



Enhancing productivity and quality of fodder maize through soil and foliar zinc nutrition

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ABSTRACT

A field experiment was conducted at Forage Research and Management Centre, NDRI, Karnal during *Kharif* season of 2014 and 2015 to study the effect of zinc application on productivity and quality of fodder maize. The treatment consists of two fodder maize cultivars African tall and J-1006 in main plot and six zinc sulphate treatments viz. No zinc sulphate, 10 kg/ha $ZnSO_4$ as basal dose, 20 kg/ha $ZnSO_4$ as basal dose, 0.5% one foliar spray of $ZnSO_4$ at 30 DAS, 0.5% two foliar spray of $ZnSO_4$ at 30 and 45 DAS and 10 kg/ha $ZnSO_4$ as basal dose+0.5% one foliar spray at 30 DAS in subplots of split plot design. Soil and foliar applied zinc sulphate had significantly improved green fodder, dry matter yield and quality parameters viz leaf length, leaf width, leaf stem ratio of both the cultivars tested. From the results of two year study, it can be concluded that maize fodder productivity and quality can be enhanced with Zinc fertilization.

Key words: Fodder maize, Foliar zinc nutrition, Productivity, Quality.

INTRODUCTION

Livestock is symbolic to wealth and power across civilizations for centuries. India is blessed with diversified type of livestock. Its livestock sector is one of the largest in the world. It has 56.7% of world's buffaloes, 12.5% cattle, 20.4% small ruminants, 2.4% camel, 1.4% equine, 1.5% pigs and 3.1% poultry. The importance of livestock in Indian agriculture is well recognized. Livestock not only provides food security through supply of milk, meat and self-employment of both men and women but also plays an important role for poverty alleviation of smallholder livestock farmers (Anonymous, 2013). The demand for milk and meat will be around 400 and 14 million tonnes, respectively in the year 2050; whereas the production in 2011 was about 122 and 5 million tonnes respectively. Quality fodder production plays an important role in dairy industry. Forage based economical feeding strategies are required to reduce the cost of quality livestock product as the feed alone constitutes 60-70% of the milk production cost. Thus any attempt towards enhancing feed availability and economizing the feed cost would result in increased margin of profits to livestock owners also. There is tremendous pressure of livestock on available total feed and fodder, as land available for fodder production has been decreasing. At present, the country faces a net deficit of 35.6% green fodder, 10.95% dry crop residues and 44% concentrate feed ingredients (Anonymous, 2013). In India the cropped area under fodder is only 4.2 to 4.4% of the total cultivated area and there is hardly any scope of expansion due to increasing pressure on agricultural land for food and cash crops. The solution

therefore, lies in increasing quality fodder production on limited space and time.

Maize (*Zea mays* L) is one of the most versatile and multi utility crops, having wider adaptability in diverse ecologies. Globally, it is known as queen of cereals because of its highest genetic potential. It is the major source of food, feed, fodder and industrial raw material and provides enormous opportunity for crop diversification, value addition and employment generation. Maize is the most important fodder crops in the world because of its high yield, high energy forage produced minimum per unit area and time than other forage crops. It is an ideal fodder crop because of its high production potential, wider adaptability, quick growing nature, succulency, palatability and excellent fodder quality. Maize fodder is free from toxicants and can be safely fed to animals at any stage of crop growth. Maize being highly exhaustive crop, it demands good nutrient management. Among different nutrients micronutrients especially zinc (Zn) plays important role in quality fodder production.

Direct linkages between soil micronutrient contents and micronutrient contents of forage and fodders have been clearly established. For micronutrients like zinc there are clearly direct linkages between the occurrence of deficiencies in soils, in food/fodder crops, and in animal and human nutrition (Nube and Voortman, 2006). Zinc is essential in both plant, animal and human nutrition, opportunities for simultaneously addressing the deficiencies by applying them as supplemental fertilizer to crops, benefiting both farmers (better yields) and consumers (higher micronutrient contents of consumed foods).

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Crop yields are often limited by low soil levels of mineral micronutrients such as zinc (Zn). Essentiality of zinc in plants was established as early as 1915 by Maze in maize. Zinc is an essential mineral nutrient and a cofactor of over 300 enzymes and proteins involved in cell division, nucleic acid metabolism and protein synthesis (Marschner 1986). Cakmak (2000) has speculated that zinc deficiency stress may inhibit the activities of a number of antioxidant enzymes, resulting in extensive oxidative damage to membrane lipids, proteins, chlorophyll and nucleic acids. Zinc can affect carbohydrate metabolism at various levels. Further, Zn is required in the biosynthesis of tryptophan, a precursor of the auxin-indole-3-acetic acid (Oosterhuis *et al.*, 1996). Zinc deficiency symptoms include, small leaves, shortened internodes giving the plant a stunted appearance. These all lead to poor fodder qualities. According to ICAR-Indian Institute of Soil Science, Bhopal, in India more than 50% soil samples tested were found deficient in zinc; furthermore in Haryana 60% samples tested were deficient. The deficiency of zinc in soil will lead to poor yield and quality of fodder along with poor zinc uptake. Since, zinc is also a major nutrient in animal nutrition; if we properly apply zinc in soil the deficiency in animal can be rectified.

