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Effect of nitrogen and zinc levels on growth, yield and economics of baby corn (*Zea mays* L.)

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Abstract
A field experiment was conducted during *Zaid* season of 2018 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, (U.P.). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.7), low in organic carbon (0.35%), available N (230 kg ha-1), available P (20 kg ha-1) and available K (189 kg ha-1). The experiment consists of 3 levels of nitrogen (80 kg ha-1, 100 kg ha-1, 120 kg ha-1) and 3 concentration of zinc applied as foliar spray (0.5%, 1.0%, 1.5%). There were 9 treatments each replicated thrice and laid out in a Randomised Block Design. Application of 120 kg N ha-1 in combination with 1.5% zinc conc. recorded maximum plant height and number of cobs. This combination has also recorded maximum cob weight with husk (81.46 g), green cob yield (7.26 t ha-1). Maximum net return (Rs 146134.91) was also seen in the same treatment.

Keywords: Baby corn, Nitrogen and Zinc level

Introduction
Corn is one of the important cereal crops of India and used as food for human beings and feed for animals. Maize (*Zea mays* L.) ranks 3rd as a food-grain crop after wheat and rice and it is not only as a cereal but also as vegetable and fodder crop. Globally, as an immature vegetable, baby corn has attracted an increasing number of peoples preference due to the enhancement of living standards and shift in dietary habit from non-vegetarian to vegetarian; however, production areas are still confined to a few countries including Thailand, Indonesia, India, and Brazil.

Maize is important crop in the world grown in more than 150 countries having 600 million ha area with 600 million ton of production. The major maize producing countries are USA, China, Brazil, Mexico, France and India. USA has the largest area and production in the world. Italy having highest productivity in the world 9600 kg ha-1 followed by France with 8800 kg ha-1. India stands at 5th position in total area, 4th in total production and 3rd in yield per hectare after USA China, Brazil and Mexico but with regards to production its rank 11th. It is a widely grown cereal and is categorized as primary staple food in many developing countries. India contributes merely about 2.5 percent in world maize production.

In India, maize is grown in an area of 9.43 million hectare, with production of 25.12 million tonnes and productivity of 2585.00 kg ha-1 (Agricultural statistics at a glance, 2015). It comes after rice and wheat but has the highest productivity potential among the cereals. The maize is cultivated throughout the year in all states of the country for various purposes including grain, fodder, green cobs, sweet corn, baby corn, popcorn in peri-urban areas. The predominant maize growing states that contributes more than 80% of the total maize production are Andhra Pradesh (20.9%), Karnataka (16.5%), Rajasthan (9.9%), Maharashtra (9.1%), Bihar (8.9%), Uttar Pradesh (6.1%), Madhya Pradesh (5.7%), Himachal Pradesh (4.4%) (India Maize summit). Apart from these states maize is also grown in Jammu and Kashmir and North-Eastern states. Hence, maize has emerged as important crop in the non- traditional regions of peninsular India as the state like Andhra Pradesh which ranks 5th in area (0.79 m ha) has recorded the highest production (4.14 m t) and productivity (5.26 t ha-1) in the country although the productivity in some of the districts of Andhra Pradesh is more or equal to the USA whereas Uttar Pradesh contributes 1236 thousand tonnes in production with 1671 kg ha-1 productivity. Contributing nearly 8.0 percent in the nation food basket (Anonymous, 2013) [28]. Directorate of economics and statistics, Department of Agriculture and cooperation, Govt. of India) in Uttar Pradesh, the area, production and productivity of Maize are 0.78 million hectare, 1.19 million tonnes and 1504 kg ha-1, respectively.

In the last decade, early harvesting of young corn, fresh, sweet and tender ears for vegetable purpose, which is called as baby corn (Ramchandrappa *et al*., 2004) [19] has picked up. It is a small young corn ear harvested at the stage of silk emergence. Baby corn ears is light yellow colour with regular row arrangement, 10 to12 cm long and a diameter of 1.0 to 1.5 cm. The delicate sweet flavor and crisp nature contributes to its increasing popularity in several countries as a common ingredient of Manchurian (Chinese), various fancy dishes and may also be eaten raw (Reddy *et al*., 2009) [23].

As 80 percent of maize is grown as rainfed crop, dry spells during flowering and grain formation lowers productivity and yield of maize and providing protective irrigation and conservation of moisture can alleviate this problem (Reddy and Raja, 1991) [36]. Baby corn is the new economic product of maize (*Zea mays* L.) refers to small young cob or ear corn or the female inflorescence (Rachis cob or style axis) before pollination or fertilization, harvested 2-3 days of silk emergence. Conversion of some of the grain maize areas contiguous to cities and towns to baby corn cultivation offers scope to increase the economic returns to the farmers besides meeting a part of country's future food requirement.

