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Response of micronutrients on productivity and economics of *Rabi* sweet corn (*Zea mays* L. var. *saccharata*)

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Abstract
A field experimentation was undertaken during *Rabi* 2021 at Integrated Farming Systems Farm of Mahatma Phule Krishi Vidyapeeth Rahuri to study the influence of Micro nutrients on growth and yield contributing characters of *Rabi* sweet corn (*Zea mays* L. var. *saccharata*). The outcome of this research revealed that maximum growth, yield and yield attributing characters and Economics of sweet corn crop were recorded with soil and foliar application of Micro Grade I and II (Micro nutrient mixtures) at 15 and 30 DAS respectively.

Keywords: Micronutrient nutrition, micro grade I & II, sweet corn, and economics

Introduction
Maize (*Zea mays* L.) is the third most widely grown crop after wheat and rice, and it is a staple food in many nations, especially in the tropics and subtropics covering 201.98 million ha. in the world with production of 1162.38 million tonnes where as in India the area under maize cultivation is 9.89 million ha. with production of 31.65 million tonnes. It is known as the "Wonder crop" or the "Queen of cereals" because of higher output potential than any other cereal crop. It is grown for human use as well as animal feed, and it has several industrial uses. Corn was most likely gathered from the wild for millennia before being domesticated and grown in North America before the year 2000 B.C. Maize (*Zea mays* L.) is classified as a C4 type crop, it can be grown successfully throughout the year. It converts solar energy into dry matter with great efficiency. Sweet corn, popcorn, baby corn, high oil corn, and other specialty corns have enormous market potential not just in India but also internationally. These speciality corns are ideal for Para urban agriculture because of their high market value.

Sweet corn is the product of a naturally occurring recessive mutation in the genes that govern sugar to starch conversion inside the maize kernel's endosperm. Sweet corn is harvested when the kernels are in milk stage and consumed as a vegetable rather than a grain, unlike other field corn types, which are harvested when the kernels are dry and developed (dent stage). Cooked sweet corn contains a high level of antioxidants, which has been linked to a lower risk of cardiac disease and cancer. Cooked sweet corn also releases more folic acid, which has health advantages including cancer prevention. Sweet corn is primarily composed of linolenic (50%) and oleic (30%) acids, sugars, dietary fibre, vitamin C, beta-carotene, niacin, calcium, and potassium. Apart from that, fodder is succulent, tasty, and easy to digest for cattle.

Modern agriculture must provide crops with adequate nutrients throughout the growth cycle in the most efficient way possible, while minimizing soil and water degradation. This can be accomplished by implementing current and precise nutrient management strategies, particularly the use of water-soluble fertilizers with a high content of micro and macro nutrients having low salt index. Maize is a demanding crop that requires lot of nutrients, and its production is largely determined by the nutrient management system. The Nutrient use efficiency (NUE) of soil applied nutrients is quite low, and it is highly dependent on soil and environmental conditions. In addition to augmenting the nutritional requirements of crops, timely delivery of important nutrients through foliar sprays in conjunction with soil applied nutrient treatments offers various advantages, including rapid and efficient response by crops.

Crop plants require relatively medium levels of zinc and iron, which are one of the necessary micronutrient elements. Apart from carbohydrate transformation, chlorophyll production, and protein synthesis they play an important role in a variety of enzymatic and physiological activities and performs a variety of catalytic roles in the plant system. The positive interactions between increasing levels of Zn and N fertilizers are feasible (Hafeez et al., 2013) [3]. Though ZnSO4 and FeSO4 have traditionally been the only reliable supply of fertilizers, several additional options are now accessible. Chelating compounds like Ethylene diamine tetra acetic acid (EDTA) are preferred by soils with strong fixation and adsorption responses, as they increase the availability of Zn and Fe and other trace metals in the soil solution. Metal ions in chelated forms are inert and readily available to plants. Micro grade I and II are scientifically blended micro nutrient mixtures also shown the promising results.

