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Effect of zinc application on growth and yield of baby corn (*Zea mays* L.) in lateritic soil of West Bengal

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Abstract
A field experiment was conducted during *rabi* season of 2017-18 at agricultural farm, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, West Bengal, to study the "Effect of zinc application on growth, yield and economics of baby corn (*Zea mays* L.) in lateritic soil of West Bengal". The experiment was laid out in Factorial RBD having two factors: one with two levels of soil application of $ZnSO_4$; 0 and 25 kg ha^{-1} and other with four levels of foliar spray of $ZnSO_4$; no foliar spray, 25 DAS, 40 DAS and twice at 25 DAS & 40 DAS. There were eight treatment combinations with each treatment replicated thrice. Soil application of $ZnSO_4$ @ 25 kg ha^{-1} exhibited significantly higher growth attributes (viz. plant height, number of leaves/plant, LAI, dry matter accumulation, crop growth rate) and yield attributes (viz. number of cobs per plant, corn and cob weight, corn and cob length, corn and cob girth and also corn yield, cob yield, husk yield and green fodder yield) of baby corn, than no soil application of $ZnSO_4$. Foliar spray of $ZnSO_4$ applied twice at 25 DAS & 40 DAS gave the highest yield components and yield in baby corn. However, this was statistically at par with foliar spray of $ZnSO_4$ at 40 DAS and 25 DAS. Combined soil application of $ZnSO_4$ @ 25 kg ha^{-1} and foliar spray twice at 25 DAS & 40 DAS interacted significantly and produced higher number of cobs per plant, number of cobs per hectare of baby corn cultivation. This was at par with soil application of $ZnSO_4$ at 25 kg ha^{-1} and foliar spray at 40 DAS and significantly higher than foliar spray at 25 DAS.

Keywords: Baby corn, zinc application, growth and yield

Introduction
Baby corn (*Zea mays* L.) being one of the most important dual purpose crop is grown widely round the year for its cob as well as green fodder in India. It has an edge over the other cultivated fodder crops due to its higher production potential, wider adaptability, fast growing nature and excellent fodder quality free from toxicants. Baby corn production has been directly integrated with dairying farms in different countries because only 13-20% of fresh ear weight is used as human food and the rest (silk, husk and green stalk) can be used as excellent feed materials for milch ruminants to improve their productivity. Baby corn is the dehusked young cobs harvested within 2-3 days of silk emergence and are consumed as vegetable due to its sweet flavour. Baby corn has high contents of folate as well as vitamin 'B' and also good source of several other nutrients. Being a short duration crop (50-60 days) it can be sown and harvested 3 to 4 times in a year. One third of the world population is reported at the risk of malnutrition due to inadequate dietary intake of zinc (Cakmak, 2009) [6]. About 50 % of Indian soils are deficient in zinc causing low level of zinc and yield losses in fodder crops and affecting the health of the livestock (Singh, 2011) [13]. According to the recent survey, zinc deficiency in human nutrition is the most wide spread nutritional disorder, next to iron, vitamin 'A' and iodine. Nearly, 49% of the global population does not meet their daily-recommended intake of 15 mg day^{-1} of zinc for an adult.
Micronutrients can increase grain yield up to 50%, as well as increase macronutrients use efficiency. Among the micronutrients, Zinc has a key role as a structural constituent or regulatory co-factor of a wide range of enzymes and proteins in many important biochemical pathways and these are mainly concerned with carbohydrate metabolism, both in photosynthesis and in the conversion of sugars to starch, protein metabolism, auxin metabolism, pollen formation, maintenance of integrity of biological membranes and

resistance to infection by certain pathogens (Alloway, 2008). Zinc applications are used to increase micronutrient in edible parts to reduce the micro nutrient deficiency in human populations. Most research on soil and foliar application of zinc focused on alleviating its deficiencies, particularly on wheat and rice cultivated in semiarid or arid regions of the world (Alloway 2004, Cakmak 2008) [1, 5]. Zinc application is essential for keeping sufficient amount of available zinc in soil solution (by soil application of zinc) and in leaf tissue (by foliar application of zinc) which contributes to the maintenance of adequate root zinc uptake.

