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Soil quality under summer fodder maize (*Zea mays* L.) influenced by agronomic fortification with zinc and iron

Avtar Singh and Maneesha

Abstract
A field experiment conducted during summer season of the year 2019 on medium black calcareous soil at Junagadh. Total ten treatment combinations, consisting of soil and foliar application of 0.2% $ZnSO_4$ and + 1.0% $FeSO_4$ and recommended dose of fertilizer with three replications. The results indicated that macro nutrients (NPK) significantly higher when crop was fertilized with 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS (T_7), Same treatment recorded higher micronutrients content (Fe, Mn, Zn, B). From the above experimentation it can be concluded that application of zinc and iron significantly influenced the nutrients content in soil under summer fodder maize.

Keywords: Macro nutrient, fodder maize, $ZnSO_4$

Introduction
Forage crops are plants and products grown for the purpose of feeding animals as feed. The most important non-legume feed and food crop grown is corn, which can be grown every year under irrigated conditions. Corn (*Zea mays* L.) is a versatile crop that can more easily adapt to different agro-climatic conditions and is grown successfully for various purposes in different seasons and ecologies. Corn is known as the "Queen of Cereals" and "King of Forage Crops" all over the world because it gives the best results among grain products. Corn provides the cheapest and most nutritious food for animals, especially cattle. Considering its increasing importance, the development of maize as a crop was very beneficial. The development of corn as a crop has received little attention due to various limitations. The complexity of abiotic and biotic constraints associated with crop management is reducing the quality and productivity of maize feed across the country. If key constraints are identified and addressed through applied research, there is great potential to increase quality food production and thereby ensure food security and agricultural income.

There are two ways to increase the food supply; horizontal development and vertical development. First, it is not possible to increase the number of crops planted to increase crop production, as the country already faces problems feeding its population, which is growing at 1.0% per year. Therefore, the only neglected way is to increase production vertically by feeding food one by one.

Also, All India Micronutrient Research Program describes micronutrient deficiencies in Indian soils. Currently, the deficiency of diethylenetriaminepentaacetate (DTPA)-extractable zinc and iron in Indian soil is estimated to be 48.1% and 11.2%, respectively. Zinc and iron deficiency are well-documented public health and important soil constraints for growing and nourishing crops. Especially corn. In general, there is a balance between soil deficiency and zinc and iron deficiency in humans and animals, indicating the need to increase micronutrient concentrations in food and feed plants (Kumar and Salakinkop, 2018) [2].

Due to decline in soil fertility, soil zinc deficiency in India is expected to increase from 42% in 1970 to 63% in 2025, leading to direct productivity losses of US$ 1.5 billion per year. Losses due to disease in the country. Only one-third of the country's population consumes adequate amounts of zinc sulphate, which increases zinc concentration in soil, rice and feed, but monitor size is needed in central and southern India (Singh and Sampath, 2011) [5].

There are two types: genetic biological enrichment and agricultural enrichment. Fortifying certain nutrients by adding fertilizers to the soil or foliage of crops at the right form, time and growth stage is called agronomic fortification and is a simple and fast method of problem solving. Zinc and iron not only increase food intake, but also improve the nutritional quality of corn feed, making it more profitable for business and health. Forage crops such as maize, pearl millet and grass respond to zinc and iron applications up to 60 and 40 kg ha-1, respectively (Rahman *et al*. 2017) [4]. Therefore, zinc and iron supplementation through enriched feed is an option to improve feed quality.

Material and Methods

A field experiment entitled "Agronomic fortification of summer fodder maize (*Zea mays* L.) with zinc and iron" was carried out during summer season of the year 2019. Geographically, Junagadh is situated at 21.5° N latitude and 70.5° E longitude with an altitude of 60 m above the mean sea level on the western side at the foothill of mountain 'Girnar' under South Saurashtra Agro-Climatic Zone of Gujarat state and enjoys a typically subtropical climate characterized by fairly cold and dry winter, hot and dry summer and warm and moderately humid monsoon. The soil was sandy loam in texture, alkaline in reaction (pH 8.1) with 0.57% organic carbon and 244, 36.5 and 267 kg/ha of available N, P and K, respectively. The experiment consists of ten treatment combinations, lay out in randomized block design with three replications. Treatments consist of, T_1- Absolute control, T_2-Recommended dose of fertilizers (RDF) (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1}), T_3- RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}, T_4- RDF + soil application of 50 kg $ZnSO_4$ ha^{-1}, T_5- RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30 DAS, T_6- RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45 DAS, T_7- RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS, T_8- RDF + foliar application of 1.0% $FeSO_4$ at 30 DAS, T_9- RDF + foliar application of 1.0% $FeSO_4$ at 45 DAS, T_{10}- RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45 DAS

