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RESPONSE OF BIO-FERTILIZER AND MICRONUTRIENTS ON GROWTH AND YIELDS OF BABY CORN (*ZEA MAYS* L.)

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ABSTRACT

The experiment was conducted during *Rabi*, season of 2021-22 and 2022-23 at the Crop Research Farm of the Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, (UP). The experiment was laid out in a Randomized Block Design (RBD) along with two factor three Bio-fertilizer levels *viz.,* Azotobacter 20 g/kg seed, PSB 20 g/kg seed and VAM 20 g/kg seed where-as four levels of micronutrients *viz.,* 20 kg zinc + 20 sulphur kg/ha, 30 kg zinc + 30 sulphur kg/ha, 40 kg zinc + 40 sulphur kg/ha and 50 kg zinc + 50 sulphur kg/ha respectively, their combination of twelve treatments which are replicated thrice. The results of experiment based on the 2020-21, the plant height was recorded the maximum i.e. 109.09 cm, Dry matter accumulation (12.68 g/plant), Crop growth rate (0.33 g/m^2/day), Relative Growth Rate (141.46 mg/g/day), number of cobs per plant (3.15), cob length (8.74 cm), cob weight (10.84 g), cob yield (8.63 t/ha), straw yield (23.99 t/ha), harvest index (26.46 %) with the application of PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha) (T_5). While, during the year 2021-22 the plant height at 60 DAS recorded the maximum was 110.07 cm, Dry matter accumulation (13.70 g/plant), Crop growth rate (0.35 g/m2/day), Relative Growth Rate (137.45 mg/g/day), number of cobs per plant (3.19), cob length (8.47cm), cob weight (11.10 g), cob yield (8.70 t/ha), straw yield (24.09 t/ha), harvest index (26.53%) and protein content in grain (10.05) with the application of PSB 20 g/kg seed + (20 kg Zn+ 20 Sulphur kg/ha) (T_5). Result of pooled analysis for plant height, at 60 DAS the maximum plant height was recorded 109.58 cm, Dry matter accumulation (13.19 g/plant), Crop growth rate (0.34 g/m^2/day), Relative Growth Rate (139.01 mg/g/day), number of cobs per plant (3.17), cob length (8.60 cm), cob weight (10.97 g), cob yield (8.67 t/ha), straw yield (24.04 t/ha), harvest index (26.50 %) with the application of PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha) (T_5).

***Key words*: Baby corn, Row spacing, Micronutrients, Economics, Growth, Yield and B:C**

Introduction

Baby corn has significant processing and export potential and is growing in popularity on both domestic and international markets. Growing maize for vegetables is a fascinating recent phenomenon (Dass *et al.,* 2008). Right now, China and Thailand produce the most baby corn worldwide. Meghalaya, Western Uttar Pradesh, Haryana, Maharashtra, Karnataka, and Andhra Pradesh are among the Indian states where baby corn is grown (Reena Rani *et al.,* 2017; Borase *et al.,* 2018). In India, which is the fifth-largest producer in the world and accounts for 3% of worldwide production, maize is grown over an area of roughly 9.18 million hectares, with a yield of 27.23 million tonnes and an average productivity of 2965 kg/ha. With a contribution of 14.87% (1.37 million tonnes) of the total Indian maize produced area, Madhya Pradesh leads the list. In India, Tamil Nadu had the highest output of about 6551 kg/ha while Karnataka produced corn at a rate of about 3.73 million tonnes, or 13.69% of the nation's total production. While Uttar Pradesh gives an area of approximately 0.73 million hectares with a 7.98% to the entire country of India, which has a production of approximately 1.53 million, (Agricultural Statistics at a Glance, 2021; Kalloo and Kumar, 1998; Mtaita *et al.,* 2019).

