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Production potential of sweet corn (*Zea mays saccharate*var.) as influenced by different levels of nitrogen and zinc

DIKSHA SETHI, KAMALESH KUMAR AND LAKHWINDER SINGH
General Shivdev Singh Diwan Gurbachan Singh Khalsa College, Patiala, 147001

Abstract

*A field experiment on "Production potential of sweet corn (*Zea mays saccharata*var.) as influenced by different levels of nitrogen and zincwas conducted at Campus for Research and Advanced Studies, Dhablan. The experiment was conducted in Factorial randomized block design and replicated thrice. The treatment consisted of three levels of zinc ($Z_1 Z_2 Z_3$) and four levels of nitrogen ($N_0 N_1 N_2 N_3$) in plots. zinc levels significantly influenced the growth, yield parameters and economics of sweet corn crop. All the growth parameters like plant height (182.25cm), number of leaves plant^{-1} (10.59), fresh weight (691.53 g), dry weight (225.85 g), LAI (2.66) were significantly higher in zinc 30 kg ha^{-1} and nitrogen 120 kg ha^{-1}. The yield attributes like number of cobs plant^{-1} (3.08) also highest and the maximum cob yield (135.11 q ha^{-1}), fodder yield (204.65 q ha$^{-1)}$ with zinc 30 kg ha^{-1} and nitrogen 120 kg ha^{-1}. Economics Study i.e. the B:C ratio was maximum (Rs.3.26) at zinc 20 kg ha^{-1} and nitrogen 120 kg ha^{-1} as compared to all other treatments.*

Keywords: sweet corn, Nitrogen levels, Zinc levels

Introduction

Sweet corn (*Zea mays saccharata* var.) is firstly recorded by Iroqious in 1779 to European settlers where the sweet corn is called 'papoon'. The native of sweet corn is America. It is the most important cereal crop in the world of agriculture and also has very high yield potential so , that's why it is called 'queen of cereals'. It belongs to family poaceae. It ranks third as a food grain followed by wheat and rice. It accounts 23 %of total area about 9.43 mha with a production of 24.35 and average productivity is 2583 kg ha. In Punjab (2019-20) cultivated area is 31 ha , production is 45.9 tonnes with yield of 1482 kg ha. After addition to staple food, for quality feed for human consumption and also used for industrial purposes like gum , cosmetic , film , textile , paper industries, alcohol beverages, pharmaceutical (Chaudhary *et al.* 2013). It has high economic value because of high sugar content as compare to other corn varieties. According to (Lingaa *et al.* 2008) carbohydrate 22.8 g , protein 3.5 g , lipid 1.0 g, fibre 2.1 g and water 72.7 g. (Kwiastkowski *et al.* 2011) It belongs to same species as field corn but the basic difference is that the saccharata group has capability to blocking sugar conversion to starch due to mutant alleles and also the total contents in seeds will increase (Jha *et al.*2016) .It can produce seeds with low starch contents and high sugar contents And at maturity level the polysaccharide content is greater in the grains of sweet corn .It is cultivated mainly to energy generation by plant biomass and also for use its fruits i.e ear for human consumption (Rios *et al.* 2015).It is grown during all the seasons because of its good mechanism of photoperiodism and ability to adapt it.

Materials and Methods

P.G. Department of Agriculture, G.S.S.D.G.S. Khalsa College, Patiala, during *rabi* season of 2021. The experimental soil of field was clayey in texture with ph of 7.4. For record the observations selecting 5 plants from each plot and tagged. Then observed the growth parameters i.e.

plant height with scale, no. of leaves, fresh weight by cutting the plant and weighing, LAI. and yield attributes i.e. no. of cobs plant $^{-1}$, cob length, no. of grains, cob weight, cob yield, fodder yield by weighing balance also observed and economic studies gross returns calculated by the cob yield and its price and net returns.

Results and Discussion

Effect of zinc and nitrogen on growth and growth parameters

The study showed that various growth characters viz. plant height, no. of leaves, fresh weight, LAI were significantly influenced by different levels of zinc and nitrogen.

