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Effect of Seed Inoculation and Seaweed Extract on Growth and Yield of Baby-corn (*Zea mays* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Zaid,* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), India. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), organic carbon (0.69%), available N (271.81 kg/ha), available P (30.19 kg/ha), and available K (331 kg/ha). The treatments comprised of seed inoculation of bio-fertilizer and foliar application of Seaweed Extract *Kappaphycus alvarezii* (*K. sap*). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice for 60 days. The results showed that *viz:* Plant height (167.50 cm), plant dry weight (116.69 g/plant) were recorded significantly higher in *Azotobacter* Seed Inoculation along with *15% K.sap* spray. Number of cobs per plant (1.38), cob length with husk (21.40 cm), cob length without husk (8.36 cm), cob girth with husk (8.45 cm), cob girth without husk (5.83 cm), cob weight with husk (68.09 g), cob weight without husk (25.53 g), cob yield with husk (16.20 t/ha), cob yield without husk (5.68 t/ha), green fodder yield (31.05 t/ha) were recorded significantly higher. Thus, biofertilizer with foliar application of Seaweed Extract (*K. sap*) could be a promising option for yield enhancement in baby-corn.

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1. INTRODUCTION

Baby corn is the female inflorescence of immature corn plants harvested before fertilization within two days of silk emergence [1]. Because of its miniature size, consumers think that it grows from dwarf corn plants, but they are simply immature ears from regular-sized corn plants [2]. Baby corn is becoming popular in domesticand for eignmar ketsan dhasenor mous processing and exportpotential. Aninteresting recent development is of growing maize for vegetable purpose [3]. Currently, Thailand and China are the world leaders in baby corn production. InIndia, baby cornis being cultivatedin Meghalaya, Western Uttar Pradesh, Haryana, Maharashtra, Karnata kaand Andhra Pradesh[4].

Azotobacter, an aerobic free-living soil microbe widely used as biofertilizer, bindsatmospheric nitrogen and release it in the form of ammonium ions into the soils. They are ubiquitous and abundantly found in neutral or weakly acidic soils. Indrysoils, *Azotobacter* can survive in the form of cysts for up to 24 years [5]. The aerobicbacteria *Azotobacter chroococcum* known to fix considerable quantity of nitrogen in therange of 20- 40 kg of nitrogen per hectare in the rhizosphere in non-leguminous crops. The bact eriumproduces growth-promoting substances like *Indoleaceticacid*, *gibberellins*, pantothenic acid, thiamine and niacin which promotes root proliferation and improve the plant growth andyield [6]. *Azospirillum*re presented the best characterized genus of plant growth-promotingrhi zobacteria.Four majoras pectsofthe *Azospirillum*- plantroot sinteractionar ehighlighted: natural habitat, nitrogen fixation, plant root interaction and biosynthesis of grow thhor mones. *Azospirillum brasilense*, a bacterium which fixes nitrogen is found in the rhizosp here of various grass species and was investigated to establish the effect of growth substances which are produced by the bacteriaon plant growth [7].

In recent years, marine bioactive substances extracted from marine algae are used as supplement to the inorganic fertilizer. These substances, recently gained importance as foliar spray for many crops, which enhances yield and quality of crops due to presence of chemical complex polysacharide compounds like laminarian, fucoidan, alginate, beneficial nutrients and growth hormones like cytokinins, auxins, betains, and sterols which promote plant growth [8]. The efficacy of the extracts is probably based upon plant hormones and trace nutrients present in the extracts. Seaweed extract, significantly enhanced the growth and yield parameters. The spraying helps in the supply of recommended nutrients to the crop regularly. Blanket application of nutrients may not be taken by plants properly but, foliar application through plant parts consumes directy by crop [9].Therefore, present study was taken to investigate the Effect of Seed Inoculation and Seaweed Extract on growth and yield of baby corn (*Zea mays* L.).

