Original Research Article

Performance of sweet corn hybrids (*Zea mays saccharata*) as influenced by soil and foliar application of zinc

Abstract

A field experiment entitled "Performance of sweet corn hybrids (*Zea mays saccharata*) as influenced by soil and foliar application of zinc" was conducted during kharif 2018 at the Experimental Farm of the Division of Agronomy, Wadura, SKUAST-K. The experiment comprised of two factors with three sweet corn hybrids, *viz.*, Sugar 75, FSCH 75 and CMVL SC and four zinc levels, viz., soil application of $ZnSO_4$ @ 20 kg ha^{-1}, soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage, soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at tasseling stage and $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed laid out in randomized complete block design (RCBD) with three replications. The results of the experiment revealed that hybrids had a significant effect on the yield attributes and yield of sweet corn and among different hybrids, Sugar 75 recorded significantly higher yield attributes and yield of sweet corn. However, hybrids had no effect on number of cobs per plant. Hybrid FSCH 75 recorded significantly lowest values for yield attributes and yield. Among zinc levels, soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage produced significantly higher yield attributes and yield whereas zinc level $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed recorded significantly lowest values of all the yield attributes and yield. However, zinc levels had no effect on number of cobs per plant. The economic analysis showed that highest net profit and benefit cost ratio of ₹466230.5 and 4.37 respectively was recorded by hybrid sugar 75 applied with zinc level of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage whereas lowest net profit and benefit cost ratio of ₹294742.5 and 2.76 respectively by hybrid FSCH 75 applied with zinc level, $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed.

Key words: Sweet corn, yield, yield attributes, zinc, hybrids

INTRODUCTION

After wheat and rice, maize (*Zea mays* L.) is emerging as the world's third most significant cereal crop. It is known as the "Queen of Cereals" because of its high productivity, ease of processing, and lower cost than other cereals (Jaliya *et al.*, 2008), and it has a wide range of industrial applications in addition to serving as human food and animal feed. Maize agriculture covers over 190 million hectares worldwide, yielding approximately 1438 million tonnes (FAO, 2019). Maize farming covers around 9.50 million hectares in India, with an annual yield of 27.23 million tonnes and a productivity of 2.87 tonnes $hectare^{-1}$ (DES, 2019). Maize is the second most important cereal crop in the union territory of Jammu and Kashmir, after rice, and is cultivated over an area of 0.31 million hectares, with a production of 0.51 million tonnes and an average productivity of 1650 kg ha^{-1} (DES, 2019).

It has earned a well-deserved status as a poor man's nutria-cereal due to its high quantity of carbs, lipids, proteins, vitamins, and minerals (Sentayehu, 2008). Maize is predicted to provide protein and calories to several million individuals in underdeveloped nations (11.1 g and 342 kcal day^{-1}) (Gopalan *et al.*, 1999). However, due to poor returns per unit area in standard maize, producers are rapidly transitioning to specialty corn cultivation, such as sweet corn and pop corn, which provide significant net returns and chances for job creation. Sweet corn has the most commercial potential of any specialty maize, as well as the most genetic variety and opportunity for nutritional improvement. This enormous potential exists not only in the home market, but also in the foreign market. Furthermore, quality fodders (based on sweetness) gathered after harvest can be sold, providing farmers with a sizable additional money because cattle love it. The sweet corn sector is expanding as a result of rising domestic demand, export development, and import substitution. It is an appealing crop for farmers because it grows fast, making it a desirable rotational crop when farming operations can be automated. . The majority of sweet corn is cultivated for the processing industry and ends up on supermarket shelves as canned kernels, frozen cobs, and frozen kernels (Najeeb *et al.,* 2011).

Maize (Zea mays L.) is a high-nutrient-demanding crop that is vulnerable to soil zinc (Zn) deficiency. Application of Zn fertilisers may be a realistic approach for meeting crop demand for Zn while also increasing its concentration in cereals. Zinc insufficiency in crops is a widespread micronutrient problem worldwide, therefore zinc malnutrition has emerged as a major health concern among resource-poor populations (Singh and Sampath, 2011). One-third of the world's population is said to be at danger of zinc deficiency due to low zinc consumption in the diet (Cakmak, 2009). Singh (2010) identified a widespread hidden hunger for zinc in seeds and feeds that affects a substantial proportion of the population, namely resource-poor households whose diet is mostly derived from cereals cultivated on zinc-deficient soils. Continuous intensive farming of high yielding crop types has exacerbated soil zinc depletion, resulting in low zinc concentrations in edible grains. Biofortification is a process in which plants are permitted to absorb minerals (Zn) from the soil and immobilise them in grains, resulting in nutritionally dense grains that meet human dietary zn requirements. Increasing seed Zn content by soil and/or foliar Zn spray has various agronomic benefits for crop yield. Zn application to plants growing in possibly Zn-deficient soils reduces P uptake and accumulation in plants. This agronomic Zn fertilisation may result in increased Zn bioavailability in the human digestive system. So agronomic biofortification with soil and foliar micronutrient (Zn) treatment not only boosts corn production but also improves the nutritional content of specialty corn for high economic returns and nutritional security.

