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EFFECT OF ZINC FERTILIZER DOSAGES ON GROWTH AND YIELD OF SPECIALITY CORN

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ABSTRACT

A field experiment entitled "Biofortification of Speciality corn with zinc" was conducted on sandy loam soils of Maize Research Center, Agricultural Research Institute, Rajendranagar during *kharif*, 2013 to study the effect of zinc nutrition in speciality corn. The experiment comprised of 18 treatments *viz.,* combination of three types of speciality corn [Popcorn, Sweet corn and Quality protein maize (QPM)] and six zinc levels [both soil and foliar application). The results revealed that three different types of corn and zinc levels significantly influenced growth parameters such as plant height, leaf area index(LAI), dry matter production and yield attributes such as cob number, number of grains per cob, cob girth and yield. Better growth and yield was registered with 25 kg $ZnSO_4$ ha^{-1}as soil application along with two foliar sprays i.e. at tasseling and milking stage. Sweet corn registered significantly higher number of cobs, longer cobs and maximum cob girth compared to QPM and popcorn. Number of grain rows per cob of popcorn was superior to QPM and sweet corn. Number of grains per row of QPM was significantly superior over popcorn and sweet corn. Green cob yield of sweet corn was significantly high and higher and lower grain yields were recorded with QPM and popcorn respectively. Likewise, sweet corn produced maximum green fodder yield compared to stover yield of QPM and popcorn.

KEYWORDS: Biofortification, popcorn, speciality corn, sweet corn, QPM, Zinc

INTRODUCTION

Maize (*Zea mays L.*) is emerging as third important cereal crop in the world after wheat and rice. It is called as "Queen of Cereals" due to the high productiveness, ease to process, low cost than other cereals (Jaliya *et al.*, 2008), besides serving as human food and animal feed with wide industrial application.

Speciality corn such as popcorn and sweet corn are popular snack foods whereas Quality Protein Maize (QPM) is important since it is enriched with tryptophan and lysine which provide nutritious food and feed for poultry, cattle. It also forms the basis as food material for poor people particularly for those with maize as staple food, thereby providing food and nutritional security.

Continuous intensive cropping of high yielding crop varieties has further aggravated the depletion of soil zinc leading to low zinc concentration in edible grains. Biofortification is a process in which plants are allowed to take up the minerals (Zn) from the soils and immobilize them in the grains so as to produce nutritionally rich grains that support dietary requirement of humans. Maize is high nutrient demanding crop but sensitive to zinc (Zn) deficiency in soil. Zinc deficiency in crops is the common problem world over; therefore, zinc malnutrition has become a major health burden among the resource poor people (Singh and Sampath, 2011). Application of Zn fertilizers could be a viable option to fulfill the crop demand for Zn and also to increase its content in grains. A field experiment was formulated to study the influence of soil and foliar applied Zn on the growth and yield of the speciality corn.

MATERIAL AND METHODS

A field experiment entitled "Biofortification with zinc in Speciality corn" was conducted during *kharif* 2013 at Maize Research Centre, Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh. The experimental soil was sandy loam in texture with pH (8.2), EC (0.56 dS m^{-1}) and OC (0.42 %). The soil was low in available nitrogen (196 kg ha^{-1}), high in phosphorus (31.21 kg ha^{-1}), high in potassium (201 kg ha^{-1}) and deficient in zinc (0.62 ppm).

The experiment was laid out in a Randomized Block Design and replicated thrice. The treatments comprised of three Speciality corn *viz.,* Popcorn, Sweet corn, QPM and six zinc levels *viz.,* Zn_0: Control (only recommended dose of fertilizer), Zn_1: 12.5 kg $ZnSO_4$ ha^{-1} as Soil

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application, Zn_2: 25 kg $ZnSO_4$ ha^{-1} as Soil application, Zn_3:Zn_1 + 2 Foliar sprays at tasseling and milking stage ($ZnSO_4$ application @ 2g l^{-1} of water), Zn_4:Zn_2 + 2 Foliar sprays at tasseling and milking stage ($ZnSO_4$ application @ 2g l^{-1} of water), Zn_5: 2 Foliar sprays ($ZnSO_4$ application @ 2g l^{-1} of water) at tasseling and milking stage. A uniform dose of NPK (180 kg N – 60 kg P_2O_5 – 50 kg K_2O ha^{-1}) as per the recommendation was applied to all the treatments.

