Original Research Article

"Influence of Seaweed Sap and Zinc on growth and yield of Baby corn (*Zea mays* L.)"

ABSTRACT

A field experiment was conducted during *Kharif* 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P) to determine the **"Influence of seaweed sap and Zinc on growth and yield of Babycorn (*Zea maize L.*)''** The results showed that treatment 9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)] recorded significantly higher plant height (176.75 cm), higher plant dry weight(g) (88.47), higher crop growth rate (88.27), higher relative growth rate (0.0910), maximum number of cobs/plant (2.82), maximum length of cob/plant (16.90 cm), maximum grith of cob (13.02 cm), maximum cob weight with husk(g) (47.57), maximum cob weight without husk(g) (11.57 g), maximum cob yield with husk (9.5t/ha), maximum green fodder yield (14.18t/ha) compare to other treatments. The maximum gross returns (99,900.00 INR/ha), maximum net return (62,464.00 INR/ha) and highest benefit cost ratio (1.68) was recorded in treatment 9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)] as compared to other treatments.

Keywords: Babycorn, Economics, Growth, Seaweed sap, Yield and Zinc.

INTRODUCTION

Baby corn is a vegetable picked from regular maize or sweet corn plants when the ears are still premature and immediately after the emergence of white silk (2–3 cm) length. It is a short season maize variety that can be grown throughout the year. The cobs from a baby corn crop take about 60–65 days to mature, and the rest of the plant can be utilized as green fodder. The young ear is de-husked, eaten raw as a salad and used to make vegetables, pickles, and soup. The nutritional value of baby corn is similar to that of several vegetables, including cauliflower, cabbage, tomato, and radish. The cultivation of the crop is gaining interest in India with increasing production in the states such as Meghalaya, Haryana, Maharashtra, Karnataka, and Andhra Pradesh. Farmers are becoming more interested in baby production due to its low production costs, high domestic demand, promising market, potential value addition, support for the domestic economy and higher revenue **Sale *et al.* (2022)**

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, 2019).**

zinc is the most commonly deficient micronutrient in agricultural soils. Analysis of over 256,000 soil samples from all over India showed that about 50% of the soils were deficient in zinc and it causes leaf bronzing and poor tillering at the early growth stages, leading to delayed maturity and significant yield loss, its main cause of deficiency of plant available Zn in soil is the precipitation or adsorption of Zn with various soil components, depending on the pH and redox potential **(Zinzala and Narwade 2019)**. Zinc is an essential micro nutrient for crop plants. Zinc is essential for several biochemical processes in rice plant, such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation and membrane integrity. Zinc enrichment leads to more root surface area and the ability to change chemistry and biology of rhizosphere by releasing phytosiderophores from roots which ultimately increases Zinc uptake by plants **(Suvarna *et al* .2015).** zinc is major component and activator of several enzymes involved in metabolic activities, its deficiency continues to be one of the key factors in determining rice production in several parts of country **(Muthukumararaja and Sriramachandrasekharan 2012)**. Foliar application of zinc usually applied under emergencies to save the crops to symptoms of Zinc appear. single foliar application may not be adequate to severe deficiency symptoms, foliar application of 0.5% aqueous solution of Zinc twice at 20 and 30 days after transplanting **(Verma *et al.*2019).**

Heavy application of inorganic fertilizer degrades the soil health and environment, under such situation there is no option left except to depend on the use of available organic and natural fertilizer. Seaweed sap can serve as an important source of organic liquid fertilizer as it contains abundant natural source of major and minor plant nutrients, amino acids vitamins, as well as growth promoting substances like cytokinines, auxins and abscisic acid and have been reported to stimulate the growth and yield of crops **(Zodape 2009, Crouch and Van-Staden 1993).**