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 auxin 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). However, micronutrients can be applied directly into the soil as well. Another essential nutrient is iron (Fe), the lack of which causes chlorosis and is responsible for significant decreases in yield and quality of plants. Although most soils contain adequate total iron, amounts that are available to plants might be inadequate dependent on various soil factors such as very high or low soil temperature, high humidity, poor soil aeration and compaction, high pH, HCO_3- and $CaCO_3$ contents. Besides the bad physical properties of the soils Fe chlorosis is also related with PO_4- and NO_3- anions and other heavy metal concentrations such as Zn, Cu, Mn, Co, Ni and Cd (Borase *et al.*, 2018; Lucena, 2000). Bio-fertilizers play an important role in the increasing availability of nitrogen and phosphorus. Among several bio agent *Azospirillum* is known to fix atmospheric nitrogen and increased about 10-15 % grain yield in maize (Patil *et al.,* 2001). The availability of phosphorous are also low as compared to that of N & K. under such situation, the phosphate solubilizing microorganism (PSB) plays significant role in making the phosphorous available to plants by secretion of organic acids and enzyme phosphatase which solubilizes the insoluble phosphate and thereby it helps in increasing the crop production. *Azotobacter and Azospirillum* is a beneficial free living (non-symbiosis) nitrogen fixing bacteria which is reported to fix 20-60 kg ha^{-1} 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 gibberellin) in addition to fixing air nitrogen (Kumar and Ahlawat 2004; Ghosh *et al.,* 2017).

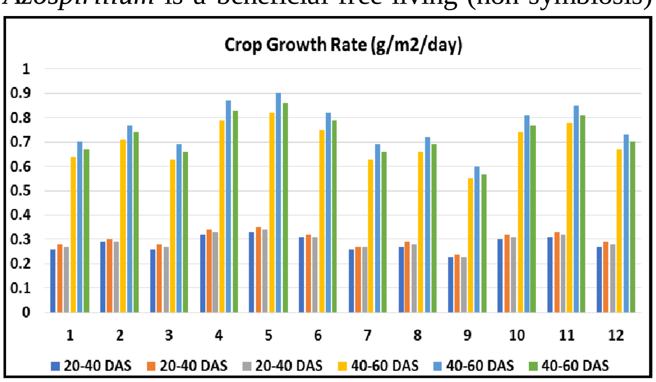

Fig. 1: Influence of Bio-fertilizer, growth regulators and micronutrients on crop growth rate ($g/m^2/day$).

Material and Methods

The experiment was conducted during the *Rabi* season 2020-21, and 2021-22 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS),Prayagraj (U.P.) which is located at 250 39 42" N latitude, 81067 56" E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the Yamuna River by the side of Prayagraj-Rewa Road about 5 km from the city. All the facilities required for crop cultivation were available. The experiment was laid out in a Randomized Block Design (RBD) along with two factor three Bio-fertilizer levels *viz.,* Azotobacter 20 g/kg seed, PSB 20 g/kg seed and VAM 20 g/kg seed where-as four levels of micronutrients *viz.,* 20 kg zinc + 20 sulphur kg/ha, 30 kg zinc + 30 sulphur kg/ha, 40 kg zinc + 40 sulphur kg/ha and 50 kg zinc + 50 sulphur kg/ha respectively, their combination of twelve treatments which are replicated thrice. The experiment was laid out in Randomized Block Design, with ten treatments treatment combinations with 3 replications and was laid out with the different treatments all located randomly in each replication *viz.* T_1: Azotobacter 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha), T_2: Azotobacter 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha), T_3: Azotobacter 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha), T_4: Azotobacter 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha), T_5: PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha), T_6: PSB 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha), T_7: PSB 20 g/kg seed +

