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Yield and economics of summer fodder maize (*Zea mays* L.) Influenced by agronomic fortification with zinc and iron

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Abstract
Field trials were conducted in medium-dark calcareous soil in Junagadh in summer 2019. A total of 10 application combinations, including soil and foliar application of 0.2% $ZnSO_4$ and +1.0% $FeSO_4$ and the recommended fertilizer, were repeated three times. The results showed a significant improvement in yield and yield in crops treated with 100% RDF + 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ foliar spray at 30 and 45 DAS (T_7). From the above experiments, it can be seen that the application of zinc and iron affects the yield and economic value of summer feed corn. Maize fertilization rates of 100:60:40 kg NPK ha-^{1} and foliar sprays of 0.2% $ZnSO_4$ and 1.0% $FeSO_4$ (T_7) at 30 and 45 DAS (T_7) were found to give significant results and pay back for medicinal improvements.

Keywords: Fodder quality, fodder maize, $ZnSO_4$

Introduction

The livestock industry provides animal energy, fertilizer, fuel, milk, urban transportation and meat. Livestock farming, the only source of income for agriculture and insurance in unproductive crops, accounts for 7% of the country's GDP and is the source of employment and living on the brink of 70% of the rural population. Feed production data varies from country to country. Food production and consumption depends on crop standards, climate, economic conditions and animal species. Currently, the country faces a deficit of 61.1% in green vegetables, 21.9% in dry crops and 64.0% in food. By 2025, the demand for green vegetables will reach 1.17 billion tons, the demand for dry food will reach 650 million tons, and the demand for fortified food will reach 152 million tons. To meet the current level of livestock farming and annual population growth, shortages of food, dry crops and all components of food need to be met by increasing productivity, using unused food, making more land by the measure of one thing. To meet demand, green fodder rice needs to increase by 3.2%.

India is the country with the most livestock with 520 million animals, accounting for approximately 15% of the world's livestock. India's land area for rice cultivation is only 2% of the world's land area. Production of animal feed and especially dairy products in India is quite low compared to developed countries; The main reason for this is the lack of feed and fodder for animals. Livestock farming is an important part of my country's rural economy, not only as animal products but also as labour. The situation is different in the state of Gujarat, where the total number of animals is about 18.84 million and the maximum demand is 42.2 million tonnes, with only 20 million tonnes available in a normal year.

Maize (*Zea mays* L.) is a versatile crop that is better adapted to different agro-climatic conditions and is successfully grown for various purposes in many countries, 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. Given its increasing importance, the development of maize as a crop has received considerable attention. The development of corn as a crop has received little attention due to various limitations. There are two ways to improve food production: 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. Additionally, the All India Micronutrient Research Institute describes micronutrient deficiencies in Indian soils. Currently, about 48.1% of the soil in India is free of diethylene triamine penta acetate (DTPA)-extractable zinc and 11.2% iron. Zinc (Zn) and iron (Fe) deficiencies are well documented from a public health perspective and are important soil constraints for crop production in general and forage maize in particular. 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. As soil fertility continues to decline, soil zinc deficiency in India is expected to increase from 42% in 1970 to 63% by 2025; This results in huge losses from disease to the body as well as direct benefits estimated at approximately $1.5 billion per year country. Only one-third of the country's population consumes adequate amounts of zinc sulphate, which increases zinc concentration in soil, grain and feed, but monitor size is needed in central and southern India.

Materials 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 experiment plot was ploughed thrice by tractor drawn cultivator and leveled. The clods were crushed weeds were removed and brought to fine tilth. The land was divided into plots of required size (2.0 m x 1.0 m). Provision was made for bunds and irrigation channels. The seeds of the variety African tall were used with seed rate of 40 kg ha^{-1}. It is an early bearing and high yielding variety. Seeds were sown with a spacing of 20 x 5 cm^2. 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 each end on each side of the plot were not included in the experiment and the border area was collected from each plot separately.

