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RESEARCH ARTICLE

Foliar Application of Seaweed Bio Formulation Enhances Growth and Yield of Banana cv. Grand Naine (AAA)

I.Ravi[1]*, K.Kamaraju[1], Sawan Kumar[2]. Sri Sailaja Nori[2]

[1]Principal Scientist, ICAR-National Research Center for Banana, Thayanur Post, Trichy -620102,India.
[2]Sea6Energy Pvt. Ltd. C-CAMP, NCBS-TIFR, GKVK , Campus, Bellary Road, Bengaluru - 560 065, India.

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***Address for correspondence**
Dr I Ravi, Principal Scientist,
Crop Production Section
ICAR-National Research Center for Banana
Thayanur Post, Trichy -620102, TN, India
E. mail address: iravi24@gmail.com; Ravi.I@icar.gov.in

ABSTRACT

Seaweed extracts have been reported to improve the yield and quality of different fruits and vegetables. In this study, a field experiment was conducted at National Research Center for Banana, Trichy, and Tamil Nadu, to evaluate the effect of different seaweed bio-formulations developed by Sea6Energy Pvt Ltd. Bangalore, on growth, yield and quality of Banana cv.Grand Naine. Four different seaweed formulations (LBS) were applied as foliar spray at vegetative and early flowering stages of the plant. It was observed that foliar application of LBS6S@1ml/L improved the bunch weight significantly by 25.24% over control followed by LBS3@5ml/L with 12.62% over water control. The number of hands and fingers per bunch also increased to 5.78% and 6.6% respectively with LBS6S @1ml/l treatment over control.

Keywords: Banana, cv. Grand Naine, Sea weed Bio formulations, Yield.

INTRODUCTION

Banana is an economically important fruit crop. It is the second most important fruit crop in India next to mango. Banana is very popular fruit due to its year round availability, taste, low price and high nutritive value. India is the largest producer of Banana in the world, followed by China, Philippines, Brazil and Ecuador. As per NHB estimate (National Horticulture Board), India produces 29.895 million tons on an area of 0.837 million ha [1]. Around 87% of all the bananas grown worldwide are produced by small-scale farmers for domestic use, while the remaining 13%, mainly dessert bananas, are traded internationally. Production of Banana is highest in Maharashtra (3924.1 mt), followed by Tamilnadu (3543.8 mt). It accounts for 13% of the total area and 33% of the production of fruits.

The banana cv. Grand Naine (AAA) is a Cavendish group of banana and an internationally accepted dessert banana cultivar. It is also extensively used for processing purposes and has occupied the premier export market. Grand Naine is gaining popularity due to its tolerance to abiotic stresses and its fruit quality such as size, colour, well-spaced hands, shelf life etc. as compared to other cultivars. Food security and climate change is one of the major challenges across the world. Sustainable agriculture has the unique potential to mitigate climate change and strengthen resilience to the impacts of climate change. Vision for sustainable agriculture is therefore important for the world. The use of eco-friendly bio-products such as seaweed extracts has emerged as one of the important strategies for sustainable agriculture. Use of seaweed extracts in agriculture could deliver an important contribution to sustainable food production.

Seaweeds are macroscopic, multicellular marine algae that commonly inhabit the coastal regions of the world's oceans. There are more than 9,000 species of macroalgae which are broadly classified into three main groups viz., Rhodophyta (red algae), Phaeophyta (Brown algae) and Chlorophyta (green algae), based on pigments present in them. The scientific benefits of applying seaweed extracts in agriculture have been extensively reported and well-reviewed in peer-reviewed scientific publications and more broadly in the plant biostimulant [2, 3, and 4]. Seaweed extracts have been used to increase crop yield, improve growth and induce resistance to biotic an abiotic stress and increase nutrient uptake from soil.Around 15 million metric tonnes of seaweed products are produced annually (FAO 2006), a considerable portion of which is used for nutrient supplements and as biostimulants or biofertilizers to increase plant growth and yield. Extract of *Ascophyllum nodosum*, a cold water brown macroalage is well documented for its use in agriculture. Its application has been shown to increase yield and productivity of different crops such as lettuce, cauliflower, spinach etc. [5, 6, 7, 8]. However, this seaweed is harvested from the wild stocks from the natural bed of the ocean. This limits its scalability in agriculture with the growing demand of food around the world.

Kappaphycus alvarezii is tropical seaweed and it is being cultivated in India since more than a decade for extraction of thickening agent called kappa-carrageenan using traditional farming systems. Extracts from Kappaphycus have also been reported to improve crop productivity. Foliar application of *K. alvarezii* extract on okra significantly increased the yield (20.47%) [9]. Similarly, application of *K. alvarezii* extract improved yield of wheat (*Triticum aestivum*). The nutritional quality of grain such as carbohydrate, protein and minerals was also improved under the influence of treatment [10]. Sea6Energy Pvt. Ltd., Bangalore has developed mechanised farming system to cultivate *Kappaphycus alvarezii* in rough sea water using patented technologies [11]. The company has also prepared different liquid bio-formulations from *Kappaphycus alvarezii* for use in agriculture using patented technology of seaweed processing [12].

