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Effect of bio fertilizers and zinc on growth and yield of sweet corn

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Abstract
A field experiment was conducted during *Zaid* season (2021) at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha) and available K (213.7 kg/ha). The Treatments consisted of Bio fertilizers B_1 (Azotobacter 20 g/kg), B_2 (Azospirillum 20 g/kg), B_3 (Azotobacter 10 g/kg + Azospirillum 10 g/kg), and 3 levels of zinc Zn_1 (0.25%), Zn_2 (0.5%), and Zn_3 (0.75%). The experiment was laid out in Randomized Block Design with 9 treatments and replicated thrice. The results revealed that the application of Azotobacter 10 g/kg + Azospirillum 10 g/kg + 0.75% zinc recorded maximum plant height (168.40 cm), Number of leaves/plant (13.2), plant dry weight (89.97 g/plant) and cobs/plant (1.90), number of grains/row (14.10), number of grain rows/cob (429.70) and cob length (20.22), girth of cob (13.98), cob yield (9.80 t/ha) and straw yield (14.07 t/ha). Maximum Gross return (Rs.126663 INR/ha), Net return (84441.90 INR/ha) and B:C ratio (2.11) were also recorded with the treatment with the application of Azotobacter 10 g/kg + Azospirillum 10 g/kg + 0.75% Zinc.

Keywords: Azotobacter, azospirillum, zinc, green cob, straw

Introduction
Maize belongs to a family poaceae is an important cereal food grain crop of the world which is being Grown in more than 166 countries across the globe including tropical, sub-tropical and temperate regions, there is no any other cereal on the Earth, which has so immense yield potential so that maize and hence occupied a place of "queen of cereals. It serves as basic raw material, and in gradient to thousands of industrial products that include starch oil, protein, alcoholic beverages, Food sweeteners, cosmetic film, textile gum, package, paper industries etc. Maize is third most important cereal crop after Rice and wheat, in human diet. In India it grown on 8.71 m ha area with 21 metres production. In 2014-2015 and productivity is 2552 kg/ha. However, in Madhya Pradesh it is grown in 0.85 m ha area with about 1.51mt of production and 1776kg/ha productivity.

So, it is grown for consuming immature kernels and harvest (at milky stage). It provides green cob in 75-80 days after sowing and harvested earlier by 35 to45 days compared to normal grain maize. It has great market potential and high market value in India (Sahoo and Mahapatra, 2007). In central India people consume sizeable quantity of green cob, which generates potential for sweet corn cultivation in the area. The plant growth involves various environmental and agronomical factors such as water, temperature, light, nutrients, Liu *et al.* (2004) [9], Yadav (2008) and Yuan *et al.* (2003).

Biofertilizer is a natural input that can be applied as a complement to, or as a substituent of chemical fertilizer in sustainable agriculture (Ebrahimpour *et al*., 2011) [2]. One way is using inoculants of microorganisms which provide many nutrients to plants; Azotobacter and Azospirillum are the two examples of these microorganisms. Mycorrhizal symbiosis increases absorption of some elements such as phosphorus, nitrogen and micronutrients, improves water uptake, produces hormones, reduces damages caused by environmental stress, improves quality of soil aggregate. Azotobacter is a beneficial free living (non-symbiosis) nitrogen fixing bacteria which is reported to fix 20-60 kg/ha nitrogen in soil annually. Azotobacter was the first and is the most common biofertilizer for some plants such as maize, wheat, sorghum and rice which produces some plant growth promoting metabolites, enzymes and hormones (auxin, cytokinin and gibberelin) in addition to fixing air nitrogen (Forlain *et al.*, 1998) [3]. Application of micronutrient also play significant role in improvement of grain yield of maize.

Among micronutrient zinc plays an important role in photosynthesis, nitrogen metabolism and regulates aux in concentration in the plant. The Zn deficiency was found wide spread in Indian soil. Zinc is most crucial amongst the micronutrients that take part in plant growth and development due to its catalytic action in metabolism of almost all crops (George and Schmitt, 2002) [4]. However, micronutrients can be applied directly into the soil as well.

Materials and Methods

The experiment was carried out in *Zaid* season of 2021 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P). Which is located at 25° 57 N latitude, 87° 50 E longitude and at an altitude of 98 metre above the mean sea level. The soil of the experimental plot was sandy loam in texture. nearly neutral in soil reaction (PH,7.1), low in organic carbon (0.28%) medium in available N (225 kg/ha), high available P (19.50 kg/ha), and available K (213.7 kg/ha). The seeds of sweet corn (Zea mays) variety' sugar 75' with seed rate 10-11kg/ha and sown at 4-5cm depth. Recommended. The experiment was laid out Randomized Block design comprised of 3 replications and total 9 treatments viz. Treatment 1 (Azotobacter 20 g/kg + 0.25% zinc), Treatment 2 (Azotobacter 20 g/kg + 0.5% zinc) Treatment 3 (Azotobacter 20 g/kg + 0.75% zinc), Treatment 4 (Azospirillum 20 g/kg + 0.25% zinc) Treatment 5 (Azospirillum 20 g/kg + 0.5% zinc), Treatment 6 (Azospirillum @ 20 g/kg + 0.75% zinc), Treatment 7 (Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.25% zinc), Treatment 8 Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.5% zinc), Treatment 9 Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc).