The raw material of baby corn is used for canning and pickling food processing industries, and enhancing profitability particularly in peri-urban areas. It also offers huge export potential and revenue generation. Baby corn, being C4 plant is an efficient converter of absorbed nutrients into food. Baby corn is rich in foliate, and a good source of several other nutrients.

Baby corn can be grown throughout the year and at optimum temperature of 24 to 35 °C. Being a short duration crop, it is taken in intensive cropping system and in addition it also provides green fodder to cattle (Das *et al*., 2008) [5]. The needs of a baby corn crop for supplemental nutrients can vary greatly among fields, seasons and crop growing conditions. Nitrogen is the most important nutrient for the growth and yield of corn. Ideal nitrogen management optimizes grain yield, farm profit and nitrogen use efficiency, while it minimizes the potential for leaching of nitrogen, thus preventing environmental pollution. Hence, there is need to evaluate sweet corn varieties under optimum combination of nitrogen and phosphorus fertilization under prevailing agro-climatic conditions. Nutrient deficiencies along with imbalanced and non-judicious fertilizers use are one of the important yield limiting factors. In India, about 62% and 49% soils are deficient in N and P respectively. Nitrogen is an essential element and important determinant of plant growth and development. Nitrogen is a component of protein and nucleic acids and when N is sub-optimal, growth is reduced (Haque *et al*., 2001) [7].

Availability in sufficient quantity throughout the growing season is essential for optimum maize growth (Haque *et al*., 2001) [7]. Nitrogen is a vital plant nutrient and a major yield determining factor required for maize production (Shanti *et al*., 1997) [24]. Almost 50% of the soils globally used for cereal production are zinc deficient (Gibbson, 2006) [6]. Little or no use of zinc along with imbalanced fertilization further aggravated the situation. Zinc deficiency in soils resulting in lower zinc content in grains and fodder (Rashid and Ryan, 2004) [21].

Materials and Methods

The experiment was carried out during the *zaid* season, 2018 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (U.P.). The Crop Research Farm is situated at 25º24'41.27" N latitude, 81°51'3.42" E longitude (*Google map*, 2018) and at an altitude of 98 m above the mean sea level. This area is situated on the right hand side of the river Yamuna and South of Allahabad City. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.7), low in organic carbon (0.35%), available N (230 kg ha-1), available P (20 kg ha-1) and available K (189 kg ha-1). The experiment consists of 3 levels of nitrogen (80 kg ha-1, 100 kg ha-1, 120 kg ha-1) and 3 concentration of zinc applied as foliar spray (0.5%, 1.0%, 1.5%). There were 9 treatments each replicated thrice and laid out in a Randomised Block Design. Following observations *viz.* Plant height, Cobs plant-1, Cob weight with husk, green cob yield and economics were recorded to find out the best treatment combination.

Results and Discussion

The findings of the present experiment entitled, "Effect of Levels of Nitrogen and Zinc on Growth and Yield of Baby Corn (*Zea mays* L.)" are being presented and discussed here in tables. This experiment was carried out during the *Zaid* season of 2018 at the Central Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, to study the performance of baby corn under varying nitrogen and zinc levels.

Plant height

Maximum plant height at 45 DAS (102.44 cm) was recorded in treatment T9 (120 kg N ha-1 + 1.5 % Zn). The data in T8 (120 kg N ha-1 + 1.0 % Zn) *i.e.* 96.07cm and T7 (120 kg N ha-1 + 0.5 % Zn) *i.e.* 94.10 cm were statistically at par with T9.

Similar findings were reported by Yerokun and Chirwa (2014) [26], Rani *et al.* (2010) [20], Mehta *et al.* (2011) [30], Dar *et al.* (2014) [4], Kumar *et al.* (2014) [29], Ullah *et al.* (2012) [25], Hussain *et al*. (2016) [8].

Number of cobs

Maximum number of cobs was recorded in treatment T9 (120 kg N ha-1 + 1.5 % Zn) *i.e.* 2.8 Treatment T8 (120 kg N ha-1 + 1.0 % Zn) *i.e.* 2.46 was statistically at par with treatment T9.

Rani *et al.* (2010) [20], Kumar *et al*. (2011) [16], Dar *et al*. (2014) [4], Kumar *et al.* (2015) [12] and Sharar *et al.* (2003) [34] has shown similar research findings.