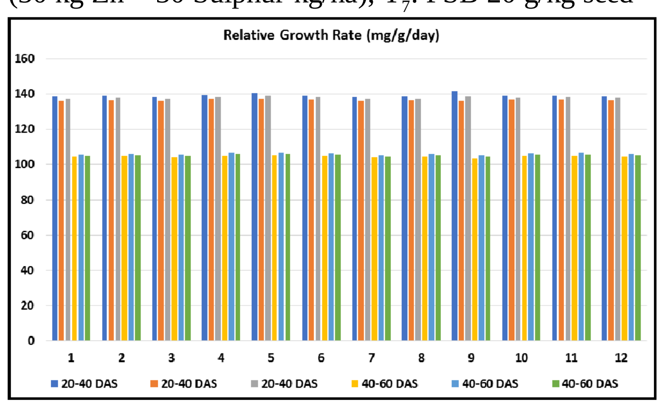

Fig. 2: Influence of Bio-fertilizer, growth regulators and micronutrients on relative growth rate (mg/g/day).

Table 1: Influence of Bio-fertilizer, Growth regulators and micronutrients on plant height (cm).

Treatment	Plant Height (cm)								
	20 DAS			40 DAS			60 DAS		
	20-21	21-22	Pooled	20-21	21-22	Pooled	20-21	21-22	Pooled
T_1: *Azotobacter* 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	29.71	30.02	29.87	53.11	53.92	53.51	87.79	88.57	88.18
T_2: *Azotobacter* 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	31.42	31.75	31.58	56.17	57.02	56.59	92.84	93.67	93.25
T_3: *Azotobacter* 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	29.37	29.67	29.52	52.5	53.3	52.9	86.78	87.55	87.17
T_4: *Azotobacter* 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	36.11	36.48	36.3	64.55	65.53	65.04	106.69	107.64	107.17
T_5: PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	**36.93**	**37.2**	**37.06**	**66**	**67.01**	**66.5**	**109.09**	**110.07**	**109.58**
T_6: PSB 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	34.35	34.71	34.53	61.4	62.34	61.87	101.49	102.4	101.95
T_7: PSB 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	29.37	29.67	29.52	52.5	53.3	52.9	86.78	87.55	87.17
T_8: PSB 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	30.42	30.73	30.57	54.37	55.2	54.78	89.87	90.67	90.27
T_9: VAM 20 g/kg seed + 20 kg Zn + 20 Sulphur kg/ha)	25.48	25.8	25.64	45.54	46.23	45.88	75.27	75.94	75.61
T_{10}: VAM 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	33.8	34.15	33.98	60.42	61.34	60.88	99.87	100.76	100.31
T_{11}: VAM 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	35.34	35.7	35.52	63.17	64.13	63.65	104.42	105.35	104.88
T_{12}: VAM 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	30.75	31.06	30.9	54.95	55.79	55.37	90.84	91.65	91.24
SEm±	1.24	1.19	0.86	2.08	2.15	1.5	3.61	3.61	2.55
CD (P=0.05)	3.65	3.49	2.45	6.09	6.31	4.26	10.58	10.59	7.28
CV (%)	6.74	6.39	6.57	6.3	6.44	6.37	6.63	6.58	6.6

(40 kg Zn + 40 Sulphur kg/ha), T_8: PSB 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha), T_9: VAM 20 g/kg seed + 20 kg Zn + 20 Sulphur kg/ha), T_{10}: VAM 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha), T_{11}: VAM 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha) and T_{12}: VAM 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha) was applied in all the plots. The major nutrients were applied in soil through urea, single super phosphate (SSP) and muriate of potash (MOP). Halt dose of nitrogen and full dose of P and K was applied as basal dressing and remaining quantity of nitrogen was top dressed in equal quantity at 30 and 60 DAS. The data on growth indices i.e. Absolute growth rate (AGR), Crop growth rate (CGR) and Relative growth rate (RGR) was evaluated as per standard process. Measurement of Absolute growth rate (AGR) was calculated by adopting the formula suggested by Kvet *et al.* (1971), AGR = $(W_2 - W_1)/(T_2 - T_1)$ and expressed in g/plant/day. Crop growth rate (CGR) is the increase in plant dry materials per unit area of land per unit time. CGR values were estimated at 20-day interval as described by Watson (1952) [20], CGR was calculated using the formula CGR = $[(W_2 - W_1)/(T_2 - T_1)$, where W_1 is total dry weight at time T_1 and W_2 is the total dry weight at time T_2 and S is the ground spacing and expressed in g/m^2/day. The RGR was determined by adopting the formula suggested by Williams (1946), RGR = $(\ln W_1 - W_2)/(T_1 - T_2)$, where W_1 is total dry weight at time T_1, W_2 is total dry weight at time T_2, and ln is natural logarithm and expressed in g/g/day. The observations were recorded for Plant height, Dry matter accumulation, Crop growth rate, Relative Growth Rate, number of cobs per plant, cob length, cob weight, cob yield, straw yield, harvest index with the application of PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha) (T_5). The collected data was subjected to statistical analysis by analysis of variance method (Gomez and Gomez,1976)

