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Effect of Micronutrient Management on Growth and Yield of Sweet Corn (*Zea mays* L. var. *Saccharata*)

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Abstract

A field investigation entitled "Effect of micronutrient management on growth and yield of sweet corn (*Zea mays* L. var. *Saccharata*)" was conducted in *Kharif* season of 2022-2023 at the Instructional farm, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra). The soil of experimental field was low in available nitrogen (192.67 kg ha^{-1}), medium in available phosphorus (17.87 kg ha^{-1}) and moderately high in potassium (432.51 kg ha^{-1}). The field experiment was laid out in randomized block design (RBD) with three replications. There were eight treatments *viz*., T_1 : Absolute control, T_2 : RDF (120: 60: 40 N: P_2O_5: K_2O kg ha^{-}1), T_3 : GRDF (120: 60: 40 N: P_2O_5: K_2O kg ha^{-1} + FYM 10 t ha^{-1}), T_4 : GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}, T_5 : GRDF + Soil application of $ZnSO_4$ @ 25 kg ha^{-1}, T_6 : GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS, T_7 : GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS and T8: GRDF + Soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS. Among the different treatments the sweet corn crop fertilized with GRDF in association with soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} along with two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS, recorded significantly higher plant height (174.84 cm), number of leaves $plant^{-1}$ (13.04), leaf area $plant^{-1}$ (32.04 dm^2) and dry matter plant-1 (239.52 g) at harvest as compared to rest of nutrient management treatments during *kharif* 2022-23. However, it was at par with GRDF in association with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS. The sweet corn crop fertilized with GRDF in association with soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} along with two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS, recorded significantly higher values of yield attributes *viz*., cob length without husk (26.88 cm), number of grain rows cob^{-1} (17.15), number of grains cob-1 (464.54), weight of grains cob-1 (158.27 g) and green cob yield (192.10 q ha^{-1}) as compared to rest of nutrient management treatments. However, it was at par with GRDF in association with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS.

Key words : Plant height, Number of leaves, Dry matter, Micronutrient Grade I, Phule liquid micro grade II.

Agriculture is the key sector of the Indian economy and allied sector contributes nearly 18.8% of GDP (Anonymous, 2022) and about around 58% of the population dependent on agriculture and allied sectors such as livestock, poultry and fishery etc. for their livelihood. Cereals are grass like crop plants in the poaceae family that are produced for their edible starchy seeds that have a global impact. The principal cereals are cultivated on almost half of the world's ploughed land. 50% of the protein consumed worldwide and 56% of the dietary calories comes from wheat, rice, corn, barley, oats, rye, sorghum and millets. In general, wheat, rice, and corn account for three quarters of global grain production. Sorghum, barley, millets, rye and oats account for the world's remaining cereal grain production.

The maize crop is cultivated throughout the year in all states of the India for various purposes including grain, fodder, sweet corn, baby corn,

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pop-corn in peri-urban areas. Among the speciality corns, sweet corn has gaining popularity both in urban and rural areas because of it's high sugar and low starch content. It is important in urban areas due to it's taste and other uses for human consumption. Thus the increase in production and productivity of sweet corn will be a desirable attribute in facilitating diversified utilization through human consumption of fresh kernels as well as processed food.

Micronutrients are vital plant nutrients consumed in minute amounts by plants. Because it contributes to essential physiological processes, a micronutrient shortage can have a major influence on crop productivity. Fe serves as an essential micronutrient for almost all living organisms because of it plays critical role in metabolic processes such as DNA synthesis, respiration, and photosynthesis. Copper involved in lignin synthesis and enzyme systems. It required in photosynthesis and intensify flavor and colour in vegetables. Manganese plays role in oxidation and reduction reaction, photosynthesis, fixation of atmospheric nitrogen and synthesis of pigments. Boron assists sugar and nutrient transfer, improve pollination and development of seed. Mo is used by selected enzymes to carry out redox reactions. Alvarez and Rico (2003) noticed that increasing Zn rate in the soil significantly increased dry matter yield of maize as compared with the control treatment without Zn addition.