Results and Discussion

Green and Dry fodder yield

Data related to green fodder yield and dry fodder yield of fodder maize as affected by agronomic fortification of summer fodder maize with zinc and iron are furnished in Table 1, data are also graphically depicted in Fig. 1. maximum green and dry yield of fodder maize produced 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 treatment T_5 i.e. crop fertilized with 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 DAS and T_6 i.e. fodder maize fertilized with 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 45 DAS (T_6).

Economics

On the basis of prevailing market prices of fodder maize and different inputs used, total cost of cultivation, gross return and net realization as well as B:C ratio were worked out for individual treatments and presented in Table 2 and Table 3.

Gross and Net return

Data revealed that maximum gross and net realization of Rs. 66977 ha^{-1} and Rs. 52311 ha^{-1}, respectively were obtained 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 closely followed by treatment T_6 i.e. application of 100% RDF along with foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 45 DAS. Numerically minimum gross and net return of Rs. 46223 and 32933 ha^{-1} were noted under control treatment (T_1).

B: C ratio

Data furnished in Table 3 showed that net realization as well as B: C ratio significantly influenced by various agronomic fortification treatments of fodder maize with zinc and iron. Significantly maximum net realization of Rs. 52377 ha^{-1} along with B: C ratio of 3.66 were obtained when fodder maize was fertilized with 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 45 DAS (T_6) which was closely followed by T_7 i.e. fertilizing the fodder maize with 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS (T_7). Minimum gross return of Rs.46223 ha^{-1} net return of Rs. 32933 ha^{-1} as well as B: C ratio of 2.48 was noted under control treatment (T_1).

Table 1: Effect of agronomic fortification with zinc and iron on green and dry fodder yields

Treatments	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})
T_1-Control	308.15	56.84
T_2-RDF (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1})	380.29	74.79
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	405.47	85.19
T_4-RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}	416.65	87.15
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30DAS	445.16	95.42
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45DAS	445.62	95.42
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45DAS	446.51	99.00
T_8-RDF + foliar application of 1.0% $FeSO_4$ at 30DAS	382.61	77.96
T_9-RDF + foliar application of 1.0% $FeSO_4$ at 45DAS	384.51	77.99
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45DAS	405.11	83.95
S.Em.±	22.45	5.10
C.D. at 5%	66.70	15.16
C.V. %	9.67	10.60

Table 2: Economics of different treatments of fodder maize cultivation

Treatments	Treatments cost Rs. (`ha^{-1})	Total cost Rs. (`ha^{-1})	Fodder yield (q ha^{-1})	Gross return Rs. (ha^{-1})	Net returns Rs. (ha^{-1})
T_1	0	13290	308.15	46223	32933
T_2	976	14266	380.29	57044	42778
T_3	1226	14516	405.47	60821	46305
T_4	1476	14766	416.65	62498	47732
T_5	1176	14466	445.16	66774	52308
T_6	1176	14466	445.62	66843	52377
T_7	1376	14666	446.51	66977	52311
T_8	1076	14366	382.61	57392	43026
T_9	1076	14366	384.51	57677	43311
T_{10}	1176	14466	405.11	60767	46301

Table 3: Effect of agronomic fortification with zinc and iron on Net return and B:C ratio of fodder maize

Treatments	Net return (Rs ha^{-1})	B:C ratio
T_1-Control	32933	2.48
T_2-RDF (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1})	42778	3.00
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	46305	3.19
T_4-RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}	47732	3.23
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30DAS	52308	3.62
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45DAS	52377	3.63
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45DAS	52311	3.57
T_8-RDF + foliar application of 1.0% $FeSO_4$ at 30DAS	43026	2.99
T_9-RDF + foliar application of 1.0% $FeSO_4$ at 45DAS	43311	3.01
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45DAS	46301	3.20
S.Em.±	2728	0.13
C.D. at 5%	8105	0.38
C.V. %	10.29	7.01

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 maximum green and dry fodder yield as well as higher financial value

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