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Productivity of Sweetcorn as Influenced by Agronomic Biofortification with Zinc and Iron

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ABSTRACT

A field experiment was conducted at Main Agricultural Research Station, Dharwad, to study the productivity of sweetcorn as influenced by agronomic biofortification with zinc and iron during Kharif 2015. The field experiment was laid out in split plot design with three replications and 21 treatment combinations involving three main and seven subplots. The results indicated that, soil application of enriched $ZnSO_4$ and $FeSO_4$ @ 10 kg each ha^{-1} with vermicompost at 250 kg ha^{-1} along with foliar spray of $ZnSO_4$ and $FeSO_4$ @ 1.0 % each at 20 and 40 days after sowing were recorded higher fresh cob yield with husk (318.63 q ha^{-1}), and fresh fodder yield (624.03 q ha^{-1}), which was at par with enriched $ZnSO_4$ and $FeSO_4$ @ 10 kg each ha^{-1} with farm yard manure at 500 kg ha^{-1} along with foliar spray of $ZnSO_4$ and $FeSO_4$ @ 1.0 % each at 20 and 40 DAS (315.30 and 620.63 q ha^{-1}, fresh cob and fodder yield, respectively).

Key words: *Biofortification, Sweetcorn, Zinc, Iron, Enrichment.*

INTRODUCTION

Sweet corn (*Zea mays* L. var. *saccharata* Sturt*)* assume tremendous market potential not only in India but also in the international market. Hungary is the leading sweet corn producing country in the European Union, having an area of 31,000 ha, constituting 40 per cent of the production area of field vegetable crops. Sweet corn is gaining importance in the star/big hotels, big shopping malls and departmental stores *etc*. It is used for preparation of special soups, sweets, jams, cream pastes and other delicious eatables in urban areas. So now a day's sweet corn industry is expanding because of increasing domestic consumption, export development and import replacement. Since, three to four crops can be harvested in a year and green fodder is highly succulent, palatable and digestible for dairy animals. Hence it is becoming increasingly popular in India and other Asian countries.

Large population of human beings in developing countries is mainly reliant on a staple diet of cereals such as rice, wheat and maize. Unfortunately all of our major cereal food crops lack of certain essential vitamins and minerals, as milled cereal grains are poor sources of lysine, vitamin A, folic acid, iron, zinc and selenium which are essential for normal growth and metabolism of human beings.

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In Asia about 35 per cent of children between age group of 0 and 5 years suffer from Zn or Fe-deficiencies, 250 million suffer from vitamin A deficiency and 58 per cent of pregnant women in developing countries are anemic from iron deficiency[2].

So, agronomic bio-fortification is a holistic approach to eliminate micronutrient deficiency in food crops through agronomic practices by means of soil and foliar application. Hence the present investigation was undertaken to study the agronomic biofortification with zinc and iron nutrition in sweetcorn.

MATERIALS AND METHODS

The field experiment was conducted at University of Agricultural Sciences, Dharwad of Northern transition zone of Karnataka, during *kharif* 2015. The field experiment was laid out in Split plot design with three replications. There were 21 treatment combinations involving three main plots (soil applications) *viz.*, **S_1-** $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1}, **S_2-** $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} (Enriched with VC at 250 kg) and **S_3-** $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} (Enriched with FYM at 500 kg) and seven subplots (foliar applications) *viz.*, (**F_1-** $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 20 DAS, **F_2-** $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 40 DAS, **F_3-** $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 20 and 40 DAS, **F_4-** $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 20 DAS, **F_5-** $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 40 DAS, **F_6-** $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 20 and 40 DAS, **F_7** - Control (No foliar spray). **Note**: Recommended dose of 100:50:25 N: P_2O_5: K_2O kg ha^{-1}, 50 % of N appliéd at basal, 25 % at 30 DAS and remaining 25 % appliéd at 45 DAS. Full dose of P_2O_5 and K_2O were appliéd at the time of sowing. Enrichment procédure: Zinc sulphate and iron sulphate was thoroughly mixed with farm yard manure and vermicompost as per the treatments. The mixture was covered with polythene sheet for natural process of composting for 45 days to fix the externally added inorganic Zn and Fe into organically bound and naturally chelated form of Zn and Fe and maintaining 50 per cent moisture in enriched compost. This enriched manures were utilized as a soil application at the time of sowing of sweetcorn. The test crop was sweetcorn (Hybrid sugar 75) fresh cob and fodder yield were recorded as per treatments accordingly.

