in the direct crop of maize and residual crop of niger due to different levels of molybdenum when compared to control (0.26 and 0.24 mg kg^{-1}) for maize and niger, respectively (Table 2).

Table 2: Effect of Mo on the Mo content in the index leaves of maize and niger and uptake at harvest

Treatments	**Mo content in the index leaves (mg kg^{-1})**		**Mo uptake (g ha^{-1})**		**Mo content in the post harvest soils (mg kg^{-1})**	
	Maize	**Niger**	**Maize**	**Niger**	**Maize**	**Niger**
T_1-0.25 kg ha^{-1} SM to maize	0.56	0.38	22.6	19.1	0.29	0.27
T_2-0.50 kg ha^{-1} SM to maize	0.71	0.41	25.4	22.9	0.36	0.33
T_3-0.75 kg ha^{-1} SM to maize	0.89	0.52	28.4	24.9	0.41	0.39
T_4-1.0 kg ha^{-1} SM to maize	0.96	0.60	32.8	27.4	0.60	0.56
T_5-0.25 kg ha^{-1} SM to maize and niger	0.50	0.42	24.0	21.1	0.31	0.30
T_6-0.50kg ha^{-1} SM to maize + 0.25 kg ha^{-1} SM to niger	0.76	0.55	24.6	22.32	0.38	0.37
T_7-0.25 to maize+0.50 kg ha^{-1} SM to niger	0.42	0.49	24.3	22.2	0.30	0.32
T_8-seed trt 0.5g /kg to both crops	0.52	0.42	23.2	19.2	0.27	0.26
T_9- FS (0.1%) SM	0.49	0.40	25.8	20.2	0.28	0.27
T_{10}-75%LR+ 0.25 kg ha^{-1} SM to maize and niger	0.79	0.42	26.8	26.1	0.41	0.40

T_{11}-75%LR+FS(01%) SM to maize and niger	0.69	0.46	28.4	24.0	0.36	0.35
T_{12}-Lime Requirement	0.41	0.39	26.4	22.3	0.36	0.35
T_{13}- FYM 5t/ha	0.30	0.28	22.0	17.6	0.27	0.25
T_{14}- Control	0.26	0.24	19.6	16.0	0.25	0.23
CD(P=0.05)	**0.04**	**0.037**	**2.73**	**2.20**	**0.03**	**0.031**

No significant difference in the molybdenum content in index leaves occurred between FYM and control plots in maize crop. Maximum molybdenum content of 0.79 mg kg^{-1}in index leaves was recorded in the treatment of 0.25 kg molybdenum ha^{-1} after liming in maize crop.

Effect of molybdenum on the molybdenum uptake

There is significant increase in molybdenum uptake with increase in molybdenum. Molybdenum uptake ranged from 23.60 to 32.80 g $ha^{-1}$with different levels of molybdenum application in direct crop of maize and 19.10 to 27.4 g ha^{-1}in residual crop i.e., niger showing significant variations. The maximum uptake of molybdenum was observed with the application of 1.0 kg sodium molybdate ha^{-1} in both direct (32.8 g ha^{-1}) and residual (27.4 g ha^{-1}) crops. Lime application alone or when combined with sodium molybdate either soil or foliar application also had increased the molybdenum uptake significantly over the control in both the maize and niger crops. Application of FYM has not resulted in significant increase in molybdenum uptake over the control (Table 2). Kotur (1994) also reported similar results with cauliflower crop.

Effect of molybdenum on the post harvest soil available molybdenum status

Soil application of molybdenum had resulted in significant built up of molybdenum in the soils after harvest of direct crop of maize and the residual effect lasted in subsequent crop of niger. Liming the soils resulted in the increased availability of molybdenum in the soils when compared to control (Table 2).

Discussion

Soil application of molybdenum to the direct crop of maize had increased the yield significantly over control and left residual effect of molybdenum on the succeeding crop of niger also when 0.75 and 1.0 kg sodium molybdate ha^{-1} was applied initially to maize crop in the maize – niger cropping system in acid soils which may be because of the soils of the experimental sites are low in p H and are deficient in molybdenum.

Conclusion

Thus, it can be concluded that soil application of 0.5 kg molybdenum ha^{-1} for the direct crop of maize and 0.75 kg molybdenum ha^{-1} applied to maize crop can meet the needs of the 2nd crop that is niger in the maize -niger cropping system grown on acid soils of high altitude zone of Andhra Pradesh in India for getting the higher yields.

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