Original Research Article

Influence of Seaweed Sap and Zinc on Growth and Yield of Baby Corn(*Zea mays*L.)

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Abstract

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A field experiment was conducted during*Kharif*(between June and November)of 2 0 2 2 ,at Crop Research Farm, Departmentof Agronomy,Sam Higginbottom University of Agriculture,Technology andSciences,Prayagraj (U.P). The aim of this experiment was to determine the **"Influence of seaweed sap and Zinc on growth and yield of Baby corn (*Zea maize L.*)''**Theresultsshowedthattreatment9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)] recorded significantly higher plant height (176.75 cm), higherplantdryweight(88.47 g), higher crop growth rate (88.27 cm), higher relative growth rate (0.0910), maximum number of cobs/plant (2.82), maximum length of cob/plant (16.90 cm), maximum girthof cob (13.02 cm), maximum cob weight with husk (47.57 g), maximum cob weight without husk(11.57 g), maximum cob yield with husk (9.5t/ha), maximum green fodder yield (14.18t/ha) compare to othertreatments. Themaximumgrossreturns(99,900.00INR/ha),maximumnetreturn(62,464.00 INR/ha) andhighestbenefitcostratio(1.68) wasrecordedintreatment9[$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)]ascomparedtoothertreatments.

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Keywords: Baby corn,Economic analysis, Significant, Growth, Seaweed sap, Yield, Zinc.

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1. 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 this crop is gaining interestand getting grounded in India with its increasedproduction in the states such as Meghalaya, Haryana, Maharashtra, Karnataka, and Andhra Pradesh. Farmers are becoming more interested in babycorn 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**)

India, which is the fifth-largest producer of maize 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 stagesof maize, leading to delayed maturity and significant yield loss (). The 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 micronutrient for crop plants (**Majamanda *et al.*, 2022).** Zinc is essential for several biochemical processes in rice plant, such as cytochrome and nucleotide synthesis, auxins 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

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enzymes involved in metabolic activities, and its deficiency in the soil 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 is usually done under emergencies to save the crops from symptoms of Zinc deficiency. 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 is recommended **(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 such as amino acids, vitamins, as well as growth promoting substances like cytokinines, auxins and abscisic acid. These 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 plantgrowth, and this may be attributed to the variety of plant hormones within this alga (A. *nodosum*). Two of the most prominent hormones within A. *nodosum* are cytokinines and abscisic acid. Cytokinines are thought to improve nutrient uptake efficiency of N, P and K by 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 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 is effective due to the fact that the plant consumes the nutrient directly (). Besides, it is economically cheaper than chemical fertilizer and it is an eco-friendly source of nutrients. In India as a step towards the expansion of native source of natural manures, the

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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 fertilizer which is highly effective nutrient and promotes maximum yield, quick germination of seeds and help boost resistance of many crops to pests and diseases**(Dewivedi *et al.*, 2014)**. The efficacy of the bio-stimulant over 27 different vegetable crops with the application of seaweed K. *alvarezii* has been reported by **Karthikeyan and Shanmugam (2016)**. 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 of the abovefacts, the experiment was conducted to find out the “Influence of Seaweed Sap and Zinc on growth and yield of Baby corn(*Zea maysL.*)”

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2. Material and methods

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Theexperimentwasconductedduring*Kharif*seasonof2022atCropResearchFarm,Department of Agronomy, Sam Higginbottom University of Agriculture, Technology andSciences, Prayagraj (U.P). The soil of the field constituting a part of central gangetic alluviumisneutralanddeep.Thesoiloftheexperimentalfieldwas sandyloamintexture,slightlyalkalineinsoilreaction(pH8),lowlevelocorganiccarbon(0.28%),availableN(219Kg/ha),P(11.6kg/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 were recorded.

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3. Data analysis

Data recorded on different aspects of crop, such as,growth, yield attributes andyield were subjected tostatistical analysis by analysis of variance method**(Gomez andGomez,1976).**

4. Results and discussions

4.1 Growthparameters

4.1.1 Plantheight(cm)

Data showsthat significantlyhigher plant height (176.75 cm) was recorded in the treatment 9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)](Table 1).The Significantly higher plant height that was observed with application of Zn might be due to its major role in metabolic activity, physiological reaction and its action in catalyzing enzymes transformation of carbohydrates, chlorophyll and protein synthesis which would in the end help the plant to gain the height. Similar results were also reported by **Ammisetty*et al.* (2021).** Further, significant and higher plant height was recorded with application of Seaweed sap.