2. MATERIALS AND METHODS

Germination of baby corn*var. G-5414*had recorded as 86.6%. A field trial was conducted during *Zaid,* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), India which is located at 25^{o}39”42” N latitude, 81^{o}67”56” E longitude, and 98m altitude above the mean sea level (MSL). The soil was sandy loam in texture,

Table 1. Composition of the evaluated treatments, with inoculation of biofertilizer seeds and foliar application of seaweed extract (K.sap)

Treatment No.	Treatment combination
1	*Azospirillum* Seed Inoculation + 5% *K.sap*
2	*Azospirillum* Seed Inoculation + 10% *K.sap*
3	*Azospirillum* Seed Inoculation + *15% K.sap*
4	*Azotobacter* Seed Inoculation + 5% *K.sap*
5	*Azotobacter* Seed Inoculation + 10% *K.sap*
6	*Azotobacter* Seed Inoculation + *15% K.sap*
7	No inoculation + 5% *K.sap*
8	No inoculation + 10% *K.sap*
9	No inoculation + *15% K.sap*

low in organic carbon and medium in available nitrogen, phosphorus, and low in potassium. The treatments comprised of seed inoculation of bio-fertilizer and foliar application of Seaweed Extract (*K. sap*). There were 9 treatments and each replicated thrice. Treatment was randomly arranged in each replication and divided into 27 plots.

The date of sowing was 26thFebruary 2022 with the seed rate of 20kg/ha. Blanket application with Recommended Dose of Fertilizer 120:60:40 NPK kg/ha. Foliar application of seaweed extract on 20 and 40 days after sowing. The growth parameters of the plants were recorded at frequent intervals from germination up until harvest at 60 days and finally, the yield parameters were recorded after harvest. The growth parameters such as plant height, plant dry weight. The yield parameters such as number of cobs per plant, cob length with husk, cob length without husk, cob girth with husk, cob girth without husk, cob weight with husk, cob weight without husk, cob yield with husk, cob yield without husk, green fodder yield. These parameters were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design [10].

3. RESULTS AND DISCUSSION

3.1 Effect on the Growth of Baby-corn

As can be seen in Table.2, growth parameters are summarized statistically.At 60 days after sowing (DAS), significantly taller plant height (167.50 cm) was recorded with application of *Azotobacter* Seed Inoculation along with *15% K.sap* spray. However, *Azotobacter* Seed Inoculation + 10% *K.sap, Azospirillum*Seed Inoculation + *15% K.sap* was statistically at par with *Azotobacter* Seed Inoculation + *15% K.sap* spray. The minimum plant height was recorded in the treatment combination of No inoculation along with 5% *K.sap* spray which is 143.49 cm. Significantly maximum dry weight (116.69 g) was recorded with application of *Azotobacter* Seed Inoculation along with *15% K.sap* spray. However, *Azotobacter* Seed Inoculation + 10% *K.sap* was statistically at par with *Azotobacter* Seed Inoculation + *15% K.sap* spray. The minimum dry weight was recorded in the treatment combination of No inoculation along with 5% *K.sap* spray which is 91.54 g. The results demonstrate that the application of two different seaweed liquidextracts (SLE) onbeanplant (*Phaseolusvulgaris*cv. Paulista), which enhanced heveget ative growth atlower concentrations of 25% of *Fucus spiralis* and 25% of *Ulvarigida* was found to have maximum influence on growth parameters like shoot and rootlength [11]. Application of 5% of *Gracilaria* extracts + 100% RDF had given higher plant height, number of branches, and grain yield per plot respectively when compared to control plot of RDF + water spray [12]. The in creaseins hootcharacteri sticsdueto the auxins content in the seaweed extracts which have an effective role in cell division and enlargement; this leadstoincreas etheshoot growth, leaf area and plant dry weight [13].

