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Avtar Singh
Ph.D. Research Scholar, SKRAU, Bikaner, Rajasthan, India

Maneesha
M.Sc. Scholar, ICAR-NDRI, Karnal, Haryana, India

Corresponding Author:
Avtar Singh
Ph.D. Research Scholar, SKRAU, Bikaner, Rajasthan, India

Growth performance of summer fodder maize 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 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 growth 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 growth providing treatment, while treatment control (T_1) remained lowest growth providing treatment among rest of the treatments.

Keywords: Summer fodder maize influenced, agronomic fortification, zinc, iron

Introduction

Currently, the country faces a deficit of 61.1% in green vegetables, 21.9% in dry crops and 64.0% in food (Anonymous, 2017). 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 (Anon., 2020). In order to meet the current level of livestock farming and annual population growth, the shortage of food, dry crops and all components of food must be met by increasing productivity, using unused food, increasing land area and taking some measures. 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 (Shah *et al*., 2011) [9]. The productivity of animals in India, especially milch animals is very low as compared to developed countries primarily due to less availability of nutritive feed and fodder to animals. Livestock rearing is a very important part of our rural economy not only for animal products, but also for draught power. The scenario is different in Gujarat state where, total animal population is about 18.84 million heads and their optimum fodder requirement worked out is 42.2 million tons whereas, only 20.0 million tons of fodder is made available in normal year (Anon., 2010). Maize (*Zea mays* L.) is one of the versatile emerging crops having wider adaptability under varied agro-climatic conditions and successful cultivation in diverse seasons and ecologies for various purposes. Globally, maize is known as "Queen of cereals" and "King of fodder crops" because it has the highest genetic yield potential among the cereals. 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. Moreover, the All India Micronutrient Survey describes micronutrient deficiencies in Indian soils. Currently, about 48.1% of the soil in India is free of diethylenetriaminepentaacetate (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 (Kumar and Salakinkop, 2018). 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 in the body as well as direct benefits estimated at approximately $1.5 billion per year.

Material and Method

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

Trial area three times with tractor and table processed. 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.

Result and Discussion

Growth attributes

Periodical plant height

Data showed that significantly maximum plant height of 174.5, 262.2 and 282.2cm was recorded when crop was fertilized with 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ (T_7) at 40, 60 DAS and at harvest, respectively which was found statistically at par with treatment T_5, T_4, T_3, T_{10} and T_8 at 40 DAS and with treatment T_5 and T_6 at 60 DAS.

Periodical number of leaves plant^{-1}

Significantly maximum number of leaves per plant of 9.7 at 40 DAS was recorded when fodder maize was applied with 100% RDF +foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS (T_7) and which was found statistically at par with treatment T_5, T_4, T_3, T_8 and T_{10}. Similarly, significantly maximum number of leaves per plant of 11.7 and 13.0 respectively at 60 DAS and at harvest were noted under treatment T_7 (i.e. 100% RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS) which remained on same bar with T_5 and T_6. Minimum number of leaves per plant of 7.4, 8.4 and 9.4 were observed under control treatment (T_1) at 40, 60 DAS and at harvest, respectively.

Number of internodes plant^{-1}

It is clear from the data (Table 1) that significantly maximum number of internodes of 14.14 was noted 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) which was remained statistically at par with treatment T_5 and T_6. Significantly least number of internodes per plant at harvest of 10.47 was recorded under control treatment (T_1).

Stem thickness

Maximum stem thickness of 2.40cm was recorded 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 was found on same bar with treatment T_5 and T_6. Significantly thinner stem of 1.57cm was noted under control treatment (T_1).

Length of internode

Effect of agronomic fortification of fodder maize with zinc and iron on length of internode found significant and significantly maximum internode length of 15.15cm was noted 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) which was comparable treatment.

Table 1: Effect of agronomic fortification with zinc and iron on plant height at different stage

Treatments	Plant height (cm) at		
	40 DAS	60 DAS	Harvest
T_1-Control	127.64	193.64	205.31
T_2-RDF (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1})	150.95	213.95	229.95
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	166.90	241.90	257.90
T_4-RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}	167.41	242.41	258.41
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30 DAS	173.92	248.92	268.92
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45 DAS	150.35	246.35	266.35
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS	174.50	262.17	282.17
T_8-RDF + foliar application of 1.0% $FeSO_4$ at 30DAS	161.28	235.61	259.61
T_9-RDF + foliar application of 1.0% $FeSO_4$ at 45 DAS	149.92	234.92	258.92
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45 DAS	162.62	242.62	263.62
S.Em.±	4.54	6.22	7.29
C.D. at 5%	13.50	18.49	21.66
C.V. %	4.96	4.56	4.95

Table 2: Effect of agronomic fortification with zinc and iron on number of leaves per plant at different stage

Treatments	Number of leaves $plant^{-1}$ at		
	40 DAS	60 DAS	Harvest
T_1-Control	7.35	8.37	9.41
T_2-RDF (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1})	8.57	9.53	10.62
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	9.62	10.60	11.82
T_4-RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}	9.40	10.48	11.61
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30 DAS	9.63	10.83	12.37
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45 DAS	8.55	10.75	12.32
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS	9.67	11.70	13.00
T_8-RDF + foliar application of 1.0% $FeSO_4$ at 30 DAS	9.20	10.53	11.68
T_9-RDF + foliar application of 1.0% $FeSO_4$ at 45 DAS	8.53	10.37	11.58
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45 DAS	9.10	10.62	11.83
S.Em.±	0.33	0.35	0.37
C.D. at 5%	0.98	1.04	1.11
C.V. %	6.38	5.85	5.56

Table 3: Effect of agronomic fortification with zinc and iron on number of internodes per plant, stem thickness, length and leaf: stem ratio

Treatments	Number of internodes $plant^{-1}$	Stem thickness (cm)	Length of internode (cm)
T_1-Control	10.47	1.57	10.85
T_2-RDF (100- 60- 40 kg N-P_2O_5- K_2O ha^{-1})	11.68	1.89	12.45
T_3-RDF + soil application of 25 kg $ZnSO_4$ ha^{-1}	12.89	2.13	13.75
T_4-RDF+ soil application of 50 kg $ZnSO_4$ ha^{-1}	12.62	2.06	13.36
T_5-RDF + foliar application of 0.2% $ZnSO_4$ (Salt) +1.0% $FeSO_4$ at 30 DAS	13.40	2.28	14.86
T_6-RDF+ foliar application of 0.2% $ZnSO_4$ (Salt) + 1.0% $FeSO_4$ at 45 DAS	13.35	2.26	14.81
T_7-RDF + foliar application of 0.2% $ZnSO_4$ + 1.0% $FeSO_4$ at 30 and 45 DAS	14.14	2.40	15.15
T_8-RDF + foliar application of 1.0% $FeSO_4$ at 30 DAS	12.38	1.97	12.93
T_9-RDF + foliar application of 1.0% $FeSO_4$ at 45 DAS	12.34	1.96	12.92
T_{10}-RDF + foliar application of +1.0% $FeSO_4$ at 30 and 45 DAS	12.73	2.12	13.19
S.Em.±	0.38	0.06	0.43
C.D. at 5%	1.13	0.19	1.27
C.V. %	5.22	5.41	5.51

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 higher growth potential

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