RESULTS AND DISCUSSION

Fresh cob and fodder yield

Sweetcorn fresh cob and fodder yield differed significantly with soil and foliar application of Zn and Fe. Among the different treatments, soil application of enriched $ZnSO_4$ & $FeSO_4$ @ 10 kg each $ha^{-1}$with vermicompost at 250 kg ha^{-1} were recorded significantly higher fresh cob yield with husk (299.05 q ha^{-1}) and fodder yield (601.68 q ha^{-1}) which was on par with enriched $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} with FYM at 500 kg ha^{-1} (Table 1). Lower fresh cob yield with husk (291.74 q ha^{-1}) and fodder yield (584.34 q ha^{-1}) was obtained in without enrichment. The significant fresh cob and fodder yield were increased due to improved availability of micronutrients (Zn and Fe) which could be attributed to the formation of stable organometallic complexes of micronutrients with organic matter, especially during the enrichment process to last for a longer time and release of nutrients slowly in the soil system in such a way that the nutrients are protected from fixation and made available to the plant root system throughout the cropping period and higher accumulation of photosynthetes and better translocation of photosynthates from source and sink which ultimately higher productivity of crops. These results are in close accordance with the findings of Sathisha *et al*[4].

Among the foliar application of micronutrients, foliar application of $ZnSO_4$ & $FeSO_4$ @ 1.0 per cent each at 20 and 40 DAS was recorded higher fresh cob (313.77 q ha^{-1}) and fodder yield (616.60 q ha^{-1}) (Table 1). Higher yield it might be due to foliar spray of micronutrients (zinc and iron) are essential for several enzymes and coenzymes that regulates the metabolic activities in plants. They involves in auxin production, transformation of carbohydrates and regulation of sugars in plants. Especially zinc and iron are involved in the synthesis of growth promoting hormones and the reproductive process of many plants which are vital role for grain formation[3].

Interaction effect of soil enriched $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} with vermicompost at 250 kg ha^{-1} and along with foliar spray of zinc and iron at 1.0 per cent at 20 and 40 days after sowing was recorded higher yield of sweet corn.

Yield attributes

Yield attributes differed significantly with soil and foliar application of Zn and Fe. Among the different treatments, soil application of enriched $ZnSO_4$ & $FeSO_4$ @ 10 kg each/ha with vermicompost at 250 kg ha^{-1} were recorded significantly higher fresh cob weight with husk (361.17 g cob^{-1}), without husk (276.28 g cob^{-1}) and number of grains per row (38.33) which was on par with enriched $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} with FYM at 500 kg ha^{-1} (Table 2).

Among the foliar application of micronutrients, foliar application of $ZnSO_4$ & $FeSO_4$ @ 1.0 per cent each at 20 and 40 DAS was recorded higher fresh cob weight with husk (376.30 g cob^{-1}), without husk (292.97 g cob^{-1}) and number of grains per row (40.89) which was on par with foliar application of $ZnSO_4$ & $FeSO_4$ @ 0.5 per cent each at 20 and 40 DAS. Lower yield attributes was observed in control. Interaction effect of soil enriched $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} with vermicompost at 250 kg ha^{-1} and along with foliar spray of zinc and iron at 1.0 per cent at 20 and 40 days after sowing was recorded higher yield attributes of sweet corn which was on par with same treatment but receiving @ 0.5 per cent at 20 and 40 DAS[1].

Table 1: Fresh cob, fodder yield and harvest index of sweet corn as influenced by agronomic biofortification