Plant height

The maximum plant height was recorded with the interaction of zinc 30 kg ha^{-1} and nitrogen 120 kg ha $^{-1}$ which is at par with the 20 kg Zn ha^{-1} at 60 DAS. (Table 1). The height was increase with zinc and nitrogen application because zinc activates the metabolic enzymes including Carboxylase hydrogenase and speeds up the cell division which increase the stem elongation and nitrogen is component of chlorophyll, then the photosynthesis will increase which enhance the vegetative growth of plant. Similar results were also found by the Panneerselvam and Stalin (2014). Amanullah *et al.* 2014 also conformity the result that higher the nitrogen levels indicate maximum vegetative growth under higher nitrogen availability.

Table 1: Effect of nitrogen and zinc on plant height of sweet corn

	N0	N1	N2	N3	Mean
Z1	511.5	521.3	526.1	532.6	174.29
Z2	525.5	531.4	528.1	550.7	178.06
Z3	526.4	531.6	550.6	566.7	181.17
Mean	173.71	176.03	178.31	183.33	

Notation:

N_0 - 0 kg ha $^{-1}$ Z_1 - 10 kg ha^{-1}

N_1 - 40 kg ha $^{-1}$ Z_2 - 20 kg ha^{-1}

N_2 - 80 kg ha $^{-1}$ Z_3 - 30 kg ha^{-1}

N_3 - 120 kg ha $^{-1}$

No. of leaves plant $^{-1}$

This data observed the maximum no. of leaves plant^{-1} was observed at 30, 60 and at harvest with the application of zinc 30 kg ha^{-1} and interaction of nitrogen 120 kg N ha $^{-1}$which is at par with the 20 kg Zinc ha^{-1} and 80 kg nitrogen ha^{-1}(Table 2). This is might due the more number of leaves obtained with zinc application which synthesis of chlorophyll from which photosynthesis is increased. Jangir *et al.* (2015) reported that significance response of zinc in terms of growth attributes and with the nitrogen sends the leaf elongation and expansion growth by regulating the rate of cell division and cell size. Rasheed *et al.* (2014) also confirmed the same results.

Table 2: Effect of nitrogen and zinc on no. of leaves plant^{-1}

	N0	N1	N2	N3	Mean
Z1	23.9	26.0	27.8	29.3	8.91
Z2	26.6	26.8	27.0	28.2	9.28
Z3	27.0	27.2	29.0	41.6	10.16
Mean	8.61	8.89	9.31	11.01	

Fresh weight (g)

The maximum fresh weight was found with the interaction of zinc and nitrogen i.eof zinc 30 kg ha ^{1}and nitrogen 120 kg ha^{-1} and at harvest which was at par with the 20 kg Zn ha^{-1} at 30 DAS Table 3). The reason behind this is due to the synthesis of growth hormones (IAA and auxins) and proteins which helps in increasing the fresh weight of sweet corn. Ravi *et al.* 2012 also found the same result that the fresh weight was increase with increase in zinc levels and nitrogen gives the better nourishment of nutrient to plant which gives the vigorous vegetative growth and succulency to plant. The same results were obtained by Inamullah *et al.* 2011 that the increase in level significantly increase the fresh weight of plant.

Table 3: Effect of different nitrogen and zinc on fresh weight (g) of crop

	N0	N1	N2	N3	Mean
Z1	1577.9	1937.2	1934.0	2019.3	622.37
Z2	1925.2	1963.1	1867.5	1958.0	667.64
Z3	1968.7	1988.8	2165.4	2344.4	680.78
Mean	607.98	654.35	663.00	702.41	

Dry weight (g)

By the application of zinc and nitrogen the dry weight is increase. The maximum dry weight was obtained with the combination of zinc 30 kg ha^{-1} and 120 kg N ha^{-1} which was at par with the 20 kg Zn ha^{-1} at 30 DAS (Table 4). This is might due to vigorous growth of plant from which all the growth parameters i.e. plant height, no. of leaves, fresh weight is increase so, that the dry weight will also increase. The similar findings were found by Adiloglu 2007 and nitrogen tends to the greater accessibility of photosynthates which developed the vegetative growth of plant which significantly increase the dry weight of plant. Similar results were found by Mohassel (2000) who observed that by increase in level of nitrogen significantly increase the growth parameters.