Ascophyllum nodosum extracts are referred to as biostimulants in most scientific literature as they are typically used to stimulate plant growth. Even at extremely dilute (micromolar) concentrations, A. nodosum enhances plant, which may be attributed to the variety of plant hormones within this alga. Two of the most prominent hormones within A. nodosum are cytokinins and abscisic acid. Cytokinins are thought to improve nutrient uptake efficiency (N, P, K, etc.) by beneficially changing roots to be longer and thinner and can stimulate chlorophyll production. Abscisic acid has novel effects on plants when applied as a biostimulant and can reduce the risk of desiccation by closing leaf stomata. However, its functional effects in A. nodosum are unclear. Hormones are not the only beneficial substance in A. nodosum extracts. Other growth stimulators from this seaweed, such as various betaines, have been shown to combat common plant infections like bean rust on top of improving the amount of 6 stored chlorophyll. Additionally, a large portion of A. nodosum is comprised of phlorotannin polymers which neutralized harmful yeast fungi in an experiment using phlorotannins from other brown algae **(Dalzell *et al.* 2019).**

Blanket application of nutrients may not be taken by plants properly but, foliar application through plant parts consumes directy by crop. Besides, it is economically cheaper than chemical fertilizer and eco-friendly source of nutrients. In India as a step towards the expansion of native source of natural manures, the seaweed liquid fertilizer application can be utilize as a booster for yield enhancement of crops. **(singh *et al.* 2015).** Bio-stimulant substances extracted from marine algae are used as fertilizer to increase the quality and yield of plants. Seaweed extract is natural organic fertilizers which is highly effective nutrient and promotes maximum yield, quick germination of seeds and ability of resistance of many crops **(Dewivedi *et al.*2014)**. The efficacy of the bio-stimulant over 27 different vegetable crops with the application of seaweed K. alvarezii. Application of 3–4 foliar applications based on the crop cycle improved the growth, yield, and quality of the produce. An increase of 11% to 52% in the yield levels were noticed for different vegetable crops **Karthikeyan and Shanmugam (2016)**. Keeping in view the above fact, the experiment was conducted to find out "Influence of Seaweed Sap and Zinc on growth and yield of Baby corn (*Zea mays L.*)"

MATERIALS AND METHODS

The experiment was conducted during *Kharif* season of 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P). The soil of the field constituting a part of central gangetic alluvium is neutral and deep. The soil of the experimental field was sandy loam in texture, slightly alkalinein soil reaction (pH 8), low level of organic carbon (0.28%), available N (219 Kg/ha), P (11.6 kg/ha) and K (217.2 kg/ha). The experiment was conducted in randomized block design consisting of 10 treatments with 3 different levels of Seaweed sap viz. 5%, 10%, 15% (15 & 30 DAS), three different levels of Zinc viz. 10, 15, 20 (basal application) with 3 replications and the treatments were allocated randomly in each replication. The treatment combinations are Treatment 1. ZnSO4 10kg/ha + Seaweed sap 5%, Treatment 2 ($ZnSO_4$ 10kg/ha + Seaweed sap 10%), Treatment 3 ($ZnSO_4$ 10kg/ha + Seaweed sap 15%), Treatment 4 ($ZnSO_4$ 15kg/ha + Seaweed sap 5%), Treatment 5 ($ZnSO_4$ 15kg/ha + Seaweed sap 10%), Treatment 6 ($ZnSO_4$ 15kg/ha + Seaweed sap 15%), Treatment 7 ($ZnSO_4$ 20kg/ha + Seaweed sap 5%), Treatment 8 ($ZnSO_4$ 20kg/ha + Seaweed sap 10%), Treatment 9 ($ZnSO_4$ 20kg/ha + Seaweed sap 15%), Treatment 10 (Control (90:60:40 NPK Kg/ha). Growth parameters, yield attributes and economics was recorded. Data recorded on different aspects of crop, such as, growth, yield attributes and yield were subjected to statistical analysis by analysis of variance method **(Gomez and Gomez, 1976).**

RESULT AND DISSCUSSION

Growth parameters

Plant height (cm)

Data revealed that significantly and higher plant height (176.75 cm) was recorded in the treatment 9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)] (Table 1). Significant and higher plant height was observed with application of Zn might be due to it plays a major role in metabolic activity, physiological reaction and act as a catalyzing enzymes transformation of carbohydrates, chlorophyll and protein synthesis. Similar results were also reported by **Ammisetty *et al.* (2021).** Further, significant and higher plant height was recorded with application of Seaweed sap increases shoot characteristics due to the auxins content in the seaweed sap extracts which have an effective role in cell division and cell enlargement this may have leads to increase shoot growth, leaf area. Similar results were also reported by **Bezawada *et al.* (2022).**

Plant dry weight (g)