Materials and Methods

Experimental site and soil

A field experiment was conducted at the AICRP on Integrated Farming Systems Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar during *Rabi* season of 2021-22. The soil in the experimental field belongs to Inceptisol order, and its texture is clay loam with a depth of more than 60 cm, and the topography is uniform and levelled. For the assessment of initial soil fertility status, representative initial soil samples were taken. These soil samples were properly mixed, and a composite soil sample was created and evaluated for physical and chemical soil parameters. The soil is medium in available nitrogen (234.06 kg ha^{-1}), medium in available phosphorus (24.95 kg ha^{-1}) and very high in available potassium (336 kg ha^{-1}). In reaction, the soil in the experimental field was mildly alkaline (pH 7.58) with 0.31% organic carbon, soil electrical conductivity was 0.71 dSm^{-1}.

Experimental design and Treatments

The experiment was laid out in Randomized block design with three replications and containing 10 treatments (T_1:control, T_2 : GRDF (80: 60: 40 kg ha^{-1} N: P_2O_5: K_2O + Vermicompost 2.5 t ha^{-1}), T_3: Soil application of $ZnSO_4$ @ 20 kg ha^{-1}, T_4: Soil application of $FeSO_4$ @ 25 kg ha^{-1}, T_5 : Soil application of Micro grade I @ 25 kg ha^{-1}, T_6: Two water spray @ 15 and 30 DAS, T_7: Two foliar spray of 0.15% chelated Zn (15 and 30 DAS), T_8: Two foliar sprays of 0.15% of chelated Fe (15 and 30 DAS), T_9: Two foliar sprays of Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively, T_{10}: Soil application of Micro grade I @ 25 kg ha^{-1} and two foliar spray Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively). Sweet corn variety Sugar-75 was used with recommended package of practices. Sweet corn seeds were sown in ridges and furrow method at the rate of 8-10 kg seeds ha^{-1} with 60 cm row to row spacing and 20 cm plant to plant spacing and at a depth of 2-3 cm.

Results and Discussion

The growth and yield attributes are significantly influenced by various zinc and iron treatments at harvest. GRDF (80: 60: 40 kg ha^{-1} N: P_2O_5: K_2O + Vermicompost 2.5 t ha^{-1}) + Soil application of Micro grade I @ 25 kg ha^{-1} and two foliar spray Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively (T_{10}) showed significantly taller plants (173.70 cm) and highest dry matter accumulation (254.40 g plant^{-1}) at harvest and as far the yield attributes are concerned the parameters such as number of cobs per plant (1.27), cob girth (22.51 cm) and number of grains per cob (681.29) were significant in T_{10} and GRDF (80: 60: 40 kg ha^{-1} N: P_2O_5: K_2O + Vermicompost 2.5 t ha^{-1}) + Two foliar sprays of Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively (T_9) remained at par. Significance of growth and yield parameters in T_{10} might be due to enhance availability and absorption of zinc and Iron by sweet corn. Zinc activates metabolic enzymes and speeds up cell division, thus aids in internodal elongation. (Iqbal *et al*. 2016; Satdev *et al*. 2020) [5, 8]. The difference among treatments due to soil and Foliar application of zinc and iron could not reach the level of significance with respect to number of cobs plant^{-1} in sweet corn. This might be since number of cobs per plant is a genetic trait of a specific variety that is less influenced by the micronutrient treatments and management practices (Anjum *et al*. 2017; Salomi *et al*. 2020) [1, 7]. Significance of cob girth and number of grains per cob is due to the role of Zinc and Iron in photosynthesis, assimilation, and translocation of photosynthates from leaves to sink (Salakinkop *et al*. 2019; Innocent *et al*. 2018) [6, 4].