Materials and Methods

Field experiment was conducted at Agricultural farm, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, Birbhum, West Bengal during *rabi* season of 2017-18. The experimental site is geographically situated at $23^0$39' N latitude and $87^0$42' E longitude with an average altitude of 58.90 m above mean sea level under sub-humid, semiarid region of West Bengal. Soil of the experimental plot was sandy loam in texture, acidic in nature (pH 5.65), medium in soil organic carbon (0.38%), available P (28.51 kg ha^{-1}) and low in Available N (225.75 kg ha^{-1}), available K (148.62 kg ha^{-1}) and Total Zn content (0.48 ppm).

Experiment was laid out in Factorial Randomized Block Design (FRBD) and replicated thrice. Treatment comprised of soil application of $ZnSO_4$ at two levels *viz.* without soil application of zinc (control) and $ZnSO_4$ @ 25 kg/ha and Foliar spray of $ZnSO_4$ at four levels *viz*. control, 0, $ZnSO_4$@ 0.5% + 0.25 % lime at 25 DAS, $ZnSO_4$@ 0.5% + 0.25 % lime at 40 DAS and $ZnSO_4$@ 0.5% + 0.25 % lime twice at 25 DAS & 40 DAS, having 08 treatment combinations *i.e*. S0F0: Control (No $ZnSO_4$), S0F1: Foliar spray of $ZnSO_4$ @ 0.5% at 25 DAS, S0F2: Foliar spray of $ZnSO_4$ @ 0.5% at 40 DAS, S0F3: Foliar spray of $ZnSO_4$ @ 0.5% twice at 25 DAS and 40 DAS, S1F0: Soil application of $ZnSO_4$ @ 25 kg/ha, S1F1: Soil application of $ZnSO_4$ @ 25 kg/ha + Foliar spray of $ZnSO_4$ @ 0.5% at 25 DAS, S1F2: Soil application of $ZnSO_4$ @ 25 kg/ha + Foliar spray of $ZnSO_4$ @ 0.5% at 40 DAS, S1F3: Soil application of $ZnSO_4$ @ 25 kg/ha + Foliar spray of $ZnSO_4$ @ 0.5% twice at 25 DAS and 40 DAS. The organic source of nitrogen was farm yard manures (0.5% N, 0.2% P and 0.5% K) on N equivalent basis applied in one month before sowing the crop. Lime was applied in furrow two weeks prior to sowing as per the treatments. Baby corn hybrid KSP-1224 was sown with a seed rate of 25 kg ha^{-1} at spacing of 40 cm x 20 cm.

The recommended dose of N, P, K, S, Zn (100%RDF) represents 120-60-60 kg N, P, K, ha^{-1}. All the nutrients were applied in experimental plot as per treatment and incorporated into the soil thoroughly before sowing of the crop. Chemical fertilizers such as nitrogen, phosphorus (P_2O_5) and potassium (K_2O) were applied from Urea, SSP and MOP, respectively as per treatment. One third quantity of nitrogen and full quantity of phosphorus and potassium were applied as basal during sowing time. One third quantity of nitrogen was top dressed at 30 DAS and rest One third quantity of nitrogen was top dressed at 45 DAS. $ZnSO_4$ was applied at the time of sowing in soil and foliar spray was done at 25 DAS and 40 DAS. Immature baby cobs were harvested within 2-3 days after silk emergence and same were weighed, dehusked and baby corn yield was recorded. After final picking, crop was harvested for green fodder and its yield was recorded. Observations on growth attributes *viz.*, plant height, number of green leaves per plant, dry matter accumulation (g/m^2), leaf area index (LAI) and crop growth rate (CGR) were measured at various stages of growth during field experimentation. Observations on yield attributes, corn yield, cob yield, husk yield and green fodder yield were recorded as the standard procedure. Data were statistically analysed as suggested by Panse and Sukhatme (1978) [10].