Keeping this in view a field experiment entitled "**Performance of sweet corn hybrids (*Zea mays saccharata*) as influenced by soil and foliar application of zinc**" was conducted as SKUAST-K, Faculty of Agriculture, Wadura, Jammu and Kashmir.

MATERIALS AND METHODS

During kharif 2018, a field experiment titled "Performance of sweet corn hybrids (Zea mays saccharata) as impacted by soil and foliar zinc treatment" was conducted at the Experimental Farm of the Division of Agronomy, Wadura, SKUAST-K. The experimental field's soil had a clay loam texture, was medium in organic carbon, low in available nitrogen, low in available phosphorus, and medium in available potassium, and had a neutral pH. The site is situated between 340 21′ N and 740 23′ E at an altitude of 1590 meters above mean sea level.

The experiment comprised of two factors with three sweet corn hybrids viz., Sugar 75, FSCH 75 and CMVL SC and four zinc levels. The experiment was consisting of twelve treatments viz., soil application of $ZnSO_4$ @ 20 kg ha^{-1}, soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage, soil application of $ZnSO_4$ @ 15 kg ha^{-1} + ZnSO4 (0.5%) foliar spray at tasseling stage and soil application $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed laid out in randomized complete block design with three replications. The various treatment combinations include T_1 : Sugar 75 + soil application of $ZnSO_4$ @ 20 kg ha^{-1}, T_2 : Sugar 75 + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + soil application of $ZnSO_4$ (0.5%) foliar spray at knee high stage, T_3 : Sugar 75 + soil application $ZnSO_4$ @ 15 kg ha^{-1} + soil application of $ZnSO_4$ (0.5%) foliar spray at tasseling stage, T_4 : Sugar 75 + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed, T_5 : FSCH 75 + soil application of $ZnSO_4$ @ 20 kg ha^{-1}, T_6 : FSCH 75 + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + soil application of $ZnSO_4$ (0.5%) foliar spray at knee high stage, T_7: FSCH 75 + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at tasseling stage, T_8 : FSCH 75 + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed, T_9 : CMVL SC + soil application of $ZnSO_4$ @ 20 kg ha^{-1}, T_{10}: CMVL SC + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage, T_{11}: CMVL SC + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at tasseling stag and T_{12}: CMVL SC + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed. The experiment was laid out in randomized complete block design with three replications.

Before picking, the total number of green cobs on five randomly tagged plants was counted and averaged as number of cobs $plant^{-1}$. To calculate grain number per cob, the total number of grains in five randomly selected cobs from each plot were manually counted. The average number of grains cob^{-1} was recorded. The length of 5 randomly selected cobs with and without husk were measured using a metre scale and averaged as young cob length with and without husk from the count of young cobs in each plot after picking. It was measured in centimetres. Fig. 1 and Fig. 2 shows some of the cobs with and without respectively. Five randomly selected cobs from each plot used for length measurement were also utilised for diameter measurement. Vernier calliper was used to measure the cob diameter. The young cobs used for length and diameter measurements were weighed with and without husk, and the weight was averaged as the weight of the young cob. It was measured in g cob^{-1}. The total weight of young cobs with and without husk from each net plot across all pickings was calculated in kilogrammes and expressed as q ha^{-1}. After pickings were completed, the greenn fodder gathered from each net plot was tied in buundles and weighed in kg $plot^{-1}$. The mass was converted to q ha^{-1}. The collected husk was alsoo included in the feed yield. The economics of all treatment combinations were calculated using green cob yield, green fodder yield, and the cost of input and output at the time of experimentaation.

Fig. 1: Cobs with husk

Fig. 2: Cobs without husk

The benefit cost ratio (returns per rupee invested) was determined as:

B:C ratio = Net returns/ total cost of cultivation

The input cost was calculated as per the expenses incurred on ploughing, manuring, fertilizer, seed, irrigation, weeding, pesticides and harvesting.