Material and Methods

The field experiment was conducted at the Instructional farm, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar during *kharif* season of 2022-23. The soil in the experimental field belongs to Inceptisol order and medium deep soil 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 collected and evaluated for physical and chemical soil parameters. The soil texture of experimental field was clay loam, low in available nitrogen (192.67 kg ha^{-1}), medium in available phosphorus (17.87 kg ha^{-1}) and very high in available potassium (432.51 kg ha^{-1}). The soil in the experimental field was slightly alkaline (pH 7.59) with 0.54% org. carbon, soil electrical conductivity was 0.43 dS m^{-1}. Geographically, the Instructional Farm of PGI, MPKV, Rahuri lies on the elevation of 495 to 569 m above sea level. It is situated between 19°0 48' and 19° 57' North latitude and 74° 10' and 74° 32' East longitude. Agro climatically, this area is located in rain scarcity zone of Maharashtra (drought prone area). Monsoon season usually begins in the third week of June and ends in the last week of September, with yearly rainfall ranging from 307 to 619 mm, with an average rainfall of 520 mm. The climatic conditions were favorable for sweet corn growth and development, according to the meteorological data.

The experiment was laid out in a randomized block design with three replications. Eight different treatment combinations were created. The seeds of sweet corn variety Phule Madhu were obtained from Chief Scientist (Seed), Seed Cell unit, MPKV, Rahuri. Sowing was done on 3rd July 2022 by dibbling two seeds at each hill at recommended spacing 60 cm x 20 cm. Harvesting was done manually at physiological maturity of crop.

Result and discussion

1. Growth characters : The data in respect of plant height, number of leaves $plant^{-1}$, leaf area $plant^{-1}$ and dry matter $plant^{-1}$ of sweet corn as influenced by different treatments during *kharif* season, 2022 are

presented in table 1. The mean plant height, number of leaves plant^{-1}, leaf area plant^{-1} and dry matter plant^{-1} were (166.87 cm, 11.41, 29.73 dm^2 and 226.58 g, respectively) at harvest of sweet corn.

The sweet corn crop applied with GRDF along with soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS registered significantly higher plant height (174.84 cm), number of leaves plant^{-1} (13.04), leaf area plant^{-1} (32.04 dm2) and dry matter plant^{-1} (239.52 g), respectively at harvest of sweet corn. However, the treatment GRDF + soil application of $ZnSO_4$ @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS was at par (172.11 cm, 12.46, 31.42 dm^2 and 236.78 g, respectively) with it. Whereas the significantly minimum plant height (151.89 cm, number of leaves plant^{-1} (9.23), leaf area plant^{-1} (24.46 dm^2) and dry matter plant^{-1} (199.43 g), respectively at harvest of sweet corn was recorded in the treatment absolute control, where no fertilizers were applied.

The increased plant height, number of leaves plant^{-1}, leaf area plant^{-1} and dry matter plant^{-1} of sweet corn with the soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} along with two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS was observed due to most favourable availability of micronutrients as Multi-micronutrient Grade I and Phule Liquid Micro Grade II contains optimum amount of Zn, Fe, Cu, Mn, B and Mo. It was also coupled with 10 tonnes FYM ha^{-1} which increases the availability of micronutrients. The RDF was beneficial to provide major nutrients, with all these combinations of major and micronutrients facilitated the luxurious growth of sweet corn. Iron plays important role in metabolism of chlorophyll while zinc is involved in carbohydrate metabolism, protein synthesis as well as boron regulate sugar transport through cell membrane, cell division, cell development etc. Copper and manganese are essential for energy transfer and photosynthesis activities. Copper increases nodulation and nitrogen fixation while manganese vital for protoplast metabolism. The beneficial effect of foliar sprays of micronutrient