Results and Discussion

Growth parameters

Plant height (cm):

Plant height was significantly influenced by different treatments at all growth stages (20, 40, and 60 DAS) during both 2020–21 and 2021–22.

At 20 DAS, the highest plant height was recorded with T_5: PSB 20 g/kg seed + (20 kg Zn + 20 kg S/ha) (36.93 cm in 2020–21; 37.20 cm in 2021–22; pooled 37.06 cm), which was statistically at par with T_4, T_6, T_{10}, and T_{11}. The lowest plant height was observed in T_9: VAM 20 g/kg seed + (20 kg Zn + 20 kg S/ha) (25.48–25.80 cm). At 40 DAS, maximum height was again with T_5 (66.00 cm in 2020–21; 67.01 cm in 2021–22; pooled 66.50 cm), at par with T_4, T_6, T_{10}, and T_{11}. Minimum height was under T_9 (45.54–46.23 cm). At 60 DAS, tallest plants were obtained in T_5 (109.09 cm in 2020–21; 110.07 cm in 2021–22; pooled 109.58 cm), followed closely by T_4, T_6, T_{10}, and T_{11}. Shortest plants were again in T_9 (75.27–75.94 cm).Significant variation in plant height can be attributed to better nutrient availability and the synergistic

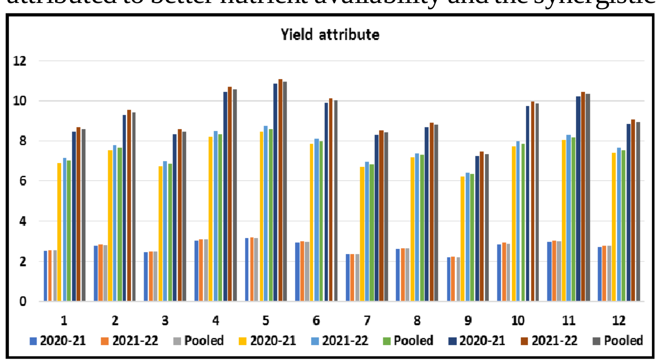

Fig. 3: Influence of Bio-fertilizer, growth regulators and micronutrients on number of cobs per plant.

Table 2: Influence of Bio-fertilizer, growth regulators and micronutrients on dry matter accumulation (g/plant).

