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Influence of potassium, zinc and FYM on growth, yield, nutrient contents and uptake by forage maize (*Zea mays* L.) grown on loamy sand soil

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Abstract
The pot experiment was carried out during summer season of the year 2015 at B. A. College of Agriculture, Anand Agricultural University, Anand on loamy sand soil to study the influence of potassium, zinc and FYM on growth, yield, nutrient contents and uptake by forage maize (*Zea mays* L.). Eighteen treatments comprising with three levels of K_2O (0, 30 and 60 kg ha^{-1}) and Zn (0, 10 and 20 kg ha^{-1}) and two levels of FYM (0 and 10 t ha^{-1}) were tried in factorial completely randomized design with three replications. The experimental results revealed that the application of K_2O @ 60 kg ha^{-1}, Zn @ 20 kg ha^{-1} and FYM @ 10 t ha^{-1} recorded significantly higher plant height, green forage yield, dry matter yield and N, P, K uptake by plant over control. The highest K content in plant was recorded with the application of K_2O @ 60 kg ha^{-1} than rest of the levels of K_2O at 30 DAS and harvest. However, the application of FYM @ 10 t ha^{-1} and zinc @ 20 kg ha^{-1} recorded significantly higher N content at 30 DAS and at harvest.

Keywords: Content and uptake, growth and yield, FYM, potassium, zinc

1. Introduction
Potassium is one of the principle plant nutrients under pinning crop yield production and quality determination. It is important major element for plant growth and accumulated in abundant amount during the vegetative growth period (Rajarathinam, 2006) [14]. Potassium activates many enzymes and plays an important role in the maintenance of electrical potential gradients across cell membranes and the generation of turgor in plants. It regulated for photosynthesis, protein synthesis and starch synthesis (Mengel and Kirkby, 1996) [12]. It is also the major cation for the maintenance of cation-anion balances. Potassium aids plant in resisting disease, insect, cold weather and drought. Zinc plays a key role as a structural constituent or regulatory co-factor of a wide range of different enzymes in many important biochemical pathways and these are mainly concerned with carbohydrate metabolism, both in photosynthesis and in the conversion of sugars to starch, protein metabolism, auxin (growth regulator) metabolism, pollen formation, the maintenance of the integrity of biological membranes, the resistance to infection by certain pathogens Keram and Singh (2014) [8]. Reduced growth hormone production in Zn-deficient plants causes the shorting of internodes and smaller than normal leaves (Tisdale *et al.*, 2003) [18].
FYM is the principle source of organic matter in our country and it is a source of primary, secondary and micronutrients to the plant growth. It is a constant source of energy for heterotrophic microorganisms, help in increasing the availability of nutrient quality and quality of crop produce. The application of FYM also enhanced the availability of plant nutrient present in soil. While, FYM applied with Zn and K increased the uptake of deficient nutrients as well as improving the soil chemical, biological and physical properties of soil. FYM is a store house of nutrient, which contain all essential plant nutrients. It is beneficial as apply fertilizer like Zn and K in combination with FYM (Nawab *et al.*, 2011) [13].
Among the various cereals, maize (*Zea mays* L.) is one the most important economic crops and is almost an ideal cereal forage crop because of its quick growing nature, high yield, palatable nutritious quality and lactogenic effect. Moreover, its wider adaptability over a range of environmental conditions and cropping season signifies as a good forage crop and provide nutritious fodder throughout year under all management practices.
Due to intensive cultivation, use of hybrid varieties which absorb more nutrients, reduction in application of organic manures like FYM which supply these nutrient and intensive cropping system resulted depletion of Zn and K in soil. Zinc deficiency virtually an all India problem.

On an average, about 48 % soils of India are deficient in Zn and in Gujarat also, Zn (24 %) deficiency in soils is wide spread. The light textured soils of Gujarat have been reported to be widely deficient in Zn (Dangerwala *et al.* 1994) [3]. Therefore, it is very essential to check out the response of Zn and fulfill the requirement of Zn to the maize by Zn application in deficient soil.