Table 4: Effect of different levels of nitrogen and zinc of dry weight (g)

	N0	N1	N2	N3	Mean
Z1	454.4	621.8	618.3	649.6	195.34
Z2	656.2	645.9	639.6	710.3	221.95
Z3	664.0	649.6	675.3	722.7	225.01
Mean	197.18	213.04	214.80	231.40	

Leaf Area Index

At all the growth stages leaf area index was consistency increase with increase in zinc and nitrogen levels. So, the maximum leaf area index was observed with combination of zinc 30 kg ha^{-1}and nitrogen 120 kg ha^{-1} which was at par with the combination of 20 kg Zn ha^{-1} and 80 kg N ha^{-1}at 30DAS, 60 DAS and at harvest respectively. The leaf area increases due to the production of tryptophan and amino acids proteins and chlorophyll which plays a great role in leaf area expansion. Wasaya *et al.* (2017) also confirmed these results that the zinc application gave the significant results in leaf area expansion. For better growth of leaves nitrogen is very decisive nutrient . Leaf area index was influenced by different levels of nitrogen at all stages. Increase or decrease in leaf area directly effects on plant growth rate. It enhances photosynthesis capacity and assimilate production. Bindhani *et al.* 2005 also investigated the same results that the leaf area significantly increases with increase in nitrogen application.

Effect of zinc on Yield and yield attributes

No. of cobs plant^{-1}

The maximum number of cobs plant^{-1} was obtained with the combination of 30 kg Zn ha^{1} and 120 kg N ha $^{-1}$ which was superior over the other treatments (Table 5). The similar findings were confirmed by Jat *et al.* (2009). This is due to the photosynthesis activity which results to better growth and development and enhance the number of cobs per plant and nitrogen influence more of vegetative and reproductive growth with higher nitrogen levels and gives more cobs plant^{-1}. Pradhan *et al.* (2007) also investigated the same results.

Table 5: Effect of nitrogen and zinc on no. of cobs^{-1} of sweet corn

	N0	N1	N2	N3	Mean
Z1	4.1	4.8	6.2	8.7	1.98
Z2	5.3	5.6	6.1	6.8	2.03
Z3	6.2	6.8	6.7	14.6	2.81
Mean	1.73	1.92	2.11	3.35	

No. of grains cob^{-1}

The maximum number of grains was obtained with the application of zinc 30 kg ha^{-1} interaction with nitrogen 120 kgha^{-1}. This is due to the translocation of nutrients. This similar result was found by Jat *et al.* 2009 that the increase in level of zinc up to 30 kg ha^{-1} increase the no. of grains cob^{-1}. This is due to the better nourishment to crop which convert more photosynthesis into sink. Pandey *et al.* 2010 was also confirmed these results the nitrogen levels significantly increase the number of grains in cob.

Table 6: Effect of different nitrogen and zinc on no. of grains cob^{-1}

	N0	N1	N2	N3	Mean
Z1	975.3	1253.7	1326.5	1301.5	428.00
Z2	1275.2	1291.8	1348.9	1601.1	467.04
Z3	1310.8	1300.5	1392.2	1862.6	481.54
Mean	300.69	427.33	451.96	529.46	

Cob length (cm)

The maximum cob length was obtained with the application of zinc 30 kg ha^{-1}with nitrogen 120 kg ha^{-1}.This is due to the chlorophyll contents which gives the positive effect on photosynthesis activity (Table 7). The results were also confirmed by the Thavaprakash *et al.* 2008 and Jat *et al.* 2009 and nitrogen acts a positive correlation between the nitrogen application and cob length. The same results were showed by Ahmed *et al.* 2018.

Table 7: Effect of different levels of nitrogen and zinc on cob length

	N0	N1	N2	N3	Mean
Z1	51.2	51.0	51.0	57.0	17.51
Z2	48.7	55.0	53.0	60.9	18.64
Z3	49.8	58.8	63.8	90.9	21.84
Mean	16.62	18.31	19.20	23.20	

Weight of cob^{-1} (g)

The maximum cob weight was observed with application of zinc 30 kg ha^{-1}and nitrogen 120 kg ha^{-1}which was at par with the 20 kg Zn ha^{-1}+ 80 kg N ha^{-1} (Table 8). This is due to the positive effect of photosynthesis which helps to produce the well-developed and bold grains which enhance the weight of cob. Asif *et al.*2013 confirmed this finding exclusively.

In the nitrogen finding, this is due to the optimum supply of nitrogen is crucial for the activity of several enzymes which helps in enhance the cob weight. Asif. *et al.* 2013 investigated the similar results.