Treatment	Dry matter accumulation (g/plant)								
	20 DAS			40 DAS			60 DAS		
	20-21	21-22	Pooled	20-21	21-22	Pooled	20-21	21-22	Pooled
T_1: *Azotobacter* 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	0.87	0.96	0.92	3.5	3.74	3.62	9.92	10.78	10.35
T_2: *Azotobacter* 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	0.96	1.03	0.99	3.82	4.06	3.94	10.89	11.73	11.31
T_3: *Azotobacter* 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	0.86	0.95	0.91	3.45	3.7	3.58	9.78	10.64	10.21
T_4: *Azotobacter* 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	1.06	1.15	1.11	4.28	4.55	4.41	12.22	13.25	12.73
T_5: PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	1.09	1.19	1.14	4.43	4.69	4.56	**12.68**	**13.7**	**13.19**
T_6: PSB 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	1.01	1.1	1.06	4.06	4.33	4.19	11.58	12.56	12.07
T_7: PSB 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	0.86	0.94	0.9	3.44	3.68	3.56	9.73	10.55	10.14
T_8: PSB 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	0.9	0.98	0.94	3.58	3.83	3.7	10.18	11.04	10.61
T_9: VAM 20 g/kg seed + 20 kg Zn + 20 Sulphur kg/ha)	0.73	0.82	0.78	3.02	3.2	3.11	8.5	9.16	8.83
T_{10}: VAM 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	0.99	1.08	1.04	4	4.26	4.13	11.39	12.34	11.87
T_{11}: VAM 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	1.04	1.13	1.09	4.19	4.45	4.32	11.94	12.96	12.45
T_{12}: VAM 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	0.91	0.99	0.95	3.64	3.87	3.76	10.35	11.21	10.78
SEm±	1.24	0.04	0.03	0.15	0.16	0.11	0.43	0.49	0.33
CD (P=0.05)	3.65	0.13	0.09	0.45	0.47	0.32	1.26	1.45	0.93
CV (%)	7.44	7.44	7.45	7	6.92	6.96	6.91	7.32	7.14

effect of PSB, Zn, and S in promoting IAA production, leading to cell elongation and increased height. Similar findings were reported by (Meena *et al.*, 2011), (Hekmat *et al.*, 2019), and (Rajesh *et al.*, 2023).

Dry Matter Accumulation (g/plant)

Dry matter accumulation showed significant differences across treatments at 20, 40, and 60 DAS.

At 20 DAS, highest dry matter was recorded in T_5 (PSB + 20 kg Zn + 20 kg S) (1.09 g in 2020–21; 1.19 g in 2021–22; pooled 1.14 g), followed by T_4, T_6, T_{10}, and T_{11}. The lowest was in T_9 (0.73–0.82 g). At 40 DAS, maximum dry matter was in T_5 (4.43 g in 2020–21; 4.69 g in 2021–22; pooled 4.56 g). Lowest was in T_9 (3.02–3.20 g). At 60 DAS, the highest accumulation was again in T_5 (12.68 g in 2020–21; 13.70 g in 2021–22; pooled 13.19 g), while the lowest was in T_9 (8.50–9.16 g). Enhanced dry matter production under PSB with Zn and S is due to improved nutrient uptake, cell division, and shoot development. Azotobacter inoculation also improved growth attributes owing to its plant growth-promoting effect. These results corroborate the findings of (Kumar *et al.*, 2007), (Kole 2010), (Rafiq *et al.*, 2010), (Bhaladhare *et al.*, 2018), and (Mtaita *et al.*, 2019).

Crop Growth Rate (CGR, g/m²/day)

Crop growth rate differed significantly during 20–40 DAS and 40–60 DAS.

At 20–40 DAS, highest CGR was recorded in T_5 (0.33 g/m²/day in 2020–21; 0.35 in 2021–22; pooled 0.34). Lowest was in T_9 (0.23–0.24 g/m²/day). At 40–60 DAS, maximum was in T_5 (0.82 g/m²/day in 2020–21; 0.90 in

Table 3: Influence of Bio-fertilizer, growth regulators and micronutrients on crop growth rate (g/m²/day).