Treatments	Fresh cob yield (q ha^{-1})	Fresh fodder yield (q ha^{-1})	Harvest index (%)
Soil application of micronutrients			
S_1- $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1}	291.74 b	584.34 b	33.29 a
S_2- $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} (Enriched with VC at 250 kg)	299.05 a	601.68 a	33.21a
S_3- $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} (Enriched with FYM at 500 kg)	296.09 ab	590.08 ab	33.42 a
SEm ±	1.32	3.20	0.17
Foliar application of micronutrients			
F_1 - $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 20 DAS	285.89 de	576.01 cd	33.15 a
F_2 - $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 40 DAS	294.33 b-d	589.28 bc	33.32 a
F_3 - $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 20 and 40 DAS	304.23 ab	609.62 a	33.29 a
F_4 - $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 20 DAS	290.89 c-e	587.84 bc	33.12 a
F_5 - $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 40 DAS	299.42 bc	601.27 ab	33.24 a
F_6 - $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 20 and 40 DAS	313.77 a	616.60 a	33.72 a
F_7 - Control (No foliar spray)	280.83 e	563.60 d	33.30 a
SEm ±	3.69	6.50	0.40
Interaction			
S_1F_1	285.30 f-h	573.63 d-g	33.08 a
S_1F_2	291.73c-h	588.00a-f	33.16 a
S_1F_3	298.73 a-g	599.50 a-e	33.26 a
S_1F_4	287.63c-h	581.93 c-g	33.08 a
S_1F_5	295.07 b-h	593.57 a-f	33.20 a
S_1F_6	307.37 a-d	605.13 a-e	33.67 a
S_1F_7	277.23 h	548.60 g	33.57 a
S_2F_1	287.37 d-h	583.73 b-g	32.99 a
S_2F_2	296.57 b-h	599.14a-e	33.12 a
S_2F_3	308.33a-c	616.53 a-c	33.34 a
S_2F_4	295.83 b-h	594.53 a-f	33.27 a
S_2F_5	303.33 a-f	610.52 a-d	33.19 a
S_2F_6	318.63 a	624.03 a	33.81 a
S_2F_7	283.27 f-h	583.30 b-g	32.78 a
S_3F_1	285.90 e-h	570.67 e-g	33.39 a
S_3F_2	294.70 b-h	580.70 c-g	33.67 a
S_3F_3	305.63 a-e	612.83 a-c	33.27 a
S_3F_4	289.20 c-g	587.07 a-f	33.01 a
S_3F_5	299.87 a-g	599.73 a-e	33.33 a
S_3F_6	315.30 ab	620.63 ab	33.69 a
S_3F_7	282.00 gh	558.89 fg	33.57 a
S.Em ±	6.10	11.26	0.15

Table 2: Yield attributes of sweet corn as influenced by agronomic biofortification

Treatments	Fresh cob with husk (g cob^{-1})	Fresh cob without husk (g cob^{-1})	Number of grains per row
Soil application of micronutrients			
S_1- $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1}	356.17 b	268.84 b	36.76 a
S_2- $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} (Enriched with VC at 250 kg)	361.47 a	276.28 a	38.33 a
S_3- $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} (Enriched with FYM at 500 kg)	359.83 ab	274.39 a	37.48 a
SEm ±	1.00	0.91	0.50
Foliar application of micronutrients			
F_1 - $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 20 DAS	349.37 d	257.36 cd	34.89 c
F_2 - $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 40 DAS	359.82 bc	275.60 b	37.56 a-c
F_3 - $ZnSO_4$ & $FeSO_4$ @ 0.5 % each at 20 and 40 DAS	370.20 a	287.77 a	39.78 ab
F_4 - $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 20 DAS	353.33 cd	265.92 c	36.33 bc
F_5 - $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 40 DAS	367.88 ab	284.07 ab	39.22 ab
F_6 - $ZnSO_4$ & $FeSO_4$ @ 1.0 % each at 20 and 40 DAS	376.30 a	292.97 a	40.89 a
F_7 - Control (No foliar spray)	337.21 e	248.52 d	34.00 c
SEm ±	3.07	3.14	1.28
Interaction			
S_1F_1	347.75 e-g	254.77 g-i	34.00 b
S_1F_2	355.29 b-f	269.83 c-g	37.00 ab
S_1F_3	365.43 a-e	282.33 a-e	38.33 ab
S_1F_4	351.40 d-f	263.40 f-h	36.00 ab
S_1F_5	365.35 a-e	280.37a-f	38.67 ab
S_1F_6	374.39 a	287.63 a-c	39.33 ab
S_1F_7	333.58 g	243.57 i	34.00 b
S_2F_1	350.69 d-g	259.20 g-i	36.67 ab
S_2F_2	363.90 a-e	280.07 a-f	38.00 ab
S_2F_3	373.29 a	291.40 ab	40.33 ab
S_2F_4	354.85 b-f	268.65 d-g	37.00 ab
S_2F_5	369.71 a-c	286.07 a-d	40.00 ab
S_2F_6	378.07 a	296.33 a	42.33 a
S_2F_7	339.79 fg	252.22 g-i	34.00 b
S_3F_1	349.67e-g	258.11 g-i	34.00 b
S_3F_2	360.27 a-e	276.90 b-f	37.67 ab
S_3F_3	371.87 ab	289.57 ab	40.67 ab
S_3F_4	353.73 c-f	265.70 e-h	36.00 ab
S_3F_5	368.57 a-d	285.77 a-d	39.00 ab
S_3F_6	376.43 a	294.93 ab	41.00 ab
S_3F_7	338.27 fg	249.77 hi	34.00 b
S.Em ±	5.32	5.43	2.22

CONCLUSION

Soil application of enriched $ZnSO_4$ & $FeSO_4$ @ 10 kg each ha^{-1} with vermicompost at 250 kg ha^{-1} and along with foliar spray at 1.0 per cent each at 20 and 40 DAS was found higher productivity in sweetcorn.

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