The results revealed that significantly higher plant dry weight (88.47g) was recorded in treatment 9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)]. Significant and higher plant dry weight was with the application of Zinc(20kg/ha) might be due to the involvement of zinc in auxin metabolism, which led to increase higher hormonal activity and growth performance at critical crop growth stages. Similar results were reported by **Kumar *et al.* (2013).** Further, higher plant dry weight was recorded with application of Seaweed sap (15%) may be due to increase of shoot characteristics due to the auxins content in the seaweed sap extracts which have an effective role in cell division and enlargement this leads to increase shoot growth, leaf area and plant dry weight. Similar results were also reported by **Raviteja *et al.* (2022)**.

Crop growth rate (g/m^2/day)

The data was found significantly higher crop growth rate (88.27) was recorded in treatment 9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)]. Significant and higher crop growth rate was recorded with the application of Zinc (20kg/ha) might be due to the involvement of zinc in auxin metabolism, which lead to higher hormonal activity and growth performance at critical crop growth stages, resulted higher crop growth rate. Similar results were also described by **Kumar *et al.* (2014).**

Relative growth rate (g/g/day)

Data found that significant and higher relative growth rate (0.0910g/g/day) was recorded in treatment 9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)]. Significant and higher relative growth rate was recorded with application of seaweed sap (15%) might be due to presence of amino acids like betainies and sterols which enhance the photosynthetic activity, N metabolism and protein synthesis which boost corn production and also availability growth regulators in extract especially Auxin and Cytokinin which are responsible for internodal elongation and cell enlargement and there by increases the relative growth rates. Similar findings also reported by **Hegede *et al.* (2016).**

Table 1. Effect of Seaweed sap and Zinc levels on growth attributes of Baby Corn.

S. No.	Treatments combinations	60 DAS		45-60 DAS	
		Plant height (cm)	Plant dry weight (g)	Crop growth rate (g/m^2/day)	Relative growth rate (g/g/day)
1.	$ZnSO_4$ (10kg/ha) + Seaweed sap (5%)	164.02	73.02	68.38	0.0667
2.	$ZnSO_4$ (10kg/ha) + Seaweed sap (10%)	162.26	75.09	68.54	0.0639
3.	$ZnSO_4$ (10kg/ha) + Seaweed sap (15%)	165.02	72.65	62.40	0.0580
4.	$ZnSO_4$ (15kg/ha) + Seaweed sap (5%)	167.39	74.13	64.46	0.0590
5.	$ZnSO_4$ (15kg/ha) + Seaweed sap (10%)	166.78	76.11	66.72	0.0597
6.	$ZnSO_4$ (15kg/ha) + Seaweed sap (15%)	166.26	80.28	69.59	0.0587
7.	$ZnSO_4$ (20kg/ha) + Seaweed sap (5%)	169.23	83.31	71.50	0.0577
8.	$ZnSO_4$ (20kg/ha) + Seaweed sap (10%)	174.61	86.95	75.12	0.0583
9.	$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)	176.75	88.42	97.53	0.0910
10.	Control (120:60:40) NPK kg/ha	162.77	70.79	60.11	0.0568
	F- test	S	S	S	S
	SEm(±)	2.23	0.68	1.40	0.0018
	CD (p = 0.05%)	6.64	2.02	4.17	0.00528

Yield and Yield parameters

Number of cobs/plant

Data revealed that significant and maximum number of cobs/ plant (2.82) was observed in treatment 9[($ZnSO_4$ 20kg/ha) + (Seaweed sap 15%)] which was superior over all other treatments. significant and maximum number of cobs/plant was with the application of Zinc (20kg/ha) might be due to higher chlorophyll contents and this had apparently a positive effect of photosynthetic activity synthesis of metabolites and growth regulator substances, oxidation and metabolic activities and ultimately better growth and development of crop which leads to increase in yield attributes namely number of cob/plant of baby corn. Similar findings also reported by **Meena *et al*. (2013).** Further, significantly increase in number of cobs/plant was with the application of seaweed sap may be due to an effective fertilizer in increasing the growth, biochemical, yield characters of many crop plants and it also improves soil fertility and sustainable yield. Similar findings also reported by **Raviteja *et al.* (2022).**

Length of cob/plant (cm)