RESULTS AND DISCUSSION

Growth parameters

The results revealed that different levels of zinc in speciality corn significantly influenced the growth parameters such as plant height, LAI and dry matter production. Higher plant height in QPM was observed which was significantly superior over the plant height obtained with Popcorn and Sweet corn. Significant increase in plant height with different levels of 'Zn' along with RDF was probably due to cell and internodal elongation, plant metabolism, there by promoting vegetative growth which is positively correlated to the productive potentiality of plant which corroborates with the results of Masood *et al.* (2011). Soil application of $ZnSO_4$ @ 25 kg ha^{-1} along with two foliar sprays at tasseling and milking stages recorded maximum plant height which was superior over all other zinc treatments. Similarly taller plants in QPM might be due to inherent genetic potential of hybrid which outperformed both Sweet corn and Popcorn (Table 1).

QPM had shown higher LAI which was significantly superior over sweet corn and popcorn. Among the varied zinc levels soil application of 25 kg $ZnSO_4$ ha^{-1} along with two foliar sprays at tasseling and milking stage had significantly produced larger leaf area index. The increase in LAI could be attributed to significant increase in leaf expansion (length and breadth), high rate of cell division and cell enlargement, rapid growth and there by improved quality of vegetative growth due to applied Zn fertilizers along with RDF, which corroborates with the results of Jat *et al.* (2010) and Bisht *et al.* (2012).

Among the three types of corn the dry matter production was significantly higher with sweet corn with higher dose of zinc (Zn_4: 25 kg $ZnSO_4$ ha^{-1} as soil application+ two foliar sprays at tasseling and milking stage) compared to QPM and Popcorn. Higher dry matter production with three different types of speciality corn and zinc could be attributed to enhanced plant height, leaf area index and photosynthates accumulation, thereby improving the plant vigor due to source-sink relationship. These findings are in conformity with those of Tetarwal *et al.* (2011) and Ravi *et al.* (2012).

Flowering was delayed with zinc fertilization. Among the three speciality corns, sweet corn attained tasseling and silking 10-11 days earlier compared to popcorn and QPM. Among zinc levels, days to 50% flowering was found earlier (7-8 days) in no zinc treatment compared to the higher dose of zinc (Zn_4: 25 kg $ZnSO_4$ ha^{-1} as Soil application+ two foliar sprays at tasseling and milking stage).

Yield and Yield attributes

Yield attributes such as number of cobs ha^{-1}, cob length and cob girth obtained with sweet corn was significantly superior over QPM and popcorn. Number of grain rows per cob of popcorn was superior over QPM and sweet corn. Number of grains per row of QPM was significantly superior over popcorn and sweet corn (Table 2). Soil application of 25 kg $ZnSO_4$ ha^{-1} along with two foliar sprays at tasseling and milking stage had significantly produced longer cobs compared to all other zinc treatments. The use of both macro and micro nutrients often results in synergism and improvement of nutrient use efficiency which leads to better cob size. These findings are similar with the findings of Ravi *et al.* (2012).

Green cob yield of sweet corn increased significantly due to increased moisture content. Maximum green cob yield was recorded with sweet corn, while the higher and lower grain yield of was recorded with QPM and popcorn respectively. The higher yield was produced with Zn_4, while lower yield was recorded with Zn_0. Speciality corn and zinc has beneficial effect on physiological process, plant metabolism, growth, there by leading to higher grain or green cob yield. The nutrients also enhance the carbohydrates supply to kernels, increasing yield components such as cob length, cob girth and number of grains row^{-1}, which have direct influence on grain yield and green cob yield. Similar results were reported by Pokharel *et al.* (2009) and Kien *et al.* (2009).