Table 8: Effect of nitrogen and zinc on weight cob^{-1}

	N0	N1	N2	N3	Mean
Z1	435.9	472.1	482.9	476.3	155.61
Z2	458.6	472.9	483.2	528.2	164.50
Z3	477.4	491.2	496.1	578.6	167.68
Mean	152.44	159.58	162.47	175.90	

Cob yield (q ha^{-1})

The maximum cob yield was found with the application of zinc 30 kg ha^{1}interaction with nitrogen 120 kg ha^{-1}ahawhich significantly increase the cob yield (Table 9). This is due to the photosynthesis activity which enhance several enzyme activities i.e. ribulose 1-5 diphosphate, carboxylase which helps in increasing the cob yield. Arya and Singh (2000) conducted the same results as well. Nitrogen enhances the photosynthesis activity from which all yield attributes i.e. no. of grains, cob weight, cob length which significantly increase the cob yield.

Sahoo and Panda (1999) noticed the similar results that higher the nitrogen levels significantly increase the cob yield.

Table 9: Effect of different levels of nitrogen and zinc on cob yield

	N0	N1	N2	N3	Mean
Z1	308.6	373.0	467.2	335.7	123.70
Z2	318.4	324.9	328.3	525.5	126.33
Z3	391.0	411.2	393.0	525.5	130.80
Mean	113.11	123.23	132.05	139.41	

Fodder yield (q ha^{-1})

The maximum fodder yield with the application of zinc 30 kg ha^{-1}and nitrogen 120 kg ha^{-1} which was significantly increase the fodder yield. This is due to the respective level of nutrient which results in higher production of green fodder by the translocation of photosynthates and more photosynthesis assimilation which leads to the higher fodder yield. Thavaprakash *et al.* (2008) and Bunker *et al.* (2013) also reported the same results.

Ghodpage *et al.* (2008) also confirmed this results that significantly increase the fodder yield with increase the nitrogen level.

Biological yield (q ha^{1})

The maximum biological yield (327.02 q ha^{-1}) was recorded with the application of zinc 30 kg ha^{1}and nitrogen 120 kg ha^{-1}a 1 hajnjjk. This is due to the higher cob yield and fodder yield which automatically gives higher biological yield and nitrogen gives more photosynthesis activity for longer period which enhance the leaf area index and crop growth rate which leads to the higher biological yield. Ayub *et al.*2003 investigated the same results.

Harvest index (%)

The maximum harvest index was found with the nitrogen level 10 kg Zn ha^{-1} and nitrogen level 0 kg ha^{-1} which was remaining at par with the 30 kg

Zn ha^{-1}+ 40 kg N ha^{1} and 20 kg Zn ha^{-1}+ 80 kg N ha^{-1}. The result was non-significant to other treatments. Azab 2015 also reported the same findings.

Economics studies

Gross Returns (Rs. ha^{-1})

The highest gross returns were obtained with 20 kg Zn ha^{-1}with 120 kg N ha^{-1}. This is due to the different levels of zinc effected the economics .This is due to the significant effect of higher yield at higher levels of nitrogen. Adhikari *et al.* 2005 .and Mahdi *et al.*2012 also shows the same economic results.

Table10: Effect of N and Zn on economics of sweet corn

	N0	N1	N2	N3	Mean
Z1	8.1	9.7	12.2	8.3	3.19
Z2	9.6	7.9	7.8	13.2	3.20
Z3	7.3	9.4	8.6	8.5	2.81
Mean	2.77	3.00	3.17	3.33	

Net Returns (Rs. ha^{-1})

The maximum net returns with application of zinc 20 kg ha^{-1} with 120 kg ha^{-1} and this is due to the cost of cultivation and the result due to the cost of cultivation is lower than the net returns are higher.

Benefit cost ratio (B:C ratio)

Highest B:C ratio was found with combination of 20 kg Zn and 120 kg N ha^{-1} which was at par with the 10 kg Zn ha^{-1} was observed the same economics studies. Adhikari *et al.* 2005 and Meena *et al.* 2013 was also obtained same results.

Conclusion

The experiment "Production potential of sweet corn (*Zea mays saccharata*var. as influenced by different levels of nitrogen and zinc conducted during 2021 at Dhablanfarm, Department of Agronomy, G.S.S.D.G.S Khalsa college Patiala showed the best performance in treatment T12 (30 kg Zn ha^{-1} + 120 kg N ha^{-1}) in case of all growth and yield attributes. But in case of economics the higher gross returns, net returns and B:C ratio was found with T11 (20 kg Zn ha^{-1} + 120 kg N ha^{-1}) as compared to all other treatments.

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