Treatment	Crop Growth Rate (g/m²/day)					
	20-40 DAS			40-60 DAS		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1: *Azotobacter* 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	0.26	0.28	0.27	0.64	0.7	0.67
T_2: *Azotobacter* 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	0.29	0.3	0.29	0.71	0.77	0.74
T_3: *Azotobacter* 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	0.26	0.28	0.27	0.63	0.69	0.66
T_4: *Azotobacter* 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	0.32	0.34	0.33	0.79	0.87	0.83
T_5: PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	0.33	0.35	0.34	0.82	0.9	0.86
T_6: PSB 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	0.31	0.32	0.31	0.75	0.82	0.79
T_7: PSB 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	0.26	0.27	0.27	0.63	0.69	0.66
T_8: PSB 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	0.27	0.29	0.28	0.66	0.72	0.69
T_9: VAM 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	0.23	0.24	0.23	0.55	0.6	0.57
T_{10}: VAM 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	0.3	0.32	0.31	0.74	0.81	0.77
T_{11}: VAM 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	0.31	0.33	0.32	0.78	0.85	0.81
T_{12}: VAM 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	0.27	0.29	0.28	0.67	0.73	0.7
SEm±	0.01	0.01	0.01	0.05	0.05	0.03
CD (P=0.05)	0.04	0.04	0.03	0.13	0.13	0.09
CV (%)	8.98	8.26	8.61	11.32	10.42	10.85

Table 4: Influence of Bio-fertilizer, growth regulators and micronutrients on relative growth rate (mg/g/day).

Treatment	Relative Growth Rate (mg/day)					
	20-40 DAS			40-60 DAS		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1: *Azotobacter* 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	138.52	136.3	137.41	104.26	105.71	104.99
T_2: *Azotobacter* 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	138.96	136.67	137.81	104.62	106.22	105.42
T_3: *Azotobacter* 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	138.39	136.21	137.3	104.08	105.47	104.77
T_4: *Azotobacter* 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	139.21	137.28	138.25	105.02	106.88	105.95
T_5: PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	140.57	137.45	139.01	105.14	107.06	106.1
T_6: PSB 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	139.07	136.91	137.99	104.82	106.52	105.67
T_7: PSB 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	138.25	136.14	137.19	103.85	105.32	104.58
T_8: PSB 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	138.61	136.45	137.53	104.4	105.94	105.17
T_9: VAM 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	141.46	135.96	138.71	103.56	105.19	104.37
T_{10}: VAM 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	139.04	136.91	137.97	104.75	106.39	105.57
T_{11}: VAM 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	139.14	137.04	138.09	104.9	106.69	105.8
T_{12}: VAM 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	138.73	136.6	137.66	104.5	106.16	105.33
SEm±	5.36	4.24	3.42	6.11	5.12	3.99
CD (P=0.05)	NS	NS	NS	NS	NS	NS
CV (%)	6.67	5.37	6.07	10.13	8.36	9.28

2021–22; pooled 0.86), followed by T_4, T_6, T_{10}, and T_{11}. Lowest was in T_9 (0.55–0.60 g/m²/day). Better CGR under PSB with Zn and S resulted from balanced macro- and micronutrient availability that enhanced photosynthetic activity. Azotobacter inoculation also contributed to improved growth through its microbial growth-promoting effects. Similar results were noted by (Bhaladhare *et al.*, 2018), (El-Shafey & El-Hawary 2016), and (Rafiq *et al.*, 2010).

Relative Growth Rate (RGR, mg/g/day)

RGR was non-significantly affected across treatments.

At 20–40 DAS, maximum RGR was observed with T_9 (141.46 mg/g/day in 2020–21; 135.96 in 2021–22; pooled 138.71), while the lowest was with T_7 (138.25–136.14; pooled 137.19). At 40–60 DAS, maximum was under T_5 (105.14 mg/g/day in 2020–21; 107.06 in 2021–22; pooled 106.10), while minimum was with T_9 (103.56–105.19; pooled 104.37). Although differences were not statistically significant, higher dry matter accumulation during early crop stages likely improved relative growth rate. Synergistic effects of bio-fertilizer, growth regulators, and micronutrients supported better growth, in line with findings of (Kole 2010), (El-Shafey & El-Hawary 2016), and Rajesh *et al.*, (2023).Plant height is one of the important growth parameters of any crop, which influences the yield attributing characters. The observations on plant height (cm) recorded at 20, 40, 60 days after sowing (DAS) and were analysed statistically during 2020-21 and 2021-22 are presented in Table 4.