The present study is to investigate the potential of different seaweed derived formulations on improving the yield and fruit quality of banana (var. Grand Naine) under field condition. The field trial was conducted at National Research Center for Banana (ICAR), Trichy, and Tamil Nadu.

MATERIALS AND METHODS

Preparation of seaweed extract

Kappaphycus species of seaweed biomass was cultivated in the tropical waters of southeast coastline of the Indian states. The seaweed biomass thus obtained was crushed to separate solid and liquid fractions. These fractions were further processed to prepare different extracts using the patented methods of extraction by Sea6 Energy Pvt Ltd [12].

Preparation of trial plot

The experiment was conducted at Research and Development plot of National Research Centre for Banana, Tamilnadu farm located at 10° 50' N latitude 74° 50' E longitude. Prior to planting banana, land was ploughed and levelled. During soil preparation basal dose of FYM is added and thoroughly mixed into the soil. A pit size of 45cm x 45cm x 45cm is dug out. Prepared pits were left to solar radiation helps in killing the harmful insects, are effective against soil borne diseases and aids aeration. The pits were refilled with topsoil mixed with 5 kg of FYM (well decomposed), 300g of single super phosphate, and 150 gm of Neem cake and 10 gm of Carbofuran. After that the pits were irrigated well a day before planting and planted next day in the pit after removing the plastic bags of tissue cultured plants. The experimental plot had silty clay loam soil type with pH of 7.9- 8.1.

Variety selection and seedling transplantation

A triploid banana cultivar 'Grand Naine, (AAA) was used for this study. The disease-free tissue cultured plants of this cultivars was obtained from Blossom Tissue Culture Nurseries, Hosur, Tamil Nadu. The plants were laid out in a simple randomized design in the field and planted with a distance of 1.8 m x 1.8 m. Each plant was considered as one replication. Minimum of 12 plants were maintained for each treatment.

Treatment details

All the seedlings were foliar sprayed before planting as per the dosage of different treatments given in Table 1. Subsequently, the various bioformulations were applied as foliar spray at 60, 120, 180 days after planting i.e during vegetative stage and at flowering stage.Standard package of practice as recommended by NRCB was followed for irrigation, pest control and fertilizer application. The Banana Sakthi (micro nutrients from NRCB) was also given at 3rd, 5th and 7th months after planting. The experimental plot was maintained as weed free with manual weeding and frequent loosening of soil.

Propping of banana plants

Casuarinas poles were provided as support to the developing bunch to avoid lodging and uprooting of plants owing to the heavy banana bunches and to protect the banana plants from wind damage.

Bunch care

For enhancing the bunch grade in terms finger size and bunch weight bunch care is important. After full opening of banana bunches, the male bud was removed and sprayed with potassium sulphate (1.5%) thoroughly drenching the bunch first one week after the opening of the last hand and a second spray one month later.

Collection of data

Physical parameters such as plant height, plant girth, no. of green leaves, no. of days to flowering, bunch weight, no. of hands, no. of fingers, finger length, finger girth, unripened fruit to pulp ratio were measured. For post-harvest analysis, the harvested fruits were artificially ripened with ethylene and the ripened fruits were analysed for their TSS (Total Soluble Solids), acidity and pulp to peel ratio.

RESULTS AND DISCUSSION

Foliar application of LBS6S@1ml/l improved the bunch weight significantly by 25.24% over water control followed LBS3@5ml/l with 12.62% over water control (Table 2, Fig 1). The number of hands and fingers per bunch also recorded an increase of 5.78% and 6.6% respectively with LBS6S @1ml/l treatment over water control (Table 3). However, no significant difference was observed in the vegetative parameters i.e., number of leaves, plant height

and girth due to the application of seaweed bioformulations (Table 2). The ratio of pulp to peel in the unripened fruits from plants treated with the bioformulations was higher as compared to water control. LBS6S@1ml/l treatment enhanced this parameter significantly by 28.77% over water control followed by 18.7% with LBS6@1ml/l. In addition, low TSS was recorded in unripened fruits from plants treated with LBS6@1ml/l as compared to water control. Higher pulps to peel ratio and low TSS in unripened fruits are highly desirable traits (Table 4). However, no significant difference in finger length and girth was observed due to the treatments.