Table 1: Growth and Yield attributes of sweet corn as influenced by different nutrient combinations

	Treatment	Plant Height (cm)	Dry matter accumulation (g plant^{-1})	No. of cobs plant^{-1}	Cob girth (cm)	No. of grains per cob
T_1 :	Control	155.97	214.56	1.01	18.02	569.53
T_2 :	GRDF (80:60:40 kg ha^{-1} N : P_2O_5 : K_2O +Vermicompost 2.5 t ha^{-1})	164.59	242.25	1.08	19.11	630.03
T_3 :	Soil application of $ZnSO_4$ @ 20 kg ha^{-1}	169.18	248.57	1.15	20.46	653.03
T_4 :	Soil application of $FeSO_4$ @ 25 kg ha^{-1}	166.66	246.77	1.15	20.13	646.83
T_5 :	Soil application of Micro grade I @ 25 kg ha^{-1}	168.57	248.93	1.14	20.87	652.70
T_6 :	Two water spray @ 15 and 30 DAS.	168.34	247.80	1.06	18.87	602.20
T_7 :	Two foliar spray of 0.15% chelated Zn (15 and 30 DAS)	173.23	252.57	1.22	21.75	676.82
T_8 :	Two foliar sprays of 0.15% of chelated Fe (15 and 30 DAS)	171.53	254.40	1.14	21.48	669.78
T_9 :	Two foliar sprays of Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively	172.99	252.99	1.22	22.23	679.68
T_{10} :	Soil application of Micro grade I @ 25 kg ha^{-1} and two foliar spray Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively.	173.70	254.40	1.27	22.51	681.29
	S.Em. ±	1.00	1.43	0.006	0.12	3.78
	C.D. at 5%	2.93	4.25	NS	0.35	11.24
	General Mean	168.47	246.32	1.15	20.54	646.19