RESULTS AND DISCUSSION

The results of the experiment indicated that sweet corn hybrids had a significant effect on yield attributes and yield of sweet corn. Data presented in Table 1 indicated that among different hybrids, Sugar 75 recorded significantly higher number of grains per cob, average cob weight with and without husk and the data presented in Table 2 revealed that hybrid Sugar 75 recorded significantly higher average cob length with and without husk and average cob girth with and without husk, green cob yield (Fig.3) and green fodder yield (Fig. 3). However hybrids had no effect on number of cobs per plant. Hybrid FSCH 75 recorded significantly lower values of all the yield attributes. Significant differences observed among yield attributes with respect to sweet corn hybrids might be due to the differences in the genetic character of the varieties. Higher green cob yield and green fodder yield with hybrid sugar 75 could be attributed to the higher yield attributes recorded by hybrid Sugar 75. The results are supported by findings of Ravi *et al*. (2012), Jeet *et al.* (2012) and Kien *et al.* (2009).

The experimental findings revealed that different zinc levels significantly influenced yield attributes and yield of sweet corn. Data presented in Table 1 indicated that among zinc levels, soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage produced significantly higher number of grains per cob, average cob weight with and without husk. whereas data presented in Table 2 revealed that among zinc levels, soil application of $ZnSO_4$ @ 15 kg ha^{-1} + $ZnSO_4$ (0.5%) foliar spray at knee high stage produced significantly average cob length with and without husk, average cob girth with and without husk, green cob yield (Fig. 4) and green fodder yield (Fig. 4) whereas zinc level, $ZnSO_4$ @ 15 kg ha^{-1} + ZnSB @ 200 ml/kg of seed recorded significantly lower values of all the yield attributes and yield.

However, zinc levels had no effect on number of cobs per plant. Zinc has main role in pollination process, formation of male and female reproductive organs and grain formation process (Ziaeyan and Rajaie, 2009). Farajzadeh *et al.,* (2009) declared foliar application of microelements acquitted all maize necessities and had the greatest influence on yield.

Table 1: Effect of different maize hybrids and Zinc levels yield attributes of Sweet corn (*Zea mays saccharata*)

Treatment	No. of cobs plant^{-1}	No. of grains cob^{-1}	Avg.cob weight With Husk(g)	Avg.cob weight Without Husk(g)
Hybrid (Varieties)				
Sugar 75	1.48	480.14	388.33	266.33
FSCH 75	1.43	420.58	355.75	255.92
CMVL SC	1.42	449.08	369.75	260.42
SEm±	**0.05**	**3.38**	**2.09**	**3.06**
CD ($p \leq 0.05$)	**NS**	**9.99**	**6.16**	**9.04**
$ZnSO_4$ levels				
20 kgha^{-1}	1.47	472.96	355.56	240.22
15 Kg ha^{-1}+ $ZnSO_4$(0.5%) Spray at knee high stage	1.51	500.98	369.56	250.45
15 Kg ha^{-1}+$ZnSO_4$ (0.5%) Spray at tasseling stage	1.44	489.29	358.33	243.89
15 Kg ha^{-1}+ZnSB@ 200 ml/kg of seed	1.36	364.89	350.00	238.56
SEm±	**0.06**	**3.91**	**2.41**	**3.54**
CD ($p \leq 0.05$)	**NS**	**11.53**	**7.12**	**6.13**

Table 2: Effect of different maize hybrids and Zinc levels yield attributes and yield of Sweet corn (*Zea mays saccharata*)

Treatment	Avg .cob length (cm) With Husk	Avg. cob length (cm) Without Husk	Avg. cob girth (cm) With Husk	Avg. cob girth(cm) Without Husk	Green Cob Yield (q ha^{-1})	Green Fodder Yield (q ha^{-1})
Hybrid (Varieties)						
Sugar 75	23.51	20.41	19.29	14.12	205.10	385.38
FSCH 75	15.76	13.15	15.17	11.63	160.28	284.33
CMVL SC	20.74	17.52	17.31	13.17	170.08	301.58
SEm±	**0.28**	**0.24**	**0.24**	**0.30**	**1.84**	**1.98**
CD ($p \leq 0.05$)	**0.83**	**0.69**	**0.70**	**0.89**	**5.43**	**5.83**
$ZnSO_4$ levels						
20 $kgha^{-1}$	19.24	17.17	17.34	13.61	174.20	325.**77**
15 Kg ha^{-1} + $ZnSO_4$(0.5%) Spray at knee high stage	21.34	19.87	19.73	15.95	188.40	358.56
15 Kg ha^{-1} +$ZnSO_4$ (0.5%) Spray at tasseling stage	18.95	15.48	16.73	12.29	165.20	310.59
15 Kg ha^{-1} +ZnSB	17.15	14.59	15.23	11.88	154.10	300.15
SEm±	**0.32**	**0.27**	**0.27**	**0.34**	**2.12**	**2.28**
CD ($p \leq 0.05$)	**0.96**	**0.80**	**0.81**	**1.02**	**6.27**	**6.73**