3.2 Effect on the Yield of Baby-corn

As can be seen in Table.3, yield parameters are summarized statistically. At the time of harvest, significantly maximum number of cobs per plant (1.38) recorded in *Azotobacter* Seed Inoculation along with *15% K.sap spray.* However, *Azospirillum* Seed Inoculation + 10% *K.sap, Azospirillum* Seed Inoculation + 15% *K.sap, Azotobacter* Seed Inoculation + 5% *K.sap, Azotobacter* Seed Inoculation + 10% *K.sap,* No inoculation + *15% K.sap* statitically at par with*Azotobacter* Seed Inoculation + *15% K.sap.* The minimum number of cobs per plant (1.04) recorded in No inoculation + 5% *K.sap spray.* At the time of harvest, significantly maximum Cob length with husk per plant (21.40 cm) recorded in *Azotobacter* Seed Inoculation along with *10% K.sap spray.* However, *Azospirillum* Seed Inoculation + 10% *K.sap, Azospirillum* Seed Inoculation + 15% *K.sap, Azotobacter* Seed Inoculation + 15% *K.sap,* statitically at par with *Azotobacter* Seed Inoculation + *10% K.sap.* The minimum Cob length with husk per plant (15.42 cm) recorded in No inoculation + 5% *K.sap spray.*At the time of harvest, significantly maximum Cob length without husk per plant (8.36 cm) recorded in *Azotobacter* Seed Inoculation along with *15% K.sap spray.* However, *Azospirillum* Seed Inoculation + 10% *K.sap, Azospirillum* Seed Inoculation + 15% *K.sap, Azotobacter* Seed Inoculation + 5% *K.sap, Azotobacter* Seed Inoculation + 10% *K.sap,* No inoculation + *15% K.sap* statitically at par with *Azotobacter* Seed Inoculation + *15% K.sap.* The minimum Cob length without husk per plant (7.08 cm) recorded in No inoculation + 5% *K.sap spray.* maximum Cob girth with husk per plant (8.45 cm) recorded in *Azotobacter* Seed Inoculation along with *15% K.sap spray.* However, *Azospirillum* Seed Inoculation + 10% *K.sap ,Azospirillum* Seed Inoculation + 15%

K.sap, Azotobacter Seed Inoculation + 5% *K.sap, Azotobacter* Seed Inoculation + 10% *K.sap,* No inoculation + *15% K.sap* statitically at par with *Azotobacter* Seed Inoculation + *15% K.sap.* The minimum Cob girth with husk per plant (6.64 cm) recorded in No inoculation + 5% *K.sap spray.* maximum Cob girth without husk per plant (5.83 cm) recorded in *Azotobacter* Seed Inoculation along with *15% K.sap spray.* However, *Azospirillum* Seed Inoculation + 10% *K.sap, Azospirillum* Seed Inoculation + 15% *K.sap, Azotobacter* Seed Inoculation + 10% *K.sap,* No inoculation + *15% K.sap* statitically at par with *Azotobacter* Seed Inoculation + *15% K.sap.* The minimum Cob girth without husk per plant (3.60 cm) recorded in No inoculation + 5% *K.sap spray.*Maximum weight of cob (68.09 g) recorded higher in *Azotobacter* Seed Inoculation + 10% *K.sap.* However, *Azospirillum*Seed Inoculation + 10% *K. sap, Azospirillum* Seed Inoculation + 15% *K.sap, Azotobacter* Seed Inoculation + 15% *K.sap* statitically at par with *Azotobacter* Seed Inoculation + *10% K.sap.*Maximum weight of cob (25.53 g) recorded higher in *Azotobacter* Seed Inoculation + 10% *K.sap.* However, *Azospirillum*Seed Inoculation + 10% *K.sap, Azospirillum* Seed Inoculation + 15% *K.sap, Azotobacter* Seed Inoculation + 15% *K.sap,* No inoculation + *15% K.sap* statitically at par with *Azotobacter* Seed Inoculation + *10% K.sap.* significantly maximum Cob yield with husk(16.20 t/ha) recorded higher in *Azotobacter* Seed Inoculation + 15% *K.sap.* However, *Azospirillum* Seed Inoculation + 10% *K.sap, Azospirillum* Seed Inoculation + 15% *K.sap, Azotobacter* Seed Inoculation + 10% *K.sap,* No inoculation + *15% K.sap* statitically at par with *Azotobacter* Seed Inoculation + *15% K.sap.* maximum Cob yield without husk(5.98 t/ha) recorded higher in *Azotobacter* Seed Inoculation + 15% *K.sap.* However, *Azospirillum* Seed Inoculation + 15% *K.sap, Azotobacter* Seed Inoculation + 10% *K.sap*statitically at par with *Azotobacter* Seed Inoculation + *15% K.sap.* At the time of harvest, maximum green fodder yield (31.05 t/ha) recorded higher in *Azotobacter* Seed Inoculation + 15% *K.sap.*The minimum green fodder yield (23.43 t/ha) recorded inNo inoculation + 5% *K.sap spray.* Seaweed liquid fertilizer derived from commonly available seaweeds acts as an effective fertilizer in increasing the growth and biochemical and yield characters of many crop plants. Further, SLF also improves soil fertility and sustainable yield [14]. They ieldsignificantly increased up to 27% and 23% under glasshouse condition by 2% SLF supplemented with 100% recommended rate of chemic alfertilizer, while groundnut recorded 30.6% increase in yield with 1% SLF supplemented with 100% recommende drate of chemicalfertilizer.The study reveal edthatthe SLF of *K. alvareziic*an be effectively used at low concentrations to promote germination, growth and yield in crop plants [15, 16] studied that the highest grain yield was recorded with applications of 15% *Kappaphykus*+ recommended dose of fertilizer which at par with 15% *Gracilaria* extracts + RDF resulting in an enhanced by 51 and 44% grain yield, respectively compared to the water applied plots in black gram. [17] carried out an experiment to study the foliar spray with different concentrations (5.0, 7.5, 10.0, and 15.0% v/v) of seaweed extracts (namely *Kappaphycus*and *Gracilaria*). Foliar applications of seaweed extract significantly