Result and Discussion

Growth characters

The growth attributes *viz.*, plant height, number of leaves per plant, dry matter accumulation, leaf area index (LAI) and crop growth rate (CGR) were significantly influenced by different zinc application treatments (Table. 1). Soil application of $ZnSO_4$ @ 25 kg ha^{-1} recorded higher growth attributes i.e. taller plant height (176.91 cm), maximum number of leaves (13.69), leaf area index (3.64) and dry matter accumulation(431.78 gm^2) which is comparable with no soil application of $ZnSO_4$. Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS recorded higher growth attributes i.e. taller plant height (176.28 cm), maximum number of leaves (13.77), leaf area index (3.64) and dry matter accumulation (433.94 gm^{-2}) which is comparable with no foliar spray of $ZnSO_4$, Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS, Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS. Whereas there was no significant interaction between soil application and foliar spray of $ZnSO_4$ at various levels on the growth attributes of baby corn. Increase might be due to rapid division and elongation of cells with balanced and adequate NPK supply, which seemed to be the reason behind the favourable influence on all the growth attributes of baby corn (Rakesh Kumar and Bohra, 2014) [11].

Baby cob, baby corn and green fodder yield

The yield attributes *viz.*, number of cobs per plant, cob and corn weight, cob and corn length, cob and corn girth were significantly influenced by different zinc application treatments (Table. 2). Soil application of $ZnSO_4$ @ 25 kg ha^{-1} recorded significantly higher yield attributes i.e. number of cobs per plant (3.05), cob weight (45.03 g cob^{-1}), corn weight (8.28 g cob^{-1}), cob length (22.07 cm), corn length (8.19 cm), cob girth (7.47 cm) and corn girth (4.30 cm) over control (no zinc). Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS recorded higher yield attributes i.e. number of cobs per plant (2.85), cob weight (45.52 g cob^{-1}), corn weight (8.32 g cob^{-1}), cob length (22.56 cm), corn length (8.31 cm), cob girth (7.54 cm) and corn girth (4.25 cm) The increase in yield attributes due to application of zinc was caused by higher chlorophyll contents, and this had apparently a positive effect on photosynthetic activity, synthesis of metabolites and growth-regulating substances, oxidation and metabolic activities and ultimately better growth and development of crop, which led to increase in yield attributes of baby corn. The results were in conformity with Meena *et al.* (2013) [8], Rakesh Kumar and Bohra (2014) [11] and Shivay & Prasad (2014) [12].

Highest yields *viz.*, corn yield, cob yield, husk yield and green fodder yield (Table. 3) was found with soil application of $ZnSO_4$ @ 25 kg ha^{-1} which is comparable with no soil application of $ZnSO_4$. Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS recorded higher yield attributes. Similar results was also recorded by Aravinth *et al.* (2011) [3] and Rakesh Kumar and Bohra (2014) [11]. Yield is an ultimate end product of many yield contributing components, physiological and morphological processes taking place in plants during growth and development (Mona, 2015) [9]. Zinc application

has beneficial effect on physiological process, plant metabolism and plant growth, which leads to higher yield. Increase in green fodder yield might be due to the enhanced translocation of photosynthates with applied zinc, which resulted in higher production of green fodder in the respective levels of nutrient. Similar results of significantly higher fodder yield with Zn application was also reported by Mahdi *et al.* (2012) [7], Balwinder Kumar *et al.* (2013) [4] and Mona (2015) [9].

Conclusion

It is concluded that among different zinc application treatments studied in baby corn soil application of $ZnSO_4$ @ 25 kg ha^{-1} recorded significantly higher growth attributes *viz.*, plant height, number of leaves per plant, dry matter accumulation, leaf area index (LAI) and crop growth rate (CGR) over control no zinc application. Similarly, growth attributes was also reported with foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS which is showed higher palatability. Significantly higher corn yield, cob yield and green fodder yield resulted with soil application of $ZnSO_4$ @ 25 kg ha^{-1} over control no zinc application. Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS showed significantly higher palatability. The present experimental study suggested that foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS is better for improving quality of baby corn and also corn yield, dry matter yield and green fodder yield.