2. Materials and Methods

For achieving the objective of present investigation, a pot experiment entitled, "Influence of potassium, zinc and FYM on growth, yield, nutrient contents and uptake by forage maize (Zea mays L.) grown on loamy sand soil" was carried out during summer season of year 2015. The experiment was conducted in the net house of the department of Soil Science and Agricultural Chemistry, B. A. College of Agriculture, Anand Agricultural University, Anand. The experiment was laid out in a completely randomized design (factorial) with three repetitions. The experiment contains three levels of K_2O (0, 30 and 60 kg ha^{-1}) and Zn (0, 10 and 20 kg ha^{-1}) and two levels of FYM (0 and 10 t ha^{-1}). For conducting the pot experiment, the soil from surface layer (0-15 cm) was collected, after collecting the required quantity of bulk fill up the earthen pot of fifteen kg capacity. In each pot, treatment wise eight seeds of maize were sown. After germination, maize plants were thinned to five plants per pot. The recommended full dose of phosphorus was applied at the time of sowing, while half recommended dose of nitrogen were applied at sowing and half at 30 DAS. The K_2O and Zn were applied in the form of KCl (muriate of potash) and $ZnSO_4$ (zinc sulphate). Pots were regularly watered and weed free condition was maintained till 60 DAS required for tasseling stage of maize crop. The observations like plant height at 30 DAS and at harvest were taken in accordance with the crop growth in pots. Top dressing of 50 % N in the form of urea was done at 30 DAS. When the maize was at tasseling stage (60 DAS), the plants were uprooted carefully. The fresh and oven dry weight of shoot and roots were recorded from each pot. The soil of experimental site was *Typic Ustochrepts* having loamy sand soil texture. All the data recorded during the study period were statistically analyzed by using standard methods as suggested by Steel and Torrie (1982) [17].

Table 1: Initial physico - chemical properties of the soil used for pot study

Sr. No	Characteristics	
1	pH (1:2.5)	8.05
2	EC (1:2.5) dS m^{-1}	0.18
3	Organic carbon (%)1	0.350
4	Available N (kg ha^{-1})	197
5	Available P_2O_5 (kg ha^{-1})	27
6	Available K_2O (kg ha^{-1})	228
7	DTPA- Zn (ppm)	0.39

3. Result and Discussion

3.1 Plant height

The results (Table 1) revealed that the plant height was significantly influenced due to the application of potassium. Significantly higher plant height was observed with application of potassium @ 60 kg ha^{-1} as compared to control at 30 DAS and at harvest but was found at par with 30 kg K_2O ha^{-1}. The higher plant height with potassium application might affect cell metabolism, enzyme activity, regulate cell osmosis and increased absorption of water and photosynthesis which promoted the more plant growth (Yadav *et al.*, 2014 and Maleki *et al.*, 2014) [19, 9].

Addition of Zn significantly increase the plant height at 30 DAS and at harvest of maize plant. Significantly higher plant height was observed with the application Zn @ 20 kg ha^{-1} as compared to control at 30 DAS but was at par with Zn @ 10 kg ha^{-1}. Whereas, at harvest it was significantly the highest observed with application of Zn @ 20 kg ha^{-1}. It's might be due to zinc plays a role in metabolic activity and physiological reaction and act as a catalyzing enzymes, transformation of carbohydrates, chlorophyll and protein synthesis (Srinivasan, 1992) [16].

However, the significantly higher plant height was recorded under treatment receiving application of FYM @ 10 t ha^{-1} over no application of FYM at 30 DAS. The plant height was increased due to the application of FYM @ 10 t ha^{-1} as it helps to improve physical and chemical condition of soil, improved fertility status of soil and better utilization of nutrients (Meena *et al.*, 2013) [11].

Table 2: Influence of potassium, zinc and FYM on plant height, green forage and dry matter yield of maize

Treatments	Plant Height (cm)		Yield (g pot^{-1})	
	30 DAS	At harvest	Green forage	Dry matter
[A] Potassium levels				
K_1 : 0 kg ha^{-1}	83.32	129	290.46	50.54
K_2: 30 kg ha^{-1}	86.73	131	334.38	54.11
K_3 : 60 kg ha^{-1}	87.46	135	350.48	59.64
S.Em ±	1.07	1.55	3.48	1.30
C.D. (0.05)	3.08	4.53	10.0	3.73
[B] Zinc levels:				
Zn_1 : 0 kg ha^{-1}	83.55	128	290.19	45.64
Zn_2 : 10 kg ha^{-1}	86.49	131	330.68	54.79
Zn_3 : 20 kg ha^{-1}	87.47	136	354.45	63.85
S.Em ±	1.07	1.55	3.48	1.30
C.D. (0.05)	3.08	4.53	10.0	3.73
[C] FYM levels				
F_1 : 0 t ha^{-1}	82.81	130	312.60	50.48
F_2 : 10 t ha^{-1}	88.86	134	337.61	59.05
S.Em ±	0.88	1.29	2.85	1.06
C.D. (0.05)	2.51	NS	8.16	3.05
CV %	5.30	5.09	4.54	10.07

3.2 Green forage and dry matter yield

The highest green forage and dry matter yield were obtained with application of K_2O @ 60 kg ha^{-1}, Zn @ 20 kg ha^{-1} and FYM @ 10 t ha^{-1}, respectively than rest of the treatments. The application of 60 kg K_2O ha^{-1}, 20 kg Zn ha^{-1} and 10 t FYM ha^{-1} level increased green forage yield by 20.66, 22.14 and 7.78 per cent and dry matter yield by 18.00, 39.89, and 16.97 per cent over their respective control treatment, respectively (Table 2).