Table 2. Effect of Bio-fertilizer and seaweed (*Kappaphycu salvarizii*) extract on growth of baby corn

Treatment Combination	At 60 DAS	
	Plant height (cm)	Dry weight (g/plant)
1-*Azospirillum* Seed Inoculation + 5% *K.sap*	151.87	97.89
2-*Azospirillum* Seed Inoculation + 10% *K.sap*	160.36	107.61
3-*Azospirillum* Seed Inoculation + *15% K.sap*	164.41	111.09
4-*Azotobacter* Seed Inoculation + 5% *K.sap*	155.93	102.39
5-*Azotobacter* Seed Inoculation + 10% *K.sap*	165.12	115.23
6-*Azotobacter* Seed Inoculation + *15% K.sap*	167.50	116.69
7-No inoculation + 5% *K.sap*	143.49	91.54
8-No inoculation + 10% *K.sap*	146.03	95.02
9-No inoculation + *15% K.sap*	158.69	104.41
F test	S	S
SEm±	1.27	1.57
CD (P = 0.05)	3.78	4.67

Table 3. Effect of Bio-fertilizer and Seaweed (*Kappaphycu salvarizii*) extract on yield of baby corn

Treatment	Number of Cobs per plant	Cob length (cm)		Cob girth (cm)		Cob weight (g)		Cob yield (t/ha)		Green fodder yield (t/ha)
		With husk	Without husk	With husk	Without husk	With husk	Without husk	With husk	Without husk	
1	1.20	17.12	7.49	7.18	4.87	55.61	21.50	12.74	4.35	26.59
2	1.31	19.62	7.91	8.02	5.52	65.23	24.12	14.88	5.01	29.13
3	1.31	20.81	8.19	8.11	5.48	66.87	24.83	15.29	5.43	30.16
4	1.24	18.32	7.75	7.70	4.83	57.20	22.79	13.00	4.50	28.09
5	1.35	21.40	8.30	8.39	5.76	68.09	25.53	15.95	5.66	30.72
6	1.38	22.32	8.36	8.45	5.83	67.13	25.07	16.20	5.98	31.05
7	1.04	15.42	7.08	6.64	3.60	49.49	19.14	9.53	3.75	23.43
8	1.17	16.95	7.33	6.98	4.23	53.57	20.93	11.31	4.05	24.82
9	1.26	19.07	7.90	7.87	5.19	61.06	23.62	14.62	4.81	29.76
F test	S	S	S	S	S	S	S	S	S	S
SEm (±)	0.06	0.73	0.26	0.27	0.21	1.52	0.84	0.75	0.25	0.95
CD (p=0.05)	0.17	2.16	0.76	0.81	0.63	4.51	2.50	2.23	0.73	2.84

enhanced the growth and nutrient uptake. The highest dry matter production, seed yield nutrient uptake was recorded with applications of 15% *Gracilaria* sap + recommended dose of fertilizer (RDF), followed by 10% and 15% *Kappaphycus* sap + RDF extract resulting in an increased percentage of growth and nutrient uptake by the plant respectively compared to the control. [18] reported that increase in concentration of seaweed extract shows higher plant height and plant dry weight.

4. CONCLUSION

Based on my research trail, the treatment combination of *Azotobacter* Seed Inoculation along with *15% K. sap* (Treatment 6)was found to be more productive and also economically feasible. Although the findings are based on one season, further research is needed to confirm the findings and their recommendation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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