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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 1544-1546

www.thepharmajournal.com
Received: 02-08-2023
Accepted: 04-09-2023

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Quality of summer fodder maize (*Zea mays* L.) influenced by agronomic fortification with zinc and iron

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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 quality parameters 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) except, crude fibre content. From the above experimentation it can be concluded that application of zinc and iron significantly influenced the quality parameters in summer fodder maize. The fodder maize under fertilizer dose of 100:60:40 kg NPK ha^{-1} along with foliar application of 0.2% $ZnSO_4$ and 1.0% of $FeSO_4$ at 30 and 45 DAS (T_7) found significantly higher quality providing treatment, while treatment control (T_1) remained lowest quality providing treatment among rest of the treatments.

Keywords: Fodder quality, 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 under irrigated conditions every year. Maize (*Zea mays* L.) is a versatile crop that adapts well to different agro-climatic conditions and has been successfully grown for many target species in different seasons and ecologies. Corn is known as the "Queen of Cereals" and "King of Forage Crops" because it is the product with the highest grain yield in the world. 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 encourage food production; horizontal 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 way is to increase the production of vertical stripes by feeding food one by one. Additionally, the All India Micronutrient Survey identified 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]. Zinc Deficiency in India Apart from the huge loss due to disease burden in the country, direct productivity loss is estimated at ₹1.5 billion per year due to decline in soil fertility, which is expected to increase from 42% in 1970 to 63% by 2025. Dollar. 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]. These 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 0.5 m long lines at the ends of each side of the parcel were not included in the experiment and the border area was collected separately from each parcel. To evaluate the quality of grown rice, representative samples were oven dried at 60 °C to keep the weight constant to determine the dry matter (DM) content, a wiley mill was used to pass the soil through a 1 mm sieve, and then stored. airtight. stored in a polyethylene bag until further analysis. Estimated protein (CP) and crude fiber (CF) content is determined according to AOAC (1975). Panse and Sukhatme'nin analysis (1985) [3].

Quality parameters

Crude protein content and protein yield

Data in Table 1 showed that various agronomic fortification treatments significantly affect the crude protein content and significantly maximum crude protein content and yield (10.19% and

10.09 q/ha) in fodder maize observed when fodder maize was fertilized with 100% RDF along with foliar spray of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS (T_7) which was closely followed by treatment T_5 (i.e. application of 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 DAS), T_4 (i.e. crop fertilized with 100% RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}), T_3 (i.e. fodder maize fertilized with 100% RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}) T_6 and T_{10} (i.e. crop fertilized with 100% RDF + foliar application of 1.0% $FeSO_4$ at 30 and 45 DAS). Significantly minimum crude protein content and yield in fodder maize of 8.18% was observed under control treatment (T_1).

Table 1: Effect of agronomic fortification with zinc and iron on N, P and K content and uptake in fodder

Treatments	N content (%)	P content (%)	K content (%)	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
T_1-Control	1.31	0.21	1.09	74.40	11.65	62.05
T_2-RDF (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1})	1.46	0.22	1.26	108.99	18.18	93.95
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	1.55	0.24	1.33	131.99	20.79	113.14
T_4-RDF+ soil application of 50 kg ZnSO4 ha^{-1}	1.55	0.25	1.36	135.63	21.36	118.27
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 30 DAS	1.60	0.25	1.37	153.12	24.00	130.96
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45 DAS	1.59	0.25	1.39	151.92	24.14	130.75
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS	1.63	0.26	1.45	161.50	25.77	143.79
T_8-RDF + foliar application of 1.0% $FeSO_4$ at 30 DAS	1.51	0.23	1.28	117.84	18.90	99.67
T_9-RDF + foliar application of 1.0% $FeSO_4$ at 45 DAS	1.50	0.23	1.27	117.19	18.84	99.28
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45 DAS	1.54	0.24	1.31	129.06	20.32	109.73
S.Em.±	0.04	0.01	0.05	9.95	1.83	7.06
C.D. at 5%	0.11	0.02	0.14	29.56	5.43	20.97

Crude fiber content and fiber yield

The results on crude fiber content of fodder maize furnished in Table 1 showed that different agronomic fortification treatment significantly affect the crude fiber content and yield. Significantly lowest crude fiber content and yield was 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 found on same bar with treatment T_3 i.e. fodder maize fertilized with 100% RDF + soil application of 25 kg ZnSO4 ha^{-1} T (application of 100% RDF + soil application of 50 kg ZnSO ha^{-1}), T_5 (i.e. fertilizing the fodder maize with 100% RDF+ foliar application of 0.2% ZnSO4 + 1.0% $FeSO_4$ at 30 DAS), T_6 (application of 100% RDF + foliar application of 0.2% ZnSO4 + 1.0% $FeSO_4$ at 45 DAS) and T10 (i.e. Fertilizing the fodder maize with 100% RDF + foliar application of 1.0% $FeSO_4$ at 30 and 45 DAS). Maximum crude fiber content of 45.76% was noted under control treatment (T1).

NPK content in fodder

Results given in Table 2 revealed that maximum nitrogen, phosphorus and potash of 1.63%, 0.26% and 1.45%, 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 remained statistically at par with rest of the treatments except, T_1, T_2, T_8 and T_9. Significantly minimum nitrogen, phosphorus and potash content of 1.31%, 0.21% and 1.09%, respectively were noted under control treatment (T_1) and it was found on same bar with T_2 in case of phosphorus content in fodder maize.

Table 2: Effect of agronomic fortification with zinc and iron on crude protein content, yield, crude fibre content and yield of fodder maize

Treatments	Crude protein content (%)	Crude protein yield (q ha^{-1})	Crude fibre content (%)	Crude fibre yield (q ha^{-1})
T_1-Control	8.18	4.65	45.76	26.01
T_2-RDF (100- 60- 40 kg N-P_2O_5-K_2O ha^{-1})	9.10	6.81	41.99	31.40
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	9.68	8.25	40.15	34.18
T_4-RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}	9.69	8.48	40.26	35.07
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30 DAS	10.00	9.57	39.43	37.63
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45 DAS	9.93	9.49	39.13	37.04
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS	10.19	10.09	38.35	37.95
T8-RDF + foliar application of 1.0% $FeSO_4$ at 30 DAS	9.44	7.36	41.76	31.49
T_9-RDF + foliar application of 1.0% $FeSO_4$ at 45 DAS	9.39	7.32	41.60	32.80
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45 DAS	9.61	8.07	41.59	34.94
S.Em.±	0.23	0.62	1.13	2.02
C.D. at 5%	0.70	1.85	3.37	6.00

NPK uptake by fodder

The results presented in Table 2 showed that significantly maximum nitrogen, phosphorus and potash removal of 161.50, 25.77 and 243.79 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) which was comparable with T_3, T_4, T_5 and T_6 in case of nitrogen and phosphorus uptake and with treatment T_5 and T_6 in case of potash uptake. Significantly minimum removal of nitrogen, phosphorus and potash of 74.40, 11.65 and 62.05 kg ha^{-1}, respectively were noted under control treatment (T_1).

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 fodder quality for the animal growth and production.

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