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Effect of multi-micronutrients mixture on yield, micronutrient uptake and quality of fodder maize (*zea mays* L.) grown on *Typic Uustochrepts* soils of Anand

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Abstract

A field experiment was conducted on *Typic Ustochrepts* of Anand (Gujarat) for studying efficacy of multi-micronutrient mixture in improving forage production of maize. Significantly higher green fodder and quality (crude protein and digestible dry matter production) was obtained with the soil application of multimicronutrients mixture containing Fe-2.0 %, Mn-0.5 %, Zn-5.0 %, Cu- 0.2 % and B-0.5 % grade in soils having marginal status of Zn (0.54 ppm Zn) and Fe (6.28 ppm Fe). Also, foliar micronutrients supplementation through 1.0 % spray of multimicronutrients mixture having Fe-2.0 %, Mn 0.5 %, Zn-8.0%, Cu-0.5% and B-0.5% Grade-II (for Zn deficiency) at 20, 30 and 40 days after sowing increased green fodder yield and quality of produce of fodder maize.

Keywords: Multimicronutrients mixture ,forage maize, yield, crude protein

Introduction

One of the most important components for forage production is balanced nutrition of the crop. The farmers utilize the inorganic fertilizers and largely neglect organic manures which results in the occurrence of micronutrients deficiencies. The widespread deficiencies of micronutrients are reported in soils of India (1) and in soils of Gujarat (2). The farmers mainly grow forage crops on soils having marginal to deficient status. A primary goal of ruminant feeding management is to provide forage with sufficient nutrients to support high levels of productivity. Therefore, prevalent Zn-Fe deficiency warrants the need for research on Zn and Fe especially on their usage individually and in mixtures as foliar/ soil application. Hence, the present investigation was undertaken to study the effect of different multimicronutrient mixture grades on growth, yield and quality of forage maize.

Materials and methods

A field experiment was conducted at Main Forage Research Station, AAU, Anand during 2000-2002 for studying the efficacy of multi-micronutrients mixture in improving forage production of maize (*Zea mays* L.) (cv. GM-2). The treatments were comprised of mixture grades viz., T_1 - Control (water spray); Foliar spray treatments: T_2 - Grade-I (General); T_3 - Grade-II (For Zn deficiency); T_4 - Grade-III (For Fe deficiency); T_5 - Grade-IV (For Zn and Fe deficiency) and soil application treatments: T_6 - mixture Grade-V (soil application) & T_7 - soil application of micronutrients as per soil test value (STV). The multimicronutrients mixture grades having composition as shown under were prepared on the basis of average removal of micronutrients by different crops (Grades I and V) and rest of grades II to IV on the basis of wide occurrence of Zn or Fe or Zn and Fe deficiencies in soils of Gujarat. The grades are supposed to provide balanced nutrition to the crops with respect to normal and deficient status for Fe or Zn or both Fe and Zn.

The rate of application of T_2, T_3, T_4 & T_5 as foliar spray was kept @ 1 %, and soil application T_6 - @ 20 kg/ha and T_7 (STV) - $FeSO_4$ @ 15 kg ha^{-1} and $ZnSO_4$ @ 8 kg ha^{-1}. Foliar application was made at 20, 30 and 40 DAS (Days After Sowing).

The treatments were repeated four times in randomized block design. The soil of the experimental field was *Typic Ustochrepts*, loamy sand in texture and had pH – 7.5, $EC_{2.5}$ – 0.29 dSm^{-1},

Sr. No.	Multimicronutrients mixture grades	Content (%)				
		Fe	Mn	Zn	Cu	B
For foliar spray						
1.	Grade I (General) : LF-I	2.0	2.0	0.5	5.0	0.2
2.	Grade II (for Zn deficiency): LF-II	2.0	0.5	4.0	0.3	0.5
3.	Grade III (for Fe deficiency): LF-III	6.0	0.5	8.0	5.0	0.5
4.	Grade IV (for Zn & Fe defi.) : LF-IV	4.0	1.0	4.0	0.3	0.5
For Soil application						
5.	Grade V (Soil application) : LF-V	2.0	1.0	6.0	5.0	0.5

Organic Carbon– 6.2 g kg^{-1}, available P_2O_5– 40.23 kg ha^{-1}, available K_2O– 216.8 kg ha^{-1}, Fe– 6.28 mg kg^{-1}, Mn– 9.25 mg kg^{-1}, Zn– 0.54 mg kg^{-1} and Cu– 2.1 mg kg^{-1}. The plant samples were taken for determination of total contents of micronutrients. The oven dried plant samples were finely ground in a S. S. Wiley mill and were digested in di-acid mixture of HNO_3: $HClO_4$ (4:1) as per the procedure outlined by Jackson (3). The soil samples drawn from the experimental field at harvest were analyzed for available micronutrients by extracting with 0.005 M DTPA (4); and the contents were determined on atomic absorption spectrophotometer (PE 3110).