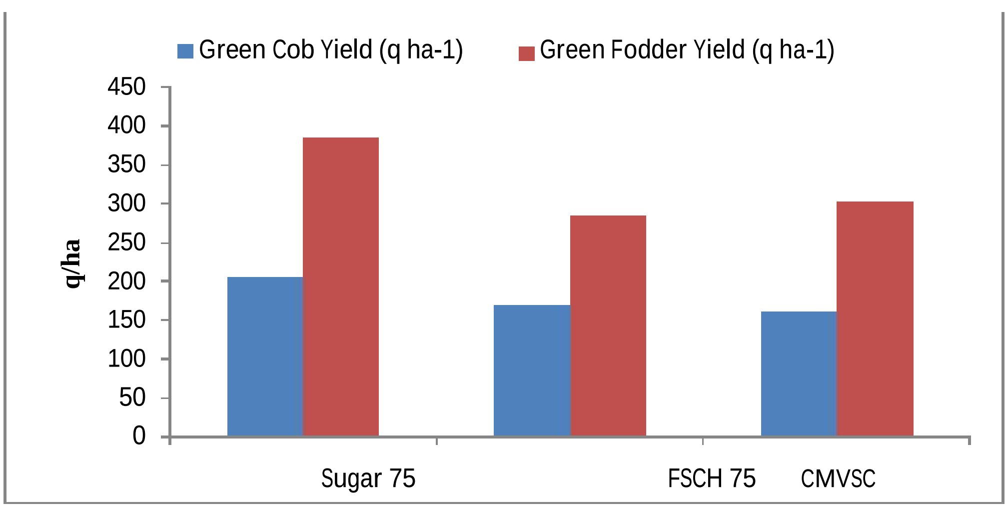

Fig. 3: Effect of hybrids on green cob yield and green fodder of sweet corn

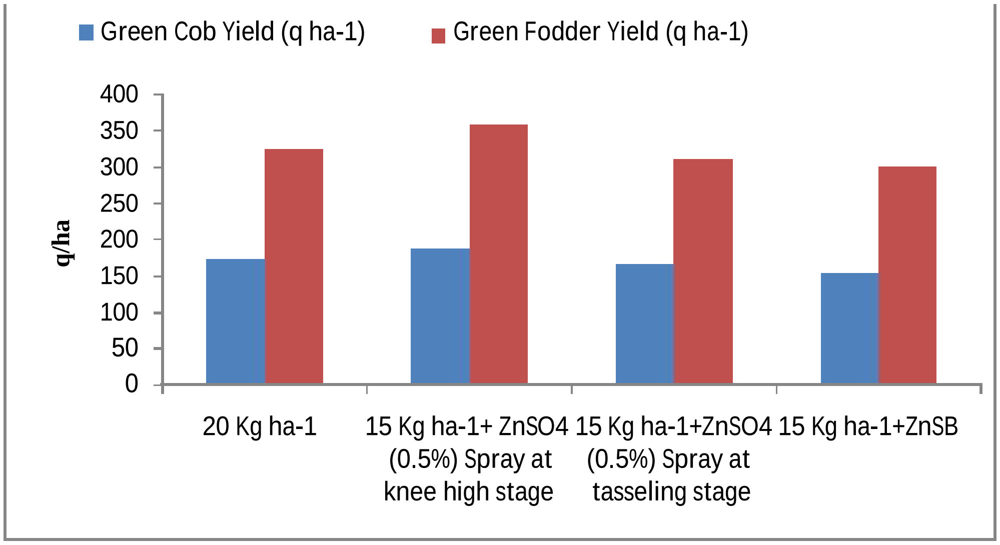

Fig. 4: Effect of different zinc levels on green cob and green fodder yield of sweet corn

ECONOMICS

Economics in terms of net returns and benefit cost ratio with respect to green cob yield and green fodder yield of sweet corn hybrids was worked out for various treatment combinations. It is evident from the data (Table 3) that highest net returns and benefit cost ratio of 466230.5 and 4.37, respectively was realised by sugar 75 hybrid which was applied with zinc level of 15 Kg ha^{-1} + $ZnSO_4$ (0.5%) spray at knee high stage (T2). The lowest net returns and benefit cost ratio of 294742.5 and 2.76, respectively was recorded by hybrid FSCH 75 which was applied with zinc level 15 Kg ha^{-1} + ZnSB (T12). Sugar 75 hybrid produced higher green cob yield and green fodder yield which resulted in higher economic returns and higher B:C ratio. Higher level of biomass accrual and efficient translocation to the reproductive parts due to supply of adequate Zn fertilizers for different corns might be responsible for the production of elevated yield attributes, yield which resulted in higher monetary returns and B: C ratio. Similar results were also reported by Choudhary *et al.* (2012) and Singh *et al.* (2012).