Zinc is very important trace element for the growth and development of humans, animals, and plants. Zn has vital role in stabilization of RNA, DNA, ribosomes and is involved in the immune system of animals, deficiency of which affects the health and milk production severely. About 50% of Indian soils are deficient in Zn (Singh, 2011) causing low levels of Zn and yield losses in fodder crops and hence affecting the health of the livestock. Therefore, scheduling, method and dose of zinc application has been tested for better quality and yield of maize in different cultivars.

MATERIALS AND METHODS

The experiment was conducted at Forage Research and Management Centre, NDRI, Karnal, located at 29°45' N, 76°58' E and at an altitude of 245 m above mean sea level in north-western zone of Haryana. Experiment was laid out in split plot design with two cultivars (African tall and J-1006) in main plot and six zinc treatments in subplots viz. No zinc sulphate, 10 kg/ha ZnSO₄ as basal dose, 20 kg/ha ZnSO₄ as basal dose, 0.5% one foliar spray of ZnSO₄ at 30 DAS, 0.5% two foliar spray of ZnSO₄ at 30 and 45 DAS and 10 kg/ha ZnSO₄ as basal dose+0.5% one foliar spray at 30 DAS during Kharif Season of 2014 and 2015. The soil of the experimental field was clay loam in texture and low in available N, P, Zn and high in available K.

Zinc sulphate having Zn content of 21% was used in study. The crop was sown for experiment on 5th June 2014 and 1st June, 2015, using seed rate at 60 kg ha⁻¹ with spacing of 30 cm x 10 cm. The recommended (120 kg N and 60 kg P₂O₅/ha) dose of fertilizers were applied, of which full dose of P and half N were applied at sowing time and remaining

half nitrogen at 30 days after sowing. For the uniform soil application, ZnSO₄ was dissolved in water and then sprayed in the plots as per treatments. foliar spray were made at 30 and 45 DAS by making 0.05% solution of ZnSO₄ (5 kg ZnSO₄ in 100 litre of water). The crop was harvested on 10th August 2014 and 7th August 2015, at the age of 65 days for green fodder purpose. Green fodder, dry matter yield and quality parameters viz leaf length, leaf width, leaf stem ratio of both the cultivars were measured. Fresh fodder yield was recorded and samples were collected. Statistical analysis was done using standard procedures of analysis of variance in RBD using IRRISTAT software (IRRI, 1999) and statistical mean differences were found by Fisher's protected least significant difference test at P<0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect on growth parameters: Among the two varieties tested higher values of various growth parameters were observed with J-1006 than African tall. However, a perusal of data (Table 1 and 2) indicated that varieties and their interactions with zinc sulphate levels failed to obtain any significant difference in growth parameters viz. plant height, number of leaves, leaf length, leaf width, and stem girth of fodder maize at 30 DAS and at harvest stage.

Soil and foliar applied zinc sulphate had significantly improved plant height, number of leaves, leaf length, leaf width, and stem girth of fodder maize at harvest. Among the treatments 20 kg/ha Zn SO₄ as basal has recorded significant maximum values of growth parameters followed by 10 kg/ha ZnSO₄ + 0.5% foliar spray at 30 DAS and 0.5% two spray of ZnSO₄ at 30 and 45 DAS, however, all these treatment remain statistically at par with each other and superior over rest of Zn treatments at harvest stage. Hamsa *et al.* (2012) also observed that application of 18 kg/ha zinc caused significantly improvement in growth in cowpea due to the auxin metabolism and increased photosynthetic rate by zinc nutrition. Similarly Kumar (2013) at Ludhiana also observed improved growth in maize fodder crop due to zinc sulphate application.

Effect on quality parameters and fodder yield: Among quality parameters leaf stem ratio was significantly higher in cultivar J-1006 (0.34 and 0.36 in 2014 and 2015, respectively), whereas, dry matter was more in cultivar African tall (22.99 and 23.93 in 2014 and 2015, respectively). Differences were not reached to the level of significance among the cultivars tested, however, higher green fodder yield (54.83 and 58.98 t/ha in 2014 and 2015, respectively) were recorded in J-1006 and dry matter yield in (11.90 and 13.32 t/ha in 2014 and 2015, respectively) African tall.