Yield parameters

Number of Cobs per Plant

Table 5: Influence of Bio-fertilizer, growth regulators and micronutrients on number of cobs per plant.

Treatment	No. of cobs/plant			Cob length (cm)			Cob weight (g)		
	20-21	21-22	Pooled	20-21	21-22	Pooled	20-21	21-22	Pooled
T_1: *Azotobacter* 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	2.52	2.57	2.55	6.92	7.14	7.03	8.48	8.69	8.59
T_2: *Azotobacter* 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	2.78	2.84	2.81	7.56	7.79	7.68	9.31	9.54	9.42
T_3: *Azotobacter* 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	2.45	2.49	2.47	6.77	6.98	6.87	8.36	8.57	8.46
T_4: *Azotobacter* 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	3.04	3.1	3.07	8.22	8.49	8.35	10.45	10.7	10.58
T_5: PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	3.15	3.19	3.17	8.47	8.74	8.6	10.84	11.1	10.97
T_6: PSB 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	2.92	2.99	2.96	7.85	8.1	7.98	9.9	10.15	10.03
T_7: PSB 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	2.36	2.38	2.37	6.73	6.94	6.84	8.32	8.53	8.42
T_8: PSB 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	2.62	2.66	2.64	7.18	7.4	7.29	8.7	8.92	8.81
T_9: VAM 20 g/kg seed + 20 kg Zn + 20 Sulphur kg/ha)	2.22	2.23	2.22	6.25	6.43	6.34	7.27	7.46	7.36
T_{10}: VAM 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	2.85	2.92	2.89	7.73	7.99	7.86	9.74	9.98	9.86
T_{11}: VAM 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	2.98	3.03	3.01	8.07	8.31	8.19	10.21	10.46	10.33
T_{12}: VAM 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	2.72	2.78	2.75	7.43	7.68	7.56	8.85	9.07	8.96
SEm±	0.11	0.12	0.08	0.3	0.33	0.22	0.37	0.39	0.27
CD (P=0.05)	0.33	0.37	0.24	0.88	0.96	0.63	1.08	1.15	0.77
CV (%)	7.26	7.8	7.54	6.98	7.37	7.19	6.92	7.23	7.08

Table 6: Influence of Bio-fertilizer, growth regulators and micronutrients on cob yield (t/ha).

Treatment	Cob yield (t/ha)			Straw yield (t/ha)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1: *Azotobacter* 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	6.47	6.6	6.53	18.33	18.52	18.43
T_2: *Azotobacter* 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	7.12	7.26	7.19	20.07	20.27	20.17
T_3: *Azotobacter* 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	6.12	6.25	6.18	17.38	17.57	17.48
T_4: *Azotobacter* 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	8.25	8.43	8.34	22.97	23.38	23.17
T_5: PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	8.63	8.7	8.67	23.99	24.09	24.04
T_6: PSB 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	7.74	7.99	7.87	21.68	22.25	21.97
T_7: PSB 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	5.84	5.99	5.91	16.58	16.89	16.74
T_8: PSB 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	6.64	6.78	6.71	18.83	19	18.91
T_9: VAM 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha)	4.93	5.1	5.01	14.07	14.4	14.24
T_{10}: VAM 20 g/kg seed + (30 kg Zn + 30 Sulphur kg/ha)	7.61	7.79	7.7	21.41	21.7	21.55
T_{11}: VAM 20 g/kg seed + (40 kg Zn + 40 Sulphur kg/ha)	8.01	8.24	8.12	22.37	22.88	22.63
T_{12}: VAM 20 g/kg seed + (50 kg Zn + 50 Sulphur kg/ha)	6.88	7	6.94	19.45	19.57	19.51
SEm±	0.28	0.3	0.21	0.64	0.74	0.49
CD (P=0.05)	0.82	0.89	0.59	1.88	2.16	1.39
CV (%)	6.9	7.29	7.1	5.61	6.37	6.01