Results revealed that significant and maximum length of cob/plant (16.90 cm) was observed in treatment 9[($ZnSO_4$ 20kg/ha) + (Seaweed sap 15%)] which was superior over all other treatments. significant and maximum length of cob/plant was with the application of Zinc (20kg/ha) might be due to continuous filling of grains due to sufficient photosynthesis might have resulted in increased length and size of the cob. Similar findings also reported by **Sravan *et al*. (2014).**

Girth of cob/plant (cm)

Data found that significant and maximum grith of cob (13.02 cm) was observed in treatment 9[($ZnSO_4$ 20kg/ha) + (Seaweed sap 15%)] which was superior over all other treatments. significant and maximum grith of cob was with the application of Zinc (20kg/ha) might be due to higher contents and this had apparently positive effect on photosynthetic activity, synthetic metabolites and growth elongating substances lead to better growth and development. Similar findings also reported by **Chand *et al*. (2017).**

Cob weight with husk (g/ha)

Results found that significant and maximum cob weight with husk of baby corn, (47.57 g) was observed in treatment 9[($ZnSO_4$ 20kg/ha) + (Seaweed sap 15%)] which was superior over all other treatments. significant and maximum cob weight with husk was with the application of Zn (20kg/ha) might be due to its role in photosynthesis and metabolic process augments the production of photosynthates and their translocation to different plant parts. Similar findings also reported by **Karrmi *et al*. (2017).**

Cob weight without husk (g/ha)

Results showed that significant and maximum cob weight with husk of baby corn, (11.57 g) was observed in treatment 9[($ZnSO_4$ 20kg/ha) + (Seaweed sap 15%)] which was superior over all other treatments. Significant and maximum cob weight without husk maximum was with the application of Zn (20kg/ha) might be due to vigorous root development, which promotes growth and development of plant leading to higher photosynthetic activity, which may have results in better development of yield attributes. Similar findings also reported by **Karrimi *et al*. (2018).**

Table 2. Effect of Seaweed sap and Zinc levels on yield attributes of Baby Corn.

S. No.	Treatments	Number of cobs per plant	Length of cob (cm)	Girth of cob (cm)	Cob weight with husk (gm)	Cob weight without husk (gm)
1.	$ZnSO_4$ 10kg/ha + Seaweed sap 5%	2.23	11.25	11.28	41.84	10.21
2.	$ZnSO_4$ 10kg/ha + Seaweed sap 10%	2.34	11.74	11.59	43.45	10.68
3.	$ZnSO_4$ 10kg/ha + Seaweed sap 15%	2.31	12.42	11.36	44.11	10.78
4.	$ZnSO_4$ 15kg/ha + Seaweed sap 5%	2.35	12.01	11.43	43.77	10.79
5.	$ZnSO_4$ 15kg/ha + Seaweed sap 10%	2.30	12.38	12.01	44.25	11.23
6.	$ZnSO_4$ 15kg/ha + Seaweed sap 15%	2.36	12.43	12.32	45.57	11.56
7.	$ZnSO_4$ 20kg/ha + Seaweed sap 5%	2.41	12.70	12.35	45.94	11.52
8.	$ZnSO_4$ 20kg/ha + Seaweed sap 10%	2.71	12.72	12.64	47.51	11.76
9.	$ZnSO_4$ 20kg/ha + Seaweed sap 15%	2.82	16.90	13.02	47.57	12.01
10.	Control	2.05	11.02	10.81	39.88	10.02
	F-test	S	S	S	S	S
	SEm (±)	0.15	0.34	0.25	0.457	0.18
	CD (p=0.05)	0.44	1.01626	0.74	1.36	0.54

Cob yield with husk (t/ha)

Data found that significant and maximum cob yield with husk of baby corn, (9.5t/ha) was observed in treatment 9[($ZnSO_4$ 20kg/ha) + (Seaweed sap 15%)] which was superior over all other treatments. significant and maximum cob yield with husk was with the application of Zn (20kg/ha) might be due to beneficial effect on physiological process, plant metabolism and plant growth, which might have leads to higher cob yield with husk. Similar findings also reported by **Chand *et al*. (2017).** Further, significant and maximum cob yield with husk was with the application of seaweed sap may be due to acting as an effective fertilizer in increasing the biochemical for growth and yield character of plants, which increased cob yield with husk. Similar findings also reported by **Raviteja *et al*. (2022).**