Among three speciality corns sweet corn produced higher green fodder yield and registered higher and lower stover yield with QPM and Popcorn respectively. Application of higher dose of Zinc (Zn_4) produced higher yield, followed by Zn_2 and Zn_0 gave the lower stover yield.

Table 1. Growth parameters of maize as influenced by soil and foliar applied zinc

Treatments	Plant height (cm)	Leaf area index (LAI)	Dry matter production (kg ha^{-1})	Days to 50% tasseling	Days to 50% silking
Speciality corn types					
Popcorn	184.11	1.701	7842	49	55
Sweet corn	181.52	2.028	9372	38	45
QPM	199.43	4.133	8703	54	60
CD (P = 0.05)	11.44	0.151	279	3	4
Zinc levels					
Zn_0 (Control, only recommended dose of fertilizer)	180.44	2.177	8122	44	49
Zn_1 (12.5 kg $ZnSO_4$ ha^{-1} asSoil application)	185.94	2.272	8464	46	52
Zn_2 (25 kg $ZnSO_4$ ha^{-1} as Soil application)	195.86	2.891	9176	50	56
Zn_3 (Zn_1 + 2 Foliar sprays at tasseling and milking stage)	187.42	2.783	8553	47	53
Zn_4 (Zn_2 + 2 Foliar sprays at tasseling and milking stage)	197.24	3.416	9255	51	57
Zn_5 (2 Foliar sprays at tasseling and milking stage)	183.23	2.184	8264	45	51
CD (P = 0.05)	NS	0.214	394	4	6

Table 2. Number of cobs ha^{-1}, cob length (cm) and cob girth (cm) as influenced by different types of corn and zinc levels

Treatments	Number of cobs ('000 ha^{-1})	Cob length (cm)	Cob girth (cm)	Number of grain rows cob^{-1}	Number of grains row^{-1}
Speciality corn types					
Popcorn	39.29	17.36	8.92	14.06	38.45
Sweet corn	45.31	17.75	12.35	12.94	29.59
QPM	42.54	16.66	10.93	13.45	36.21
CD (P = 0.05)	0.44	NS	0.15	NS	0.18
Zinc levels					
Zn_0 (Control, only recommended dose of fertilizer)	39.58	16.10	9.97	12.77	32.44
Zn_1 (12.5 kg $ZnSO_4$ ha^{-1} asSoil application)	41.60	16.86	10.51	13.13	33.84
Zn_2 (25 kg $ZnSO_4$ ha^{-1} as Soil application)	44.42	18.30	11.41	14.26	36.86
Zn_3 (Zn_1 + 2 Foliar sprays at tasseling and milking stage)	42.36	17.30	10.70	13.36	34.49
Zn_4 (Zn_2 + 2 Foliar sprays at tasseling and milking stage)	45.47	18.50	11.56	14.36	37.63
Zn_5 (2 Foliar sprays at tasseling and milking stage)	40.77	16.50	10.26	13.02	33.23
CD (P = 0.05)	0.62	1.69	0.22	NS	0.25

Higher stover yield or green fodder yield among speciality corn and zinc were due to higher plant height, LAI, dry matter accumulation, more nutrient availability and uptake by speciality corn. These results are in conformity with the results of Septa and Kumar (2007) and Singh and Nepalia (2009).

Harvest index of sweet corn increased due to increased moisture content. Maximum harvest index was recorded with sweet corn, while the higher and lower harvest index was recorded with QPM and popcorn respectively. The higher harvest index was produced with Zn_4, while lower harvest index was recorded with Zn_0. Similar results were reported by Arif *et al.* (2010) and Rani *et al*. (2013).

CONCLUSION

Soil application of 25 kg $ZnSO_4$ ha^{-1} along with 2 foliar sprays at tasseling and milking stage (Zn_4) recorded higher growth and yield but it was on par with soil applied 25 kg $ZnSO_4$ ha^{-1} (Zn_2). Among the three types of corn (Popcorn, Sweet corn and QPM) tested, Sweet corn and QPM registered higher growth and yield compared to Popcorn. For southern Telangana zone of Telangana state sweet corn is better with a soil application of 25 kg $ZnSO_4$ along with two foliar sprays.

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