The number of cobs per plant was significantly influenced by the treatments during both years of study. The maximum number of cobs per plant was recorded under T_5: PSB 20 g/kg seed + (20 kg Zn + 20 kg S/ha) (3.15 in 2020–21; 3.19 in 2021–22; pooled 3.17), which remained at par with T_4, T_6, T_{10}, and T_{11}. The lowest number of cobs per plant was observed in T_9: VAM 20 g/kg seed + (20 kg Zn + 20 kg S/ha) (2.22–2.23). Higher cobs per plant with PSB, Zn, and S can be attributed to improved nutrient availability, better vegetative growth, and higher dry matter accumulation, which enhanced reproductive efficiency. These results are in agreement with (El-Shafey and El-Hawary 2016), (Singh *et al.*, 2018), and (Rajesh *et al.*, 2023).

Cob Length (cm)

Cob length was significantly affected by different treatments. The longest cobs were recorded in T_5 (8.47 cm in 2020–21; 8.74 cm in 2021–22; pooled 8.60 cm), which was statistically at par with T_4, T_6, T_{10}, and T_{11}. The shortest cob length was observed in T_9 (6.25–6.43 cm; pooled 6.34 cm). The increase in cob length is linked to better vegetative growth, nutrient uptake, and photosynthetic efficiency provided by bio-fertilizers and micronutrients. Similar findings were reported by (Fakirah and Alshabi 2015), (Fadlalla *et al.*, 2016), (Singh *et al.*, 2018) and (Rajesh *et al.*, 2023).

Cob Weight (g)

Cob weight differed significantly across treatments. The heaviest cobs were recorded in T_5 (10.84 g in 2020–21; (11.10 g) in 2021–22; and pooled 10.97 g), at par with T_4, T_6, T_{10}, and T_{11}. The lightest cobs were obtained in T_9 (7.27–7.46 g; pooled 7.36 g). Higher cob weight resulted from increased assimilate partitioning to reproductive parts due to improved nutrient availability and microbial activity. The results are consistent with those of (Yosefi *et al.*, 2011),(Fakirah and Alshabi 2015), (Fadlalla *et al.*, 2016), (Singh *et al.*, 2018) and (Rajesh *et al.*, 2023).

Cob Yield (t/ha)

Cob Yield: The maximum green cob yield was recorded under T_5 (6.71 t/ha in 2020–21; 6.89 t/ha in 2021–22; pooled 6.80 t/ha), statistically comparable with T_4, T_6, T_{10}, and T_{11}. The minimum yield was obtained in T_9 (4.50–4.57 t/ha).

Straw yield (t/ha)

Straw yield (t/ha): Similarly, T_5 produced the highest green fodder yield (22.78 t/ha in 2020–21; 23.64 t/ha in 2021–22; pooled 23.21 t/ha), while T_9 recorded the lowest (15.34–16.12 t/ha). The superior yields under PSB with Zn and S are attributed to enhanced photosynthetic activity, nutrient use efficiency, and better source–sink relationship. These results corroborate the findings of (Meena *et al.*, 2011), (Singh *et al.*, 2018), and (Rajesh *et al.*, 2023).

Conclusion

The present investigation clearly demonstrates that the integrated use of Bio-fertilizer, growth regulators and micronutrients sources significantly enhanced the growth, yield, and profitability of baby corn under open field conditions. Among the various treatments, PSB 20 g/kg seed + (20 kg Zn + 20 Sulphur kg/ha) (T_5) consistently outperformed all others across multiple growth parameters, including plant height, dry weight, grain number, test weight, grain yield, and harvest index. This treatment also provided the highest economic returns, indicating not only superior biological performance but also greater profitability. Treatments VAM 20 g/kg seed + 20 kg Zn + 20 Sulphur kg/ha) (T_9), followed closely in several traits, suggesting that these bio fertilizer sources also offer considerable advantages when integrated with recommended fertilizer doses.

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