Table 1. Plant height, number of leaves, leaf area plant^{-1} and dry matter plant^{-1} at harvest of sweet corn as influenced by different treatments

Treatment	Plant height (cm)	No. of leaves plant^{-1}	Leaf area plant^{-1} (dm^2)	Dry matter plant^{-1} (g)
T_1 - Absolute control	151.89	9.23	24.46	199.43
T_2 - RDF (120: 60: 40 N: P_2O_5: K_2O kg ha^{-1})	162.67	10.68	28.69	222.67
T_3 - GRDF (120: 60: 40 N: P_2O_5: K_2O kg ha^{-1} + FYM 10 t ha^{-1})	165.45	10.88	29.59	225.14
T_4 - GRDF + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1}	170.87	11.97	30.87	231.52
T_5 - GRDF + Soil application of $ZnSO_4$ @ 25 kg ha-1	169.48	11.75	30.45	229.60
T_6 - GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS	168.07	11.48	30.28	227.94
T_7 - GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS	174.84	13.04	32.04	239.52
T_8 - GRDF + Soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS	172.11	12.46	31.42	236.78
S. Em±	1.19	0.25	0.37	2.47
CD (P= 0.05)	3.63	0.76	1.11	7.41
General mean	166.87	11.41	29.73	226.58

mixtures associated with high photosynthetic activity and protein synthesis which promotes cell division and elongation that in turn accelerates vegetative growth and increase in number of leaves with vigorous and succulent growth. The application of macro and micronutrients increase significantly more leaf area by the use of these nutrients. The leaf area is a measure of size of the assimilatory system of the food in plant and it is the product of leaf length and breadth. The dry matter of sweet corn is the product of luxurious plant growth and photosynthates assimilation. The zinc played a role in metal activator of enzyme, boron in cell differentiation and development, manganese and copper played role in metabolic activities. The current experiment's results are consistent with those published by Zende (2006), Kumar *et al*., (2007), Patel *et al*., (2009), Adhikary *et al*., (2010), Azhar *et al*., (2011) and Maravalli and Shekh (2019).

2. Yield contributing characters : The data in respect of cob length without husk, number of grain rows cob^{-1}, number of grains cob^{-1} and weight of grains cob^{-1} of sweet corn as influenced by different treatments during kharif season, 2022 are presented in table 2. The mean cob length without husk, number of grain rows cob^{-1}, number of grains cob^{-1} and weight of grains cob^{-1} (22.62 cm, 14.72, 405.41 and 128.26 g, respectively) of sweet corn was obtained during investigation.

The data in respect of cob length without husk, number of grain rows cob^{-1}, number of grains cob^{-1} and weight of grains cob^{-1} of sweet corn was influenced significantly due to different nutrient combinations at harvest. The sweet corn crop fertilized with GRDF along with soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro grade II @ 1% at 30 and 45 DAS produced significantly maximum cob length without husk, number of grain rows cob^{-1}, number of grains cob^{-1} and weight of grains cob^{-1} (26.88 cm, 17.15, 464.54 and 158.27 g, respectively) as

Table 2. Cob length with husk and without husk, Number of grain rows cob^{-1}, number of grains cob^{-1}, weight of grains cob^{-1} and green cob yield of sweet corn as influenced by different treatments

Treatment	Cob length without husk (cm)	No. of grain rows cob^{-1}	No. of grains cob^{-1}	Wt. of grains cob^{-1} (g)	Green cob yield (q ha^{-1})
T_1 - Absolute control	17.24	10.16	250.35	67.92	90.21
T_2 - RDF (120: 60: 40 N: P_2O_5: K_2O kg ha^{-1})	21.23	13.59	382.85	117.67	141.76
T_3 - GRDF (120: 60: 40 N: P_2O_5: K_2O kg ha^{-1} + FYM 10 t ha^{-1})	21.42	14.33	397.95	121.45	165.47
T_4 - GRDF + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1}	23.95	15.61	443.83	144.91	178.17
T_5 - GRDF + Soil application of $ZnSO_4$ @ 25 kg ha^{-1}	22.53	15.38	430.27	135.56	176.54
T_6 - GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS	21.96	15.17	419.69	128.06	174.63
T_7 - GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha-1 + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS	26.88	17.15	464.54	158.27	192.10
T_8 - GRDF + Soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS	25.76	16.34	453.76	152.24	189.34
S. Em±	0.87	0.48	5.85	3.64	3.45
CD (P= 0.05)	2.63	1.46	17.75	11.04	10.39
General mean	22.62	14.72	405.41	128.26	163.53