Cob weight

Maximum cob weight with husk (g) was recorded in treatment T9 (120 kg nitrogen ha-1 + 1.5% zinc) *i.e.* 81.46 g. Treatment T8 (120 kg nitrogen ha-1 + 1.0 % zinc), T7 (120 kg nitrogen ha-1 + 0.5% zinc), T6 (100 kg nitrogen ha-1 + 1.5% zinc), T5 (100 kg nitrogen ha-1 + 1.0% zinc), T4 (100 kg nitrogen ha-1 + 0.5% zinc) and T3 (80 kg nitrogen ha-1 + 1.5% zinc) were statistically at par with treatment T9.

The results are in conformity with the findings of Yerokun and Chirwa (2014) [26], Rani *et al.* (2010) [20], Ashoka *et al.* (2011) [1], Paramesh *et al.* (2014) [18], Kumar *et al.* (2015) [12], Khan *et al.* (2014) [11], Chand *et al.* (2017) [3], Kumar *et al.* (2014) [29] and Kumar *et al.* (2018) [15].

Cob yield

Observation for this data are presented in table 4.8. Highest cob yield with husk was recorded in treatment T9 (120 kg nitrogen ha-1 + 1.5% zinc) *i.e.* 7.26 t ha-1. Cob yield in treatment T8 (120 kg nitrogen ha-1 + 1.0% zinc), T7 (120 kg nitrogen ha-1 + 0.5% zinc) and T6 (100 kg nitrogen ha-1 + 1.5% zinc) were significantly at par with treatment T9.

The higher cob yield with husk is ascribed to its profound influence on vegetative and reproductive growth because of the application of higher levels of balanced nutrition and fertilizers. These results are in accordance with Pandey *et al.* (2000) [32], Yerokun and Chirwa, (2014) [26], Paramesh *et al.* (2014) [18], Kumar *et al.* (2015) [12], Khan *et al.* (2014) [11], Chand *et al.* (2017) [3], Ashoka *et al.* (2011) [1] and Kumar *et al.* (2018) [15].

Economics of baby corn

Highest net return was found in treatment T9 (120 kg N ha-1 + 1.5 % Zn) *i.e.* Rs. 146134.91. The results are in agreement with Ashoka *et al.* (2011) [1], Umar *et al.* (2014), Kumar *et al.* (2015) [12], Pandey *et al.* (2000) [32], Dar *et al.* (2014) [4], Rani *et al.* (2010) [20], Ullah *et al.* (2012) [25], Raskar *et al.* (2013) [22], Verma *et al.* (2013) [35]. The net return was markedly influenced due to different cost incurred and yield (cob and stover) obtained under various treatments.

Table 1: Effect of nitrogen and zinc levels on growth of baby corn

Treatment	Plant height (cm)	Number of cobs	Cob weight with husk (g)	With husk cob yield (t ha-1)	Cost of Cultivation (Rs ha -1)	Net return (Rs ha -1)
45 DAS						
1.80 kg N ha-1 + 0.5 % Zn	82.85	1.86	55.46	4.77	50774.37	84524.63
2.80 kg N ha-1 + 1.0 % Zn	81.90	1.93	63.13	4.77	50814.37	94484.63
3.80 kg N ha-1 + 1.5 % Zn	83.4	2.00	63.60	4.81	50854.37	97444.63
4.100 kg N ha-1 + 0.5 % Zn	84.84	2.06	65.33	5.18	51078.73	108220.27
5.100 kg N ha-1 + 1.0 % Zn	87.86	2.13	65.86	5.53	51118.73	120481.27
6.100 kg N ha-1 + 1.5 % Zn	84.99	2.20	68.93	5.96	51158.73	127440.27
7.120 kg N ha-1 + 0.5 % Zn	94.10	2.26	70.00	6.09	51383.09	132915.91
8.120 kg N ha-1 + 1.0 % Zn	96.07	2.46	71.53	6.42	51423.09	136176.91
9.120 kg N ha-1 + 1.5 % Zn	102.44	2.80	81.46	7.26	51463.09	146134.91
F – test	S	S	NS	S		
SEd (±)	5.09	0.203	8.47	0.756		
CD at 5%	10.79	0.43	-	1.602		

Conclusion

Based on the findings, of this experiment it can be concluded that treatment with 120 kg N ha-1 + 1.5 % Zn is the best and economically profitable. Application of 120 kg N ha-1 and 1.5% zinc is profitable for farmers because it has significantly recorded higher Plant height, Cob weight with husk and Green cob yield. This treatment also recorded maximum net return *i.e.* Rs 146134.91. Although the finding is based on one year. Further research is needed to confirm the findings and its recommendation.

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