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. These may have led to increase in shoot growth and leaf area, similar to results reported by **Bezawada *et al.* (2022).**

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4.1.1 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%)]. Significantly higher plant dry weight was with the application of Zinc(20kg/ha) which might be due to the involvement of zinc in auxin metabolism, which led to increased higher hormonal activity and growth performance at critical crop growth stages (**Kumar *et al.*, 2013).** Further, higher plant dry weight was recorded with application of Seaweed sap (15%). This may have been due to increase in shoot characteristics due to the auxins content in the seaweed sap extracts which have an effective role in cell division and enlargement. Increased cell division and enlargementleads to increased shoot growth, leaf area and plant dry weight (**Raviteja *et al.*, 2022)**.

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

The results also revealed significantly higher crop growth rate (88.27) in treatment 9 [$ZnSO_4$(20kg/ha) + Seaweed sap (15%)].This crop growth rate was recorded with the application of Zinc (20kg/ha) which 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 hence resulting into higher crop growth rate (**Kumar *et al.*, 2014).**

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4.1.4 Relative growth rate (g/g/day)

The study also revealed significantly higher relative growth rate of (0.0910g/g/day) in treatment 9 [$ZnSO_4$ (20kg/ha) + Seaweed sap (15%)]with application of seaweed sap (15%). The higher significant growth rate might be due to presence of amino acids like betainies and sterols which enhance the photosynthetic activity of N metabolism and protein synthesis. These boost corn production and also availability of growth regulators in extracts especially Auxin and Cytokinines which are responsible for intermodal elongation and cell enlargement there by increases the relative growth rates (**Hegede *et al.*,2016).**

Table 1. Effect of Seaweed sap and Zinc levelson 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

4.2 Yield and Yield parameters

4.2.1 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. This observation was with the application of Zinc (20kg/ha) which might be due to higher chlorophyll content production which might apparently have a positive effect on photosynthetic activity, synthesis of metabolites and growth regulator substances. It might have also influenced oxidation and metabolic activities and ultimately induce better growth and development of crop which led to increase in yield attributes namely number of cob/plant of baby corn (**Meena *et al.*, 2013).** Further, significantly increase in number of cobs/plant was with the application of seaweed sap which may have increased organic fertilizer resulting in increased biochemicals, growth and yield characters. Organic fertilizer improves soil fertility and sustainable yield in crops (**Raviteja *et al.*, 2022).**

4.2.2 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.This significant and maximum length of cob/plantwas with the application of Zinc (20kg/ha). It might have resulted to this finding due tocontinuous filling of grains influenced by zinc availability (). Sufficient photosynthesis might also have resulted in increased length and size of the cob **(Sravan*et al.*, 2014).**

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4.2.3 Girth of cob/plant (cm)

Data found that significant and maximum girth 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 girth of cob was with the application of Zinc (20kg/ha) and might have come due to higher zinc contents and this had apparently positive effect on photosynthetic activity, synthetic metabolites and growth elongating substances which led to better growth and development of the crop (**Chand *et al.*, 2017).**

4.2.4 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) and might be due to its role in photosynthesis and metabolic processwhich augments the production of photosynthates and their translocation to different plant parts (**Karrmi *et al.*, 2017).**

4.2.5 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) and might be due to vigorous root development induced by zinc, which promotes growth and development of plant leading to higher photosynthetic activity, this may have also resulted in better development of yield attributes such as ….. (**Karrimi *et al.*, 2018).**

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Table 2. Effect of Seaweed sap and Zinc levelson yieldattributes 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

4.2.6 Cob yield with husk (t/ha)

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

4.2.7 Green fodder yield (t/ha)

Results revealed 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) which might have enhanced translocation of photosynthetic materials and might have resulted in higher production in respective levels of essential nutrients (**Chand *et al.*, 2017).** Further, significant and maximum green fodder was with the application of seaweed sap Saps also enhance nutrient uptake by maize cob and fodder; hence the presence of some macro and micro-elements and plant growth regulators, especially cytokinines, IAA, GA, were responsible for increase in yield of baby corn (**Pal *et al*., 2015).**

Table 3. Effect of Seaweed sap and Zinc levelson 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

4.3 Economics analysis

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

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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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