The test area was plowed and leveled three times with a tractor pulling the cultivator. Soil clods are crushed, weeds are removed and fine tillage is carried out. Divide the land into parcels that should be large (2.0m x 1.0m). Canals and canals were built. Use African high variety seeds at a sowing rate of 40 kg ha-1. This variety is an early maturing and high-yielding variety. Seeds are sown at a distance of 20 x 5 cm2. The furrows are well covered with a thin layer of soil and the soil is lightly watered. 20 days after planting, thin the seedlings so that the distance between plants is 5 cm. 20 days after planting, manual weeding is done to clear the field of weeds. Water every 10-15 days, depending on soil moisture, throughout the entire planting period. A total of 8 irrigations were performed. Eliminate boundary effects; Two rows of 0.5 m length were separated from each end of the parcel and the net area was collected from each parcel separately. Determination of nitrogen (Subbiah and Asija, 1956) [6], phosphorus (Olsen *et al*., 1954) [7] and potassium (ammonium acetate method) in soil before and after harvest. Analysis by Panse and Sukhatme (1985) [3].

Nutrient status of soil after harvest

Available NPK in soil after harvest

Data presented in Table 1 revealed that significantly maximum available N, P_2O_5 and K_2O of 169.3, 39.2 and 166.9 kg ha^{-1}, respectively were observed when fodder maize was fertilized with 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS (T_7) and it was comparable with treatments T_5, T_6 and T_{10}. Significantly minimum available N, P_2O_5 and K_2O of 140.2, 25.6 and 140.7 kg ha^{-1}, respectively were observed under control treatment (T_1) and it was closely followed by T_2, T_3, T_4, T_8 and T_9 in case of available nitrogen, with T_2, T_3 and T_4 in case of available K_2O.

Available micronutrient (Mn, Cu, Zn and Fe) in soil after harvest

Data presented in Table 2 revealed that various agronomic fortification treatments in fodder maize significantly affect the micronutrient content in soil after harvest of fodder maize. Significantly maximum values of Mn, Cu, Zn and Fe in soil after harvest of fodder maize were 5.96, 1.77, 0.83 and 4.75 ppm, respectively when fodder maize fertilized with 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS (T_7) and it remained on same bar with treatments T_3, T_4, T_5, T_6 and T_{10} in case of Mn, with treatments T_4, T_5 and T_6 in case of Cu, with treatments T_3, T_4, T_5 and T_6 in case of Zn and with treatments T_3, T_4, T_5, T_6 and T_{10} in case of Fe. Minimum micronutrient Mn, Cu, Zn and Fe of 5.16, 1.42, 0.55 and 4.21 ppm were noted under control treatment (T_1) and which found statistically at par with treatments T_2, T_8 and T_9 in case of Mn and Cu, with treatment T_2 in case of Zn and with treatments T_2, T_8, T_9 and T_{10} in case of Fe.

Table 1: Effect of agronomic fortification with zinc and iron on available N, P_2O_5 and K_2O in soil after harvest of crop

Treatments	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
T_1-Control	140.2	25.6	140.7
T_2-RDF (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1})	155.6	31.6	158.6
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	163.3	35.2	162.0
T_4-RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}	163.7	35.3	162.4
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30 DAS	166.1	38.8	165.9
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45DAS	167.5	39.0	166.2
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS	169.3	39.2	166.9
T_8-RDF + foliar application of 1.0% $FeSO_4$ at 30DAS	156.1	33.6	160.6
T_9-RDF + foliar application of 1 .0% $FeSO_4$ at 45 DAS	157.9	33.8	160.7
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45 DAS	162.4	34.9	161.8
S.Em. ±	5.11	1.21	5.39
C.D. at 5 %	15.19	3.60	16.00

Table 2: Effect of agronomic fortification with zinc and iron on available Mn, Cu, Zn and Fe content in soil after harvest of crop

Treatments	Available Mn (ppm)	Available Cu (ppm)	Available Zn (ppm)	Available Fe (ppm)
T_1-Control	5.16	1.42	0.55	4.21
T_2-RDF (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1})	5.21	1.49	0.61	4.31
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	5.71	1.63	0.77	4.55
T_4-RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}	5.73	1.65	0.78	4.59
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30 DAS	5.91	1.74	0.81	4.65
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45DAS	5.93	1.76	0.82	4.74
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS	5.96	1.77	0.83	4.75
T_8-RDF + foliar application of 1.0% $FeSO_4$ at 30DAS	5.34	1.51	0.63	4.32
T_9-RDF + foliar application of 1.0% $FeSO_4$ at 45DAS	5.34	1.54	0.64	4.45
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45 DAS	5.65	1.61	0.71	4.47
S.Em.±	0.18	0.04	0.02	0.11
C.D. at 5 %	0.54	0.12	0.06	0.31

Conclusion

On based on one-year experiment, it may be concluded that application of 100% RDF along with foliar spray of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS (T_7) provide better soil nutritional quality.

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