Table 3: Effect of different maize hybrids and zinc levels on relative economics

Treatments	Cost of Cultivation ₹ha^{-1}	Gross Returns ₹ha^{-1}	Net Returns ₹ha^{-1}	B : C Ratio
T1	106705	554041.5	447336.5	4.19
T2	106461	572691.5	466230.5	4.37
T3	106461	562668	456207	4.28
T4	106625	514300	407675	3.82
T5	106705	445774	339069	3.28
T6	106461	459680	353219	3.32
T7	106461	426116	319655	3.00
T8	106625	418525	311900	2.93
T9	106705	448740.5	342035	3.21
T10	106461	508189.5	401728.5	3.17
T11	106461	405450	298989	2.81
T12	106625	401367.5	294742.5	2.76

CONCLUSION

From the findings of the present investigation it can be concluded that in order to achieve higher yield and economics of sweet corn, the hybrid Sugar-75 applied with recommended dose of fertilizer along with the application of ZnSO4 @ 15 Kg ha^{-1} (soil) + $ZnSO_4$ (0.5%) Spray at knee high stage is suitable.

References

Cakmak I.. Enrichment of fertilizers with zinc: An excellent investment for humanity and crop production in India. Journal of trace elements in medicine and biology. 2009; 23: 281-289

Choudhary M, Verma A and Singh H. Productivity and economics of maize as influenced by phosphorus management in south Rajasthan. Annals of Agricultural Research. 2012; 33 (1 &2): 88-90.

Directorate of Economics and Statistics, (2019).

Farajzadeh MT, Khorshidi MB, Ahmadzadeh V. Effect of micronutrients and their application method on yield, crop growth rate and net assimilation rate of corn. The Journal of Food, Agriculture and Environment. 2009; 7: 611-615.

Food and Agriculture Origanisation, (2019).

Gopalan C, Sastri RBV and Balasubramanian SC. Nutritive value of Indian foods, 1999. NIN, ICMR, Hyderabad

Jaliya MM, Falaki AM, Mahmud M, Abubakar IU and Sani YA. Response of Quality Protein Maize (QPM) (Zea Mays L.) to sowing date and NPK fertilizer rate on yield & yield components of Quality Protein Maize. Savannah Journal of Agriculture. 2008; **3**: 24-35.

Jeet S, Singh JP, Kumar R, Prasad RK, Kumar P, Kumari A and Prakash, P. Effect of nitrogen and sulphur levels on yield, economics and quality of QPM hybrids under dry land condition of eastern uttar pradesh, India. Journal of Agricultural Sciences. 2012; 9: 31-38.

Kien TT, Hao PX and Khiem DT. Effect of N, P, K dosages on grain yield and protein quality of QPM variety QP4 and normal maize variety LVN10 in Thainguyen, Vietnam. Proceeding of the Tenth Asian Regional Maize Workshop. 2009; 552-556.

Najeeb S, Sheikh FA, Ahangar MA and Teli NA. Popularization of sweet corn under temperate condition to boost the socioeconomic condition. Main Genetics Cooperation Newsletter. 2011. **85**: 174-180.

Ravi N, Basavarajappa R, Chandrashekar CP, Harlapur SI, Hosamani MH, and Manjunatha MV. Effect of integrated nutrient management on growth and yield of quality protein maize. Journal of Agricultural Sciences**.** 2012; 25(3): 395-396.

Sentayehu A. Protein, tryptophan & lysine contents in Quality Protein Maize, North India. Ethiopia. Journal of Health Sciences**.** 2008; 18(2): 9-15.

Singh 2010. Detrimental effect of zinc deficiency on crops productivity and human health. First Global Conference on Biofortification, Harvest Plus, Washington, USA.

Singh MV and Sampath KT. Micronutrient status in farms of India and their effect on health and productivity. Proceedings 10th NAAS Congress, held, Lucknow, 11-13 Feb. 2011.

Singh R, Singh T and Soni RL. Enhancement in the productivity of maize through integrated balanced nutrient management in banswara district. Annals of Agricultural Research**.** 2012; 33(1 &2): 14-16.

Ziaeyan AH and Rajaie M. Combined effect of zinc and boron on yield and nutrients accumulation in corn. International Journal of Plant Production.2009; 3: 33-45.