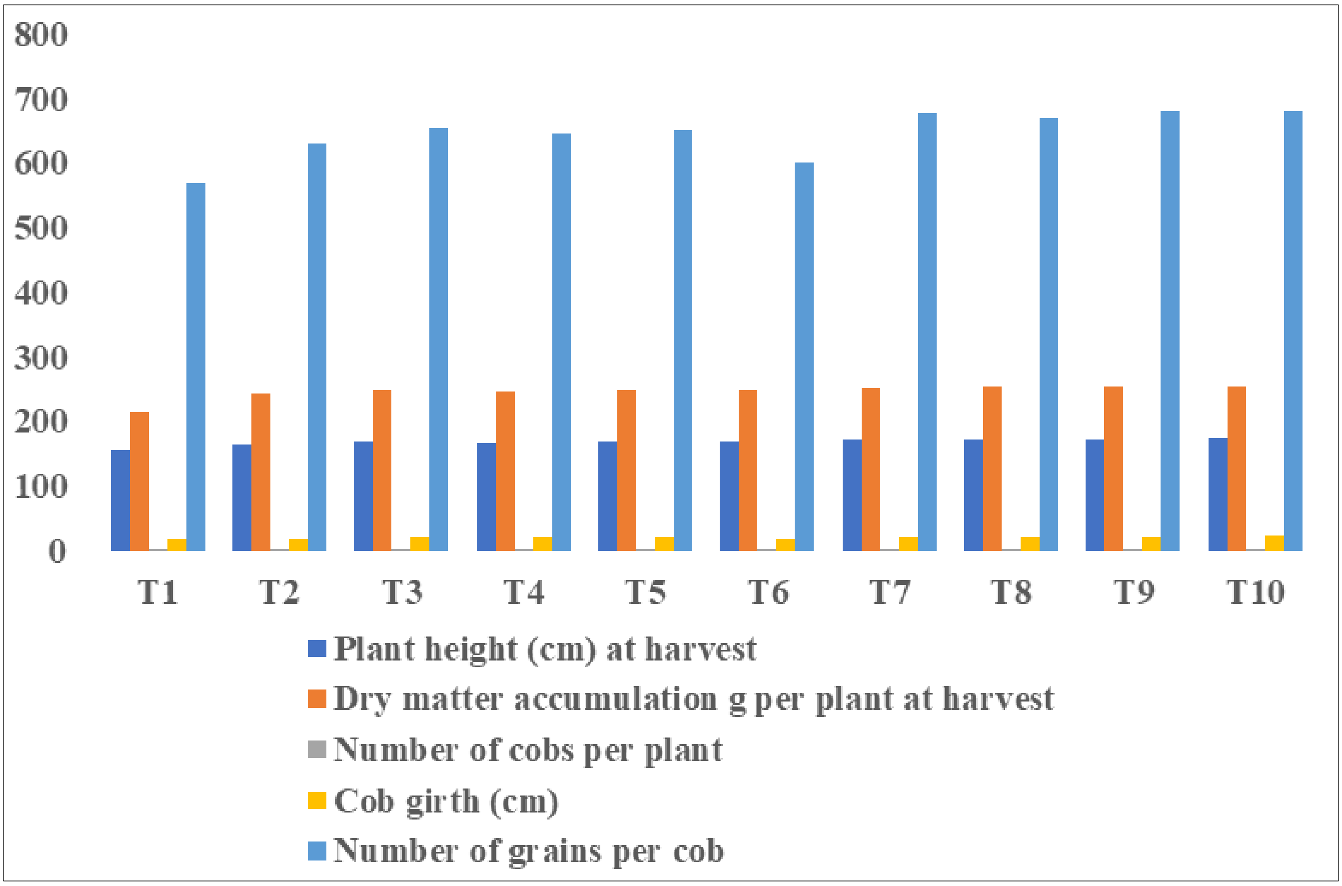

Fig 1: Growth and Yield attributes of sweet corn as influenced by different nutrient combinations

The cob yield and fodder yield of sweetcorn were significantly influenced by the different micronutrient treatments. Amongst the various treatments tested, significantly the highest cob yield (13.24 t ha-1) and fodder yield (22.81 t ha-1) was obtained with GRDF (80: 60: 40 kg ha-1 N: P2O5: K2O + Vermicompost 2.5 t ha-1) + Soil application of Micro grade I @ 25 kg ha-1 and two foliar spray Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively (T10), which stood on a par with T9. The lowest cob yield (8.51 t ha-1) and fodder yield (18.71 t ha^{-1}) were noticed in the control treatment. The improvement in cob yield of sweetcorn might be due to more availability and absorption of zinc and iron by soil application along with foliar spray. Also, zinc and iron may increase translocation of photosynthates from source to sink, ultimately leading to higher stover yield (Salakinkop, 2018) [6].

Table 2: Yield and Economics of sweet corn as influenced by different nutrient combinations

Treatment		Cob yield (t ha^{-1})	Fodder yield (t ha^{-1})	COC (Rs. ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C ratio
T_1 :	Control	8.51	18.71	45030	73450	28420	1.63
T_2 :	GRDF (80:60:40 kg ha^{-1} N : P_2O_5 : K_2O + Vermicompost 2.5 t ha^{-1})	10.80	19.54	55528	120188	64660	2.16
T_3 :	Soil application of $ZnSO_4$ @ 20 kg ha^{-1}	11.24	21.12	55630	136828	81198	2.45
T_4 :	Soil application of $FeSO_4$ @ 25 kg ha^{-1}	11.52	21.32	56300	137125	80825	2.43
T_5 :	Soil application of Micro grade I @ 25 kg ha^{-1}	12.14	22.72	56442	138121	81679	2.44
T_6 :	Two water spray @ 15 and 30 DAS.	10.93	19.12	55100	136224	81124	2.47
T_7 :	Two foliar spray of 0.15% chelated Zn (15 and 30 DAS)	12.60	21.41	57524	138536	81012	2.40
T_8 :	Two foliar sprays of 0.15% of chelated Fe (15 and 30 DAS)	12.16	21.34	58120	144250	85741	2.46
T_9 :	Two foliar sprays of Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively	12.90	21.79	58624	145984	86864	2.49
T_{10} :	Soil application of Micro grade I @ 25 kg ha^{-1} and two foliar spray Micro grade II @ 0.5% and 1.0% @ 15 and 30 DAS respectively.	13.24	22.81	60128	148256	88124	2.56
	S.Em. ±	0.08	0.15	-	-	-	-
	C.D. at 5%	0.44	0.46	-	-	-	-
	C.V	8.12	8.54	-	-	-	-
	General Mean	11.60	20.98	55842	250132	75964	2.41