Results and discussion

Green forage yield

The green forage yield (GFY) of maize significantly improved due to foliar and soil application of multimicronutrients mixture in all three years as well as on pooled basis (Table 1). Amongst the foliar treatments, spray application of Grade –II (for Zn deficiency) (T_3) gave significantly higher GFY, which was at par with LF Grade – III (T_4) in second year and on pooled basis. In third year, application of LF Grade – IV (T_5) was found significant and effective in increasing GFY over control (263 q ha^{-1}).

Soil application of Grade – V @ 20 kg ha^{-1} was found superior in all the years and in pooled also. The Fe and Zn application as per STV was found at par with T_6 treatment in increasing forage yield of maize during second year and in pooled also. The highest GFY (271 q/ha) was recorded under T_6 treatment with an increase by 41.1 per cent over control (192 q ha^{-1}) in pooled. Soil application of Grade – V (T_6) produced significantly higher GFY than other treatments during first and third year.

Table 1: Effect of multimicronutrients mixture on green forage yield of maize

Treatment	Green Forage Yield (q/ha)			
	2000	2001	2002	Pooled
Foliar application				
T_1 Water spray (Control)	144	169	263	192
T_2 LF Grade-I (General)- –LF I	156	198	289	215
T_3 LF Grade-II (For Zn deficiency)- –LF II	169	257	300	242
T_4 LF Grade-III (For Fe deficiency)- –LF III	160	217	301	221
T_5 LF Grade-IV (For Zn & Fe defi.)-LF IV	156	194	318	223
Soil application				
T_6 LF Grade-V (General) - LF V	204	243	366	271
T_7 Micronutrients application as per STV	175	228	282	228
S.Em. ±	12	16	17	9
C.D. at 5%	35	49	49	26
C.V. %	14.24	15.26	10.98	13.26
Y x T	NS			

The overall results revealed that foliar spray of LF Grade – II (T_3) and soil application of LF Grade – V (T_6) were found superior over rest of the treatments in increasing forage yield of maize.

Dry matter yield

The dry matter yield (DMY) of maize significantly increased due to foliar and soil application of micronutrients mixture in first, second and third year (Table 2). The foliar application of Grade –II (for Zn deficiency) (T_3) significantly increased GFY in first and second year, whereas spray application of Grade –III (for Fe deficiency) (T_4) significantly improved the GFY in second and third year. The application of LF Grade – IV (T5) was only found effective in third year. Soil application of Grade – V (T_6) produced significantly higher DMY than rest of the treatments in first and third year only. On pooled basis, the maximum DMY (61.0 q ha^{-1}) was recorded under the treatment of soil application of Grade – V which recorded an improvement in the yield by 44.9 % over control (42.1 q ha^{-1}). The interaction effect of Y x T were found significant.

The interaction effect of Y x T indicated that maximum DMY (73.6 q ha^{-1}) was recorded under the soil application of Grade – V in third year. The increase in maize green fodder as well as dry matter yield due to multimicronutrients supplementation could be a result of balanced nutrition of the crop. Since the soil was marginal in available Zn and Fe status, their supplementation in balanced form along with other micronutrients might have played an important role to mitigate the hidden hunger of the crop for micronutrients. Although the micronutrients are required in small quanty, their supplementation during the crop growth help in better utilization of all other nutrients which in turn result in increase of crop growth and yield. Similar observations have been made by several workers in different crops (5), growth and yield of tomato (6), wheat yield (7). Also, foliar application with multimicronutrients significantly increased growth traits viz., plant height, 100 kernel weight, grain per plant of both white and yellow maize (8) and barley (9).

Crude protein yield

The crude protein yield (CPY) of maize improved due to foliar and soil application of multimicronutrients mixture grades in first, second and third year (Table 3). However, differences due to the treatments were not significant. On pooled basis, treatment of soil application Grade – V (T_6) synthesized maximum CPY (397.6 q ha^{-1}) followed by foliar treatment of Grade – II (357.4 q ha^{-1}). The increase in CPY due to treatment - T_6 was by 45.5 per cent over control (273.2 q ha^{-1}). The interaction effect of Y x T was found significant. The interaction effect revealed that maximum CPY (592.3 q ha^{-1}) was recorded under the soil application of Grade – V in third year.