Soil and foliar applied zinc sulphate had significant effect on corn green fodder as well as dry matter yield (Table 3). Zn treatment either by soil or foliar application led to an increase in the green fodder yield by 13.09 to 28.93 % than

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Treatments	Leaf length (Cm)				Leaf width (Cm)				Stem girth (Cm)			
	30DAS		Harvest		30DAS		Harvest		30DAS		Harvest	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Varieties												
African tall	50.63	53.17	104.81	115.29	3.16	3.47	7.71	8.63	4.76	5.00	7.33	8.06
J-1006	54.89	57.64	109.35	120.28	3.19	3.51	7.79	8.72	5.23	5.49	8.04	8.85
CCD 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Zinc sulphate levels												
No zinc sulphate	48.88	51.32	93.75	103.13	2.94	3.24	6.54	7.32	4.55	4.78	7.00	7.70
10 kg/ha ZnSO ₄ as basal dose	56.18	58.98	105.29	115.82	3.35	3.69	7.50	8.40	5.05	5.30	7.76	8.54
20 kg/ha ZnSO ₄ as basal dose	65.08	68.33	115.63	127.19	3.44	3.78	8.43	9.44	5.18	5.44	7.98	8.77
0.5% one foliar spray of ZnSO ₄ at 30 DAS	48.98	51.42	103.03	113.33	2.94	3.24	7.66	8.58	5.02	5.27	7.73	8.50
0.5% two foliar spray of ZnSO ₄ at 30 and 45 DAS	48.63	51.06	112.38	123.61	3.01	3.31	8.18	9.16	5.07	5.32	7.80	8.58
10 kg/ha ZnSO ₄ as basal dose +0.5% one foliar spray at 30 DAS	48.85	51.29	112.41	123.65	3.36	3.70	8.18	9.16	5.10	5.36	7.85	8.64
CCD 5%	12.05	12.65	10.38	11.42	0.39	0.42	0.65	0.73	NS	0.48	NS	0.78
NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Varieties X Zinc sulphate levels												

Table 3: Effects of varieties and zinc sulphate on leaf stem ratio, Dry matter content, green fodder and dry matter yield of fodder maize.

Treatments	Leaf stem ratio			Dry matter content(%)			GreenFodder Yield(t/ha)			DryMatter Yield(t/ha)		
	2014	2015		2014	2015		2014	2015		2014	2015	
Varieties												
African tall	0.28	0.29		22.99	23.93		51.75	55.66		11.90	13.32	
J-1006	0.34	0.36		20.96	21.90		54.83	58.98		11.54	12.96	
CD 5%	0.04	0.04		1.83	1.68		NS	NS		NS	NS	
Zinc sulphate levels												
No zinc sulphate	0.31	0.33		21.61	22.28		45.00	48.39		9.73	10.78	
10 kg/ha ZnSO ₄ as basal dose	0.30	0.31		22.04	23.04		51.20	55.00		11.28	12.64	
20 kg/ha ZnSO ₄ as basal dose	0.29	0.30		23.01	24.05		58.02	62.29		13.33	14.97	
0.5% one foliar spray of ZnSO ₄ at 30 DAS	0.32	0.33		21.50	22.47		50.89	54.79		10.90	12.24	
0.5% two foliar spray of ZnSO ₄ at 30 and 45 DAS	0.32	0.34		21.61	22.58		57.08	61.56		12.37	13.91	
10 kg/ha ZnSO ₄ as basal dose +0.5% one foliar spray at 30 DAS	0.32	0.34		22.08	23.07		57.55	61.88		12.71	14.29	
CD 5%	NS	NS		NS	NS		5.93	6.56		1.65	1.87	
Varieties X Zinc sulphate levels	NS	NS		NS	NS		NS	NS		NS	NS	

control. The increase in dry matter yield ranged 12.02 to 36.99 % compared to control. The highest green fodder and dry matter yield of corn fodder was obtained in 20 kg/ha Zn SO₄ as basal has recorded significant maximum values of growth parameters followed by 10 kg/ha ZnSO₄ + 0.5% foliar spray at 30 DAS and 0.5% two spray of ZnSO₄ at 30 and 45 DAS, however, all these treatment remain statistically at par with each other and superior over rest of Zn treatments at harvest stage. The improvement in green fodder and dry matter yield could be due to favorable effect of Zn application on growth parameters viz. plant height, number of leaves, leaf length and leaf width, which increased leaf area and ultimately photosynthetic efficiency. The positive and encouraging effects of Zn fertilization on growth and yield

of corn has also been reviewed by Mousavi *et al.* (2013) and observed by Kumar (2013).

CONCLUSIONS

Soil and foliar applied zinc sulphate had significant effect on growth, green fodder, dry matter yield and quality of maize fodder. The highest green fodder yield, dry matter yield and zinc concentration of maize was obtained with soil application ZnSO₄ at 20 kg/ha followed by 10 kg/ha ZnSO₄ + 0.5% foliar spray at 30 DAS and 0.5% foliar sprays at 30 and 45 DAS. Thus, it can be concluded from the study that maize fodder productivity and quality can be enhanced with Zn fertilization as basal and foliar application both, which will further strengthen and sustain the performance of livestock in terms of health and milk production.

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