These results are in accordance with those of Kajal *et al.*, (2001) [6] who reported that application of potassium probably caused higher mobilization of nutrient in soil and plant, enhanced enzymatic activities and translocation of photosynthesis in plant system and ultimately increased in the green and dry matter yield. These results reported that the green forage and dry matter yield significantly increased to zinc application due to zinc which play role in metabolism of maize plant as an activator of several enzymes and in turn into may directly or indirectly affect the synthesis of carbohydrate and protein (Arya and Singh 2000) [1]. The green forage and dry matter yield was increased due to the application of FYM which improve physical and biological condition of soil was also reported by Faujdar *et al.*, (2014) [4].

3.3 Nutrient contents and Uptake
N and P content were found non-significantly influenced by application of potassium. Application of FYM @ 10 t ha^{-1} recorded significantly higher N content at 30 DAS and at harvest. The findings were corroborate the reports of Karki *et al.*, (2005) [7] in maize with FYM @ 10 t ha^{-1} (Table 3). The highest content in plant was recorded with application of K_2O @ 60 kg ha^{-1} than rest of the levels at 30 DAS and harvest. Potassium content was significantly higher with increasing application of K was also found by Sartain *et al.*, (2002) [15]. This could be due to more K^+ concentration in soil solution and on the exchange as evident from the higher K content in plant. Bukhsh *et al*., (2009) [2].

In nutrients uptake study, application of K_2O @ 60 kg ha^{-1}, Zn @ 20 kg ha^{-1} and FYM @ 10 t ha^{-1} recorded significantly the highest uptake of N, P and K by crop (Table 3). Similar results were obtained by Jat *et al.*, (2013) [5] in maize. This might be due to potassium which increased the rate of CO_2 and enzyme activity as a result of photosynthesis and carbohydrate produce which provide ultimately high uptake of K was reported by Marschner (1995) [10].

Table 3: Influence of potassium, zinc and FYM on N, P and K content in forage maize at 30 DAS and at harvest

Treatments	Nutrients content (%) at 30 DAS			Nutrients content (%) at harvest		
	N	P	K	N	P	K
[A] Potassium levels						
K_1 : 0 kg ha^{-1}	2.20	0.235	1.31	1.21	0.163	1.10
K_2: 30 kg ha^{-1}	2.22	0.240	1.44	1.23	0.162	1.18
K_3 : 60 kg ha^{-1}	2.28	0.237	1.60	1.25	0.167	1.18
S.Em ±	0.04	0.002	0.02	0.01	0.002	0.01
C.D. (0.05)	NS	NS	0.05	NS	NS	0.03
[B] Zinc levels						
Zn_1 : 0 kg ha^{-1}	2.19	0.242	1.42	1.18	0.162	1.16
Zn_2 : 10 kg ha^{-1}	2.28	0.237	1.46	1.25	0.167	1.14
Zn_3 : 20 kg ha^{-1}	2.23	0.234	1.47	1.26	0.163	1.15
S.Em ±	0.04	0.002	0.02	0.01	0.002	0.01
C.D. (0.05)	NS	NS	NS	0.03	NS	NS
[C] FYM levels						
F_1 : 0 t ha^{-1}	2.17	0.239	1.43	1.20	0.163	1.15
F_2 : 10 t ha^{-1}	2.30	0.236	1.47	1.26	0.166	1.16
S.Em ±	0.03	0.002	0.01	0.01	0.001	0.01
C.D. (0.05)	0.08	NS	NS	0.03	NS	NS
CV %	6.70	3.98	4.66	4.04	4.01	3.43

Table 4: Influence of potassium, zinc and FYM on N, P and K uptake by forage maize at harvest

Treatments	Nutrients Uptake (mg pot^{-1})		
	N	P	K
[A] Potassium levels			
K_1 : 0 kg ha^{-1}	614.11	82.63	556.27
K_2: 30 kg ha^{-1}	669.16	87.58	638.38
K_3 : 60 kg ha^{-1}	749.16	100.05	701.05
S.Em ±	18.21	2.42	15.19
C.D. (0.05)	52.23	6.95	43.61
[B] Zinc levels			
Zn_1 : 0 kg ha^{-1}	539.22	74.07	530.37
Zn_2 : 10 kg ha^{-1}	685.16	91.73	627.31
Zn_3 : 20 kg ha^{-1}	808.01	104.45	738.02
S.Em ±	18.21	2.42	15.19
C.D. (0.05)	52.23	6.95	43.61
[C] FYM levels			
F_1 : 0 t ha^{-1}	605.77	82.05	578.51
F_2 : 10 t ha^{-1}	749.18	98.11	685.30
S.Em ±	14.87	1.98	12.41
C.D. (0.05)	42.68	5.68	35.60
CV %	11.40	11.42	10.20

