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Investigation on potassium rich biostimulant from seaweed on yield and quality of some tropical and sub tropical varieties banana grown under field condition in semi-arid zone

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ABSTRACT

A field study was conducted to study the effect of bio-stimulant AQUASAP manufactured from seaweed Kappaphycus alvarezii on some tropical and subtropical banana varieties such as Karpuravalli (ABB), Rasthali (AAB), Naadu (ABB/AAB) and Ottu (ABB/AAB) by applying 5% through foliar spray at the 3rd, 5th and 7th month of plantation during the year 2012-13. Both quantitative and qualitative data of fruits were examined along with vegetative growth of the plants. The highest yield was found in Naadu with 40.26% over control followed by Karpuravalli, Rasthali and Ottu with 23.38%, 30.03% and 26.61% respectively. Fruits of treated plants also showed less moisture level as compared to control with 42.25%, 33.68%, 49.50% and 30.23% increased protein content in Karpuravalli, Rasthali, Naadu and Ottu respectively. In addition to this 15.75%, 23.55%, 13.95% and 14.26% more carbohydrate content was observed in all the four banana varieties. Therefore Kappaphycus alvarezii seaweed biostimulant can be used in banana for better yield with improved quality.

Keywords: Seaweed, *Kappaphycus alvarezii*, Aquasap, Biostimulant, Banana yield

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INTRODUCTION

Seaweed liquid extracts are the new type of products which are used in agriculture and horticulture crops in the recent years and now seaweeds are used widely extended due to their good biostimulant activity [1]. Some of the seaweed which are commercially used for making biostimulant are *Kappaphycus alvarezii*, *Jania rubens*, *Gracilaria* spp., brown algae like *Laminaria* spp. *Sargassum* spp., *Fucus* spp., *Ascophyllum nodosum* [2] and green algae like *Ulva* spp. *Enteromorpha* spp. *Cladophora* spp. [3]. It acts as biostimulant mainly due to the presence of phytohormones, amino acids and fatty acids which are responsible for the development, plant growth and resistance to pathogens [4]. Seaweed liquid extracts practiced widely in cultivation of agriculture and horticulture crops which exhibits positive effects on those cultivation crops. It improves plant resistance to frost and drought and increased crop yield. Foliar application of seaweed liquid extracts was also characterized by higher resistance to pest and pathogens and more efficient consumption of nutrients from soil. Seaweed liquid extracts contribute to the recovery of damages caused by insects and bacterial or fungal diseases [5].

Banana is one of the major economically important fruits of India and it has grown widely in tropics and subtropics' of Capricorn, cultivated over 130 countries [6]. It occupies 20% area among the total area for crop in India. Particularly in Tamil Nadu it leads in total area and production with 56.50 lakh mt from 1.18 lakh hectares [7]. In recent years, the production of banana was increased significantly and the banana cultivation was undergone in the area which has increased from year to year [8]. Karthikeyan and Shanmugam (2014) had reported the effect of biostimulant from seaweed *K. alvarezii* on the yield and quality of some hill and foothills banana varieties [9]. The most important varieties of banana cultivated in India are Red banana (AAA), Rasthali (Silk AAB), Robusta (AAA), Poovan (Mysore AAB), Nendran (AAB), Karpuravalli (ABB) and Monthan (ABB/AAB).

The present investigation deals with the biostimulation effect of Aquasap on the yield and quality of fruits of some tropical and sub tropical banana varieties grown under field condition in a semi-arid zone.

MATERIALS AND METHODS

Preparation of Trial Plots

The trial was carried out at Research & Development plot of AquAgri Processing Private Limited, Manamadurai, Sivagangai Dt., Tamil Nadu, India. 9°42′56″N and 78°28′2″E was during the year, 2012-13. The plot was prepared as recommendation by Indian Horticulture Department. Plot size was 40 m × 2 m and distance between the plots was 3.5 m. The number of plants per plot was 36 plants and allotted two plots for each variety for conducting trial. Flooding method of irrigation was done for every 7-8 days during winter season whereas in summer the irrigation interval was about 4-5 days. Recommended Fertilizer Dose (RFD) was applied as per National Horticulture Board, India.

Selection of Banana Varieties for Trial

Four varieties of banana, i.e., Karpuravalli, Rasthali, Naadu and Ottu which are generally cultivated in tropical and sub tropical area of Tamil Nadu were selected for our present investigation study. Suckers of and Naadu (ABB/AAB) and Ottu (ABB/AAB) were sourced from Tamil Nadu Agriculture University, Coimbatore whereas Rasthali (AAB) and Karpuravalli(ABB) was obtained from Banana Research Centre at Trichy (Tamil Nadu, India). The selected suckers for plantation were free from mechanical injuries and diseases and uniform in weigh of 500 g ± 50 g.