compared to rest of the nutrient management treatments. However, the treatment GRDF + soil application of ZnSO4 @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS was found at par with it in cob length without husk, number of grain rows cob^{-1}, number of grains cob^{-1} and weight of grains cob^{-1} (25.76 cm, 16.34, 453.76 and 152.24 g, respectively) at harvest of sweet corn. Whereas, the significantly minimum cob length without husk, number of grain rows cob^{-1}, number of grains cob^{-1} and weight of grains cob^{-1} (17.24 cm, 10.16, 250.35 and 67.92 g, respectively) were recorded in the treatment absolute control, where no fertilizers were applied during the experimentation. The role of zinc and iron in photosynthesis, net assimilation, and translocation of photosynthates from leaves to sink may be the cause of increased cob length without husk, number of grain rows cob^{-1} and number of grains cob^{-1}. The combined use of basal treatment and foliar application of micronutrients improves the increase in weight of grains cob^{-1}.

According to Patel *et al*., (2009), Adhikary *et al*., (2010), Azhar *et al*., (2011), Chandrakanth *et al*., (2017), Jayant *et al*., (2018) and Drocelle *et al*., (2019) a combination of basal and foliar nutrients enhances length of cob, number of grain rows cob^{-1}, number of grains cob^{-1} and weight of grains cob^{-1}.

3. Green cob yield : The data in respect of green cob yield of sweet corn as influenced by different treatments during kharif season, 2022 are presented in table 2. The mean green cob yield of sweet corn (163.53 q ha^{-1}) was obtained during investigation.

The data in respect of green cob yield of sweet corn was influenced significantly due to different nutrient combinations at harvest. The sweet corn crop applied with GRDF along with soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS produced significantly maximum green cob yield of sweet corn (192.10 q ha^{-1}) as compared to rest of the nutrient management treatments. However, the treatment GRDF + soil application of $ZnSO_4$ @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS was found at par with it (189.34 q ha^{-1}) in green cob yield. Whereas the minimum green cob yield of sweet corn (90.21 q ha^{-1}) was recorded in the treatment absolute control, where no fertilizers were applied during the experimentation. The sweet corn applied GRDF along with soil application of Multi-micronutrient Grade I or $ZnSO_4$ @ 25 kg ha^{-1} + two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS offered easy availability for the absorption of micro and macro nutrients in higher amount. The efficient utilization of zinc helped in the synthesis of IAA and uptake of water. Boron boosts the salt absorption, hormone movement and carbohydrate metabolism. Iron played vital role in synthesis of chlorophyll and act as oxygen carrier. The continuous availability of the micronutrients from soil and foliar spray increases the growth characters and zinc and iron increases the translocation of photosynthates from source to sink ultimately leads to higher green cob yield. The similar findings were reported by Adhikary *et al*., (2010), Karanjikar *et al*., (2020) and Salomi *et al*., (2020).

Conclusion

The application of GRDF (120: 60: 40 N: P_2O_5: K_2O Kg ha^{-1} + FYM 10 t ha^{-1}) along with soil application of Multi-micronutrient Grade I or ZnSO4 @ 25 kg ha^{-1} and two foliar sprays of Phule Liquid Micro Grade II @ 1% at 30 and 45 DAS to sweet corn crop found beneficial for increase of growth, yield attributes and yield grown on medium deep soil.

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