4. Conclusion
The results of the present investigation revealed that application of K_2O @ 60 kg ha^{-1}, Zn @ 20 kg ha^{-1} and FYM @ 10 t ha^{-1} recorded significantly higher plant height, green forage yield, dry matter yield and N, P, K uptake by plant over control. The highest K content in plant was recorded with the application of K_2O @ 60 kg ha^{-1} than rest of the levels of K_2O at 30 DAS and harvest. However, the application of FYM @ 10 t ha^{-1} and zinc @ 20 kg ha^{-1} recorded significantly higher N content at 30 DAS and at harvest. Thus, use of potassium and zinc and FYM increase productivity by maintaining soil health.

5. References

1. Arya KC, Singh SN. Effect of different levels of phosphorus and zinc on yield and nutrients uptake of maize (*Zea mays* L.) with and without irrigation. Indian Journal of Agronomy. 2000; 45(4):717-721.
2. Bukhsh MA, Ahmad R, Ishaque M, Malik AU. Response of maize hybrids to varying potassium application in Pakistan. Pakistan Journal of Agriculture Science. 2009; 46(3):179-184.
3. Dangerwala RT, Patel KP, Geeorge V, Patel KC, Ramani VP, Patel MS. Micronutrient and sulphur Research in Gujarat. Bulletin, Gujarat Agricultural University, Anand, 1994.
4. Faujdar RS, Sharma M, Solanki RL, Dangi RC. Effect of FYM, biofertilizers and zinc on yield and micronutrients uptake in maize. An Asian Journal of Soil Science. 2014; 9(1):121-125.
5. Jat G, Majumdar SP, Jat NK. Potassium and zinc fertilization of wheat (*Triticum aestivum*) in western arid zone of India. Indian Journal of Agronomy. 2013; 58(1):67-78.
6. Kajal KM, Desai BG, Patil ER. Effects of different levels of nitrogen, phosphorus, and potash on the production of hybrid napier grass (Var. NB21). Forage Research. 2001; 27(2):91-95.
7. Karki TB, Ashok K, Gautam RC. Influence of integrated nutrient management on growth, yield, content and

uptake of nutrients and soil fertility status in maize (*Zea mays L.*). *Indian Journal of Agriculture Science*, 2005; 75(10):682-685.

8. Keram, Singh K. Responce of zinc fertilization to wheat on yield, quality, nutrients uptake and soil fertility grown in a zinc deficient soil. European Journal of Acadamic Essays. 2014; 1(1):22-26.
9. Maleki A, Fazel S, Naseri R, Rezaei K, Heydari M. Effect of potassium and zinc sulphate application on grain yield of maize under drought stress conditions. Advances in Environmental Biology. 2014; 8(4):890-893.
10. Marschner H. Mineral nutrition of higher plants. Education academic press, Sandiego. 1995, 379-396.
11. Meena SK, Mundra SL, Singh P. Responce of maize (*Zea mays* L.) to nitrogen and zinc fertilization. Indian Journal of Agronomy. 2013; 58(1):127-128.
12. Mengel K, Kirkby EA. Principles of plant nutrition" book published by Panima Publishing Corporation, New Delhi/Bangalore. 1996, 427-446.
13. Nawab K, Shah P, Arif M, Khan M, Ali K. Effect of cropping patterns, FYM, K and Zn of wheat growth and grain yield. Sarhad Journal of Agriculture. 2011; 27(3):371-375.
14. Rajarathinam A. An imperial investigation to study the trend in crop response based on parametric and non-parametric regression approaches in long term experiment Ph. D. thesis, Anand agricultural university, Anand, 2006.
15. Sartain JB. Tifway bermudagrass response to potassium fertilization. *Crop Science*, 2002; 42(2):507-512.
16. Srinivasan K. Effect of amendment and zinc level on the growth and yield of maize (*Zea mays* L.). Indian Journal of Agronomy. 1992; 37(2):246-249.
17. Steel GD, Torrie JH. Principles and procedures of statistics. McGraw Hill Book Co. Inc. New York, 1982.
18. Tisdale SL, Nelson WL, Beaton JD. Soil Fertility and Fertilizer. 4th Edition. Macmillan publishing company, New York, 2003.
19. Yadav R, Nanwal RK, Kumar A. Effect of potash, zinc and biofertilizer application on productivity and quality of pearlmillet. Environment & Ecology. 2014; 32(3):980-983.