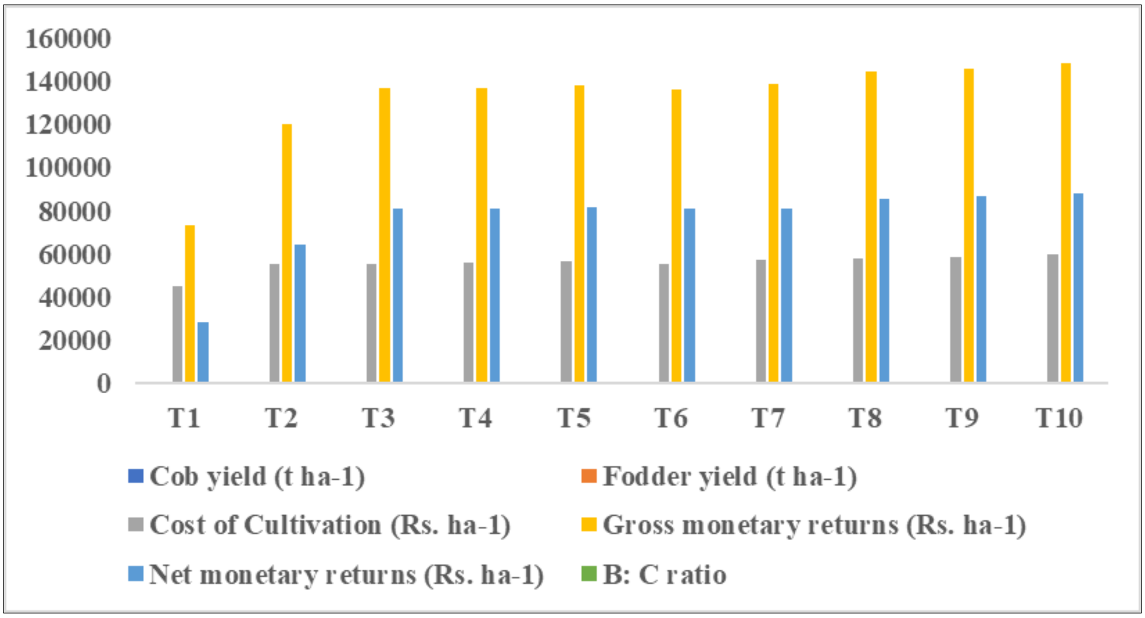

Fig 2: Yield and Economics of sweet corn as influenced by different nutrient combinations

The soil application of Micro grade I @ 25 kg ha^{-1} and two foliar sprays of Micro grade II @ 0.5 percent and 1.0 percent @ 15 and 30 DAS respectively, had the highest total cost of cultivation (60,128 Rs. ha-1), Gross monetary returns (1,48,256 Rs. ha^{-1}), Net monetary returns (88,124 Rs. ha-1) and benefit : cost ratio (2.56) followed by the Two foliar sprays of Micro grade II @ 0.5 percent and 1.0 percent @ 15 and 30 DAS respectively. (Ashoka et al.,2008 and Tetarwal et al., 2009) [2, 9].

Conclusion

Results of the study concluded that soil application of Micro grade I @ 25 kg ha^{-1} and two foliar sprays of Micro grade II @ 0.5 percent and 1.0 percent @ 15 and 30 DAS respectively along with GRDF (80: 60: 40 kg ha^{-1} N: P_2O_5: K_2O + Vermicompost 2.5 t ha^{-1})gave higher growth parameters *viz.* plant height (173.70 cm), dry-matter accumulation (254.40 g plant^{-1}), yield parameters *viz.* number of grains per cob (681.29) and cob girth (22.51 cm), cob yield (13.24 t ha^{-1}) and fodder yield (22.81 t ha^{-1}) and Cost of Cultivation (60,128 Rs ha^{-1}), Gross monetary returns (1,48,256 Rs ha^{-1}) and Net Monetary returns (88,124 Rs ha^{-1}).

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