Green fodder yield (t/ha)

Results reveled that significant and maximum cob weight with husk of baby corn, (14.18t/ha) was observed in treatment 9[($ZnSO_4$ 20kg/ha) + (Seaweed sap 15%)] which was superior over all other treatments.Significant and maximum green fodder yield was with the application of Zn (20kg/ha) might be due to enhanced translocation of photosynthesis with applied zinc, which resulted in higher production in respective levels of essential nutrients. Similar findings also reported by **Chand *et al*. (2017).** Further, significant and maximum green fodder was with the application of seaweed sap may be due to saps also enhance nutrient uptake by maize cob and fodder; hence the presence of some macro and micro-elements and plant growth regulators, especially cytokinins, IAA, GA, responsible for increase in yield of baby corn. Similar findings also reported by **Pal *et al*. (2015).**

Table 3. Effect of Seaweed sap and Zinc levels on yield of Baby Corn.

S. No.	Treatments	Cob yield with husk (t/ha)	Green fodder yield (t/ha)
1.	$ZnSO_4$ 10kg/ha + Seaweed sap 5%	7.57	22.37
2.	$ZnSO_4$ 10kg/ha + Seaweed sap 10%	7.90	23.49
3.	$ZnSO_4$ 10kg/ha + Seaweed sap 15%	8.22	23.22
4.	$ZnSO_4$ 15kg/ha + Seaweed sap 5%	8.71	23.37
5.	$ZnSO_4$ 15kg/ha + Seaweed sap 10%	8.64	23.64
6.	$ZnSO_4$ 15kg/ha + Seaweed sap 15%	8.73	23.73
7.	$ZnSO_4$ 20kg/ha + Seaweed sap 5%	9.00	24.00
8.	$ZnSO_4$ 20kg/ha + Seaweed sap 10%	9.46	24.12
9.	$ZnSO_4$ 20kg/ha + Seaweed sap 15%	9.95	24.61
10.	Control	7.05	20.76
	F-test	S	S
	SEm (±)	0.18	0.19
	CD (p=0.05)	0.53	0.58

Economics analysis

The result showed that maximum gross returns (99.500.00 INR/ha), Maximum net return (62.464.00INR/ha) and highest benefit cost ratio (1.68) was recorded treatment-9 ($ZnSO_4$ 20kg/ha) + (Seaweed sap 15%). Higher B:C ratio was with application of Zn (20kg/ha) might be due to increase in yield attributes, higher gross return, net returns was found economically viable. Similar results also reported by **Chand *et al.* (2022).** Further, higher B:C ratio was with application of seaweed sap (15%) may be due to application as a foliar organic nutrient source for enhancing growth and yield of maize, which adds higher gross returns, net returns. Similar results also reported by **Basavaraja *et al.* (2018).**

Table 4. Effect of Zinc and Seaweed sap on Economics of Baby corn.

S. No.	Treatments	Total cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1.	$ZnSO_4$ 10kg/ha + Seaweed sap 5%	35,036	75700	40664	1.16
2.	$ZnSO_4$ 10kg/ha + Seaweed sap 10%	35,536	79000	43464	1.22
3.	$ZnSO_4$ 10kg/ha + Seaweed sap 15%	36,036	82220	46184	1.28
4.	$ZnSO_4$ 15kg/ha + Seaweed sap 5%	35,536	87100	51564	1.45
5.	$ZnSO_4$ 15kg/ha + Seaweed sap 10%	36,036	86400	50364	1.39
6.	$ZnSO_4$ 15kg/ha + Seaweed sap 15%	36,536	87300	50764	1.38
7.	$ZnSO_4$ 20kg/ha + Seaweed sap 5%	36,036	90000	53964	1.49
8.	$ZnSO_4$ 20kg/ha + Seaweed sap 10%	36,536	94600	58064	1.58
9.	$ZnSO_4$ 20kg/ha + Seaweed sap 15%	37,036	99500	62464	1.68
10.	Control	33,536	70500	36964	1.10

CONCLUSION:

Based on the above findings it is concluded that application of $ZnSO_4$ (20kg/ha) and Seaweed sap (15%) perform better growth parameters and yield attributes of baby corn and also proven profitable.

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