Table 2. Effect of multimicronutrients mixture on dry matter yield of fodder maize

Treatment	Dry matter Yield (q/ha)			
	2000	2001	2002	Pooled
Foliar application				
T_1 Water spray (Control)	41.1	39.5	45.8 (22.9)*	42.1
T_2 LF Grade-I (General)- –LF I	45.3	44.4	50.6 (25.3)	46.8
T_3 LF Grade-II (For Zn deficiency)- –LF II	47.1	60.6	54.4 (29.7)	56.0
T_4 LF Grade-III (For Fe deficiency)- –LF III	53.1	56.7	58.1 (31.7)	54.0
T_5 LF Grade-IV (For Zn & Fe defi.)-LF IV	49.8	48.4	57.1 (30.4)	51.8
Soil application				
T_6 LF Grade-V (General) - LF V	58.7	50.8	73.6 (40.2)	61.0
T_7 Micronutrients application as per STV	54.9	51.8	52.6 (27.7)	53.1
S.Em. ±	3.5	4.0	3.1 (1.7)	3.4
C.D. at 5%	10.4	12.0	9.3 (5.0)	NS
C.V. %	14.07	16.04	11.14(11.3)	13.73
Y x T	Sig.			

* Figures in parenthesis indicate digestible dry matter production in q/ha.

Table 3 : Effect of multimicronutrients mixture on crude protein yield of fodder maize

Treatment	Crude Protein Yield (kg /ha)			
	2000	2001	2002	Pooled
Foliar application				
T_1 Water spray (Control)	209.6 (5.10)*	248.9 (6.30)	361.0 (7.61)	273.2 (6.34)
T_2 LF Grade-I (General)- LF I	232.7 (5.14)	276.0 (6.21)	331.9 (7.79)	280.2 (6.38)
T_3 LF Grade-II (For Zn deficiency)- LF II	283.6 (5.34)	372.7 (6.18)	414.2 (8.81)	357.4 (6.78)
T_4 LF Grade-III (For Fe deficiency)- LF III	244.4 (5.19)	340.5 (6.01)	396.5 (7.50)	327.1 (6.23)
T_5 LF Grade-IV (For Zn & Fe defi.)-LF IV	297.8 (5.98)	295.0 (6.09)	470.0 (9.01)	354.3 (7.03)
Soil application				
T_6 LF Grade-V (General) - LF V	286.2 (4.88)	314.3 (6.19)	592.3 (7.00)	397.6 (6.02)
T_7 Micronutrients application as per STV	261.0 (4.769)	321.9 (6.21)	391.4 (7.50)	324.7 (6.16)
S.Em. ±	17.9 (0.55)	24.6 (0.33)	23.2 (0.71)	28.3 (0.30)
C.D. at 5%	53.2 (NS)	73.0 (NS)	68.8 (NS)	NS (NS)
C.V. %	13.82 (18.26)	15.86 (9.21)	10.96 (15.57)	13.36 (14.87)
YxT	Sig.			

* Figures in parenthesis indicates crude protein content (%)

Interaction effect of Year x Treatment for dry matter yield of maize fodder

Treatment	Dry Matter Yield (q/ha)		
	2000	2001	2002
T_1	41.1	39.5	45.8
T_2	45.3	44.4	50.6
T_3	53.1	60.6	54.4
T_4	47.1	56.7	58.1
T_5	49.8	48.4	57.1
T_6	58.7	50.8	73.6
T_7	54.8	51.8	52.6
S.Em. +	3.6		
CD at 5 %	10.1		

Interaction effect of Year x Treatment for crude protein yield of fodder maize

Treatment	Crude Protein Yield (q/ha)		
	2000	2001	2002
T_1	209.6	248.9	361.0
T_2	232.7	276.0	331.9
T_3	283.6	372.7	414.2
T_4	244.4	340.5	396.5
T_5	297.8	295.0	470.0
T_6	286.2	314.3	592.3
T_7	261.0	321.9	391.4
S.Em. +	22.1		
CD at 5 %	62.6		

The supplementation of micronutrients cause improvement in the content besides crop growth. Therefore, the increase in uptake of the micronutrients is expected which help in utilization of the nutrients. The similar effect of multimicronutrients have also been reported on application of micronutrients to which significantly enhanced micronutrients contents in onion (10) and uptake by soybean (11).

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