Overall, the application of seaweed derived bioformulations has improved several crop parameters and yield in banana. Tropical red seaweed bioformulations used in the present study have shown enhanced root development, improved photosynthetic efficiency and better nutrient uptake in several plant model systems such as mung bean, cucumber, tomato, rice in lab conditions and field (data unpublished).The seaweed bioformulations used in this study are rich in potassium and functional saccharides from *Kappaphycus alvarezii* and these components are known to have plant growth promoting effect. Potassium is one of the principle plant nutrients and it is involved in many physiological processes such as stomatal movement, photosynthesis, enzyme activity etc. [13, 14]. Application of potash has also been shown to increase the yield and quality of maize, wheat, soybean and cotton [15]. Thalooth et al. (2006) showed that foliar application of potassium enhances the vegetative growth of the plants and improves crop yield. It is also well established that seaweed cell wall oligosaccharides can stimulate or inhibit growth and development in plants [16]. Gonzalez et al. (2013) also showed that oligosaccharide from red seaweed increase growth of tobacco plants by enhancing photosynthesis, basal metabolism, and cell division as well as metabolic pathways involved in nitrogen and sulfur assimilation [17, 18].

CONCLUSION

It can be concluded from the present study that the yield of Banana Cavendish cv. Grand Naine, (AAA) is enhanced by foliar application of seaweed formulations. Based on the yield & yield components and quality parameters, the seaweed bio-formulations LBS6S@1 ml/L has performed the best followed by LBS3 @5ml /L.

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Table 1: List of treatments

S. No.	Chemical	Dosage
T1	LBS3	@ 5 ml/L
T2	LBS4	@ 2 ml/L
T3	LBS6	@0.5 ml/L
T4	LBS6	@ 1 ml/L,
T5	LBS6S	@ 1 ml/L
T6	Control	Water spray

Table 2: Effect of sea weed bio-formulations on Plant Growth parameters at flowering in cv. Grand Naine

Treatment	Height	Girth	No. of Green Leaves	No. of days taken for flowering
Control (Water Spray)	218.71	66.53	14.11	231.54
LBS 3 @ 5 ml/L	214.04	65.36	13.78	238.21
LBS 4@ 2 ml/L	213.54	65.19	14.28	237.13
LBS 6@ 0.5 ml/L	216.44	69.89	14.22	241.39
LBS 6@ 1ml/L	216.22	68.17	14.00	238.78
LBS 6S @ 1 ml/L	215.04	64.53	13.86	252.46
General Mean *	210.65	64.58	13.97	249.30
CD at 5% *	6.55	6.63	NS	32.39
CV (%) *	5.03	8.79	3.86	9.42

*General Mean, CD and CV values provided here is for the complete study conducted.

Table 3 : Effect of sea weed bio-formulations on Plant Growth parameters at flowering in cv. Grand Naine

Treatment Name	Bunch wt.(Kg)	No. of hands	No. of fingers	Finger Length (cm)	Finger girth (cm)
LBS 3 @ 5 ml/L	20.88	8.65	147.94	19.67	13.00
LBS 4@ 2 ml/L	18.13	8.32	141.53	20.33	12.67
LBS 6@ 0.5 ml/L	19.88	8.49	140.69	22.00	13.50
LBS 6@ 1ml/L	20.44	9.22	151.89	21.67	13.33
LBS 6S @ 1 ml/L	23.22	9.33	158.33	21.07	12.71
Control (Water Spray)	18.54	8.82	148.44	21.00	13.83
General Mean*	20.55	8.99	153.89	20.91	13.18
CD at 5%*	2.93	0.76	14.42	NS	NS
CV(%)*	14.69	8.36	5.30	5.32	3.85

*General Mean, CD and CV values provided here is for the complete study conducted.

Table 4: Effect of sea weed bio-formulations Post-harvest quality parameters of un-ripened green banana fruits

Treatment Name	Un-ripened Fruit Pulp/peel ratio	Un-ripened Fruit TSS*	Ripened fruit TSS*	Ripened fruit Acidity
Control (Water Spray)	1.39	3.06	20.00	0.30
LBS 3 @ 5 ml/L	1.43	3.25	19.62	0.30
LBS 4@ 2 ml/L	1.55	2.82	19.54	0.37
LBS 6@ 0.5 ml/L	1.63	3.85	18.84	0.30
LBS 6@ 1ml/L	1.65	2.94	19.74	0.31
LBS 6S@ 1 ml/L	1.79	2.91	20.47	0.32
General Mean**	1.56	3.08	19.93	0.31
CD at 5%**	0.32	1.13	NS	0.06
CV (%)**	4.67	1.97	2.58	2.39

* Total soluble solids

** General Mean, CD and CV values provided here is for the complete study conducted.

Fig-1: Harvesting of fully matured banana and weighing in the field.
(A) Control (Water spray) (B) Foliar Spray with LBS 6