Table 1: Plant height (cm), No. of leaves/plant, Leaf Area Index, Dry matter accumulation (g/m^2) as influenced by zinc application

Treatment	Growth attributing characters			
Soil application(kg ha^{-1})	**Plant height (cm)**	**No. of leaves $plant^{-1}$**	**Leaf Area Index**	**Dry matter accumulation (g/m^2)**
0	165.02	12.99	3.19	390.04
25	176.91	13.69	3.64	431.78
S Em (±)	2.53	0.18	0.08	7.14
CD (p=0.05)	7.66	0.55	0.25	21.66
Foliar spray(DAS)				
No foliar spray	164.09	12.68	3.17	378.29
25	170.81	13.38	3.36	411.40
40	172.68	13.53	3.49	420.02
25 & 40	176.28	13.77	3.64	433.94
S Em (±)	3.57	0.26	0.11	10.10
CD (p=0.05)	10.83	0.78	0.35	30.63
Interaction (Soil×Foliar)				
S Em (±)	5.05	0.36	0.16	14.28
CD (p=0.05)	NS	NS	NS	NS
CV (%)	5.12	4.72	8.21	6.02

Table 2: Number of cobs $plant^{-1}$, cob and corn weight, cob and corn length and cob and corn girth as influenced by zinc application

Treatment	Yield attributing characters						
Soil application(kg ha^{-1})	**No of cobs $plant^{-1}$**	**Cob fresh weight(g)**	**Cob length (cm)**	**Cob girth (cm)**	**Corn fresh weight(g)**	**Corn length (cm)**	**Corn girth (cm)**
0	2.13	40.55	20.94	6.98	6.73	7.56	3.86
25	3.05	45.03	22.07	7.47	8.28	8.19	4.30
S Em (±)	0.06	0.80	0.34	0.11	0.12	0.12	0.06
CD (p=0.05)	0.18	2.42	1.03	0.33	0.35	0.36	0.19
Foliar spray(DAS)							
No foliar spray	2.05	39.35	20.45	6.82	6.72	7.49	3.89
25	2.68	43.03	21.38	7.31	7.40	7.80	4.14
40	2.77	43.27	21.65	7.23	7.58	7.91	4.03
25 & 40	2.85	45.52	22.56	7.54	8.32	8.31	4.25
S Em (±)	0.08	1.13	0.48	0.15	0.16	0.17	0.09
CD (p=0.05)	0.26	3.42	1.46	0.47	0.50	0.51	0.27
Interaction (Soil×Foliar)							
S Em (±)	0.12	1.59	0.68	0.22	0.23	0.24	0.13
CD (p=0.05)	0.36	NS	NS	NS	NS	NS	NS
CV (%)	8.04	6.45	5.47	5.21	5.35	5.27	5.45

Table 3: Cob yield, corn yield, green husk yield and green fodder yield as influenced by zinc application

Treatment				
Soil application(kg ha^{-1})	**Cob yield (Kgha^{-1})**	**Corn yield (Kg ha^{-1})**	**Green husk yield (t ha^{-1})**	**Green fodder Yield (t ha^{-1})**
0	11326.15	1874.06	10.53	22.27
25	17196.88	3167.40	14.16	29.34
S Em (±)	496.78	58.46	0.46	0.57
CD (p=0.05)	1506.83	177.31	1.41	1.73
Foliar spray(DAS)				
No foliar spray	10384.17	1788.33	9.66	22.02
25	14729.38	2547.29	12.63	25.89
40	15329.79	2705.42	13.07	27.14
25 & 40	16602.71	3041.88	14.03	28.16

S Em (±)	702.56	82.67	0.66	0.81
CD (p=0.05)	2130.98	250.76	1.99	2.44
Interaction (Soil×Foliar)				
S Em (±)	993.56	116.92	0.93	1.14
CD (p=0.05)	NS	NS	NS	NS
CV (%)	12.07	8.03	13.02	7.65

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