Results and Discussions

Data pertaining to growth parameters which is plant height (cm), number of leaves/plants, dry weight (g/plant) was recorded and tabulated in Table 1. The significantly maximum plant height was recorded with application of Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc which was significantly superior over all the treatments (168. 40 cm) and statically at par with application of Azospirillum 20 g/kg + 0.75% zinc (167.00 cm) and Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.5% zinc(165.20cm). The significantly maximum number of leaves/plants was recorded with application of Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.25% zinc which was significantly superior over all the treatments (12.70) and statically at par with application of Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc (12.30). The significantly maximum plant dry weight was recorded with application of Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc which was significantly superior over all the treatments (89.97 g/plant) and statically at par with application of Azospirillum 20 g/kg + 0.75% zinc (87.35 g/plant). Seed inoculation with biofertilizer improve the soil through microbial activity which might have facilitate better crop growth. biofertilizer efficiently provide nutrients to the crop also enhance moisture in the soil that lead to increase growth, number of leaves/plant and dry matter effectively. These findings are in conformity with Headge. *et al* (1999) [6].

Table 1: Growth attributes of sweet corn as influenced by Biofertilizers and zinc levels

S. No.	Treatments	Plant Height (cm)	No. of leaves/ plant	Dry Weight (g)
1	Azotobacter 20 g/kg + 0.25% zinc	153.20	10.20	73.44
2	Azotobacter 20 g/kg + 0.5% zinc	153.00	11.10	76.77
3	Azotobacter 20 g/kg + 0.5% zinc	159.40	11.50	81.82
4	Azospirillum 20 g/kg + 0.25% zinc	153.60	10.70	77.82
5	Azospirillum 20 g/kg + 0.5% zinc	162.50	11.10	81.50
6	Azospirillum 20 g/kg + 0.75% zinc	167.00	11.70	87.35
7	Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.25% zinc	160.40	11.30	80.62
8	Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.5% zinc	165.20	12.30	78.55
9	Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc	168.40	12.70	89.97
	S.Em(±)	1.33	0.65	5.99
	CD (P=0.05)	3.99	10.20	73.44

Table 2: Yield attributes and Yield of Sweet corn as influenced by Biofertilizers and Zinc levels

Treatments	Cobs/plant	Grains/cob	Grain row/cob	Grains/row	Cob length	Cob yield (t/ha)	Straw yield (t/ha)	Cob length
Azotobacter 20 g/kg + 0.25% zinc	1.33	274.60	11.00	25.0	15.17	9.03	13.43	15.17
Azotobacter 20 g/kg + 0.5% zinc	1.20	293.70	11.60	25.3	14.97	8.96	13.70	14.97
Azotobacter 20 g/kg + 0.75% zinc	1.44	334.10	12.50	26.7	16.64	9.00	13.20	16.64
Azospirillum 20 g/kg + 0.25% zinc	1.60	302.50	11.70	25.9	15.70	8.93	13.90	15.70
Azospirillum 20 g/kg + 0.5% zinc	1.22	363.20	12.50	28.9	17.23	8.90	13.10	17.23
Azospirillum 20 g/kg + 0.75% zinc	1.70	387.50	13.10	29.3	20.06	9.00	14.03	20.06
Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.25% zinc	1.11	328.90	12.50	26.3	16.47	9.03	13.27	16.47
Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.5% zinc	1.70	385.70	13.78	28.6	18.34	9.60	13.87	18.34
Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc	1.90	429.70	14.10	30.4	20.22	9.80	14.07	20.22
S.Em (±)	0.14	14.16	0.34	0.66	0.06	0.11	0.16	0.37
CD (P=0.05)	0.43	42.48	1.01	1.99	0.20	0.34	0.48	1.10

Yield Attributes

At Harvest, maximum Number of cobs/plant (1.90) recorded with application of Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc which was significantly superior over all the treatments and statically at par with application of Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.5% zinc (1.70) and Azospirillum 20 g/kg + 0.75% zinc (1.70). Number of grains/ cob (429.70) recorded with application of

Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc which was significantly superior over all the treatment, Number of grain row/cob (14.10) maximum is recorded with application of Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc which was significantly superior over all the treatments and maximum cob length is (20.22 cm) Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc which was significantly superior over all the treatments and at statistically at par with application Azospirillum 20 g/kg + 0.75% zinc (20.06 cm). On the basis of experiment conducted by Kruczek (2005) [7] by applying different levels of multi-component fertilizers gave a significant effect on number of grain rows per cob. Application of zinc in combination with biofertilizers has increased the number of grains per cob insignificantly in this field experiment. The increment in number of grains per cob might be due to the presence of magnesium in multi-nutrients solution as grains number are direct index of pollen viability and where magnesium is proved to increase fruit set and pollen viability and significant effect on pollen formation as reported by Mahgoub *et al.*, (2010) [8] and Siam *et al.*, (2008).

Yield

The ultimate goal of experimental purpose to find out maximize practices which produce more yield. Yield component based on better growth and yield attributes performing under best treatment. Yield evaluated after harvesting of crop so significantly increasing trend by application of biofertilizers and zinc levels. Significantly maximum cob yield (9.80 t/ha) was recorded with application Azotobacter 10 g/kg + Azospirillum 10 g/kg + 0.75% zinc. Inoculation with Azospirillum resulted in significant yield increases of the magnitude 10 to 30% (Bashan *et al.*, 2004) [1] Similar findings by Hajnal-Jafari *et al.*, (2012) [5] who indicated that grain yield increased with inoculation by Azotobacter. The findings were also similar to Surendra and Sharanappa (2000) who observed that Azotobacter chrococcum significantly increased grain yield of maize over no inoculation.

Similarly stover yield (14.07 t/ha) also found significantly maximum with application of Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc, treatment with application of Azospirillum 20 g/kg + 0.75% zinc (13.87) which was statically at par.

Conclusion

From the findings of experiment, application Azotobacter 10 g/kg+ Azospirillum 10 g/kg + 0.75% zinc of obtaining higher yield attributes and yield of Sweet corn crop useful for eastern Uttar Pradesh condition.

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