Karpuravalli (Syn. Kanthali, Jammulapelam collection, Pisang Awark, Bharat Moni, Chinali, Pey Kunnan, Kosta Bantha and Jaurmani Kanthali) is a strong and tall plant. Even it can also be cultivated in drought condition. The crop life cycle was about 12 months. Predominantly it is cultivated in Kerala and in Central and South districts of Tamil Nadu.

Rasthali (Syn. Amithapani, Maribhog, Mortam, Rasabale, Kulfiait, Sabri and Salsikola) was medium and tall sized variety. Commonly Rasthali is cultivated in Salem, Erode, Dindigul, Trichy and Tanjore district of Tamil Nadu and other than Tamil Nadu in Kerala, Karnataka, Andra Pradesh and Bihar.

Naadu (Syn. Monthan) (ABB/AAB) and Ottu (Syn. Muppattai) (ABB/AAB) are the new type of prolific clone. Both of them have similar characters but slightly dissimilar in bunch and fruits. Both the varieties are very popular variety in Sivagangai and Madurai district of Tamil Nadu. They are tall, robust and well suited for drought condition.

Application of biostimulant Aquasap

Commercially manufactured Aquasap (Batch No.: 09122011-3) was collected from the stock of AquAgri Processing Private Limited and used for this experimental trial. 5% solution was prepared and applied as foliar application at the 3rd (juvenile phase), 5th (flowering and budding differentiation stage) and 7th month of (bunch development stage) plantation for all four varieties of banana were studied.

Collection of Data

Physical parameters like height and width of trees, number of leaves and its length cum breadth, bunch weight, number of hands and its weight, fruits number and its weight, length, breadth and ratio of flesh and skin were recorded. Chemical parameters like moisture, crude protein, crude fiber, crude fat, crude carbohydrate, ash content, macro and micro elements, and vitamins of fruits were also analyzed. Elements were determined by atomic absorption spectroscopy (Association of Analytical Communities 18th edition: 2005) and vitamins were estimated

by titration method (AOAC 985.33). Crude protein, total carbohydrate, crude fiber contents of harvested banana fruits were tested by spectrophotometric methods using Chemito Spectra Scan UV-2600, double beam UV-visible spectrophotometer.

Statistical Analysis

Statistical analysis such as analysis of variance (ANNOVA, SYSTAT version 7), correlation and regression were applied to analyze the data.

RESULTS AND DISCUSSION

Yield and Quality of Fruits

Karpuravalli

The bunch weight of control plants ranged from 17.05 kg to 26.51 kg with average of 21.85 kg and in Aquasap treated plants, the average bunch weight was 17.71 kg with a range from 13.41 kg to 23.35 kg, therefore, 23.38% more yield over control with positive significant variation (*F-ratio* = 5.734; $P \leq 0.05$) was observed in treated plants (Table 1). Number of hands per bunch ranged from 10 to 12 (average 10.86) and 10 to 13 (average 12.00) in control and treated plant respectively with significant positive correlation with fruits weight (r = 0.784; P = 0.05) and negatively correlated with leaves length (r = -0.800; P = 0.05). Average hands weight in control and treated plants were 1.26 kg (1.01 kg to 1.62 kg) and 1.74 kg (1.31 kg to 1.89 kg) respectively. Weight of hand in treated was 38.09% more when compared to control with significant variation (*F-ratio* = 19.142; $P \leq 0.05$) (Table 1).

All the four varieties of banana viz. Karpuravalli, Rasthali, Naadu and Ottu had responded well to biostimulant Aquasap at 5% concentration. The highest yield was found in Naadu with 40.26% over control followed by Karpuravalli, Rasthali and Ottu with 23.38%, 30.03%, 26.61% respectively. It was also observed that emerging of first flower noticed in all the treated plants 10-15 days earlier to control plants [9]. The hands weight increased to 38.09% in Karpuravalli, 19.23% in Rasthali, 18.72%, 24.50% in Naadu and Ottu respectively. Similar kind of results was reported in chillies when it treated with 1% and 2% of SLF of *K. alvarezii*; it increased the crop yield to 23% and 15% respectively when compared to control [10]. Abetz and Young (1983) reported that the seaweed extract of *Ascophyllum nodosum* applied on cauliflower increased the heart size of the florets and curd diameter than control plants [11].

Nutritional Content of Fruits

Karpuravalli

Fruit sizes were generally uniform in treated plants (Figure 1(1)). The number of fruits per bunch ranged from 167 to 203 (average 184.4) and 175 to 227 (average 205.4) in control and treated plant respectively. Number of fruits per bunch in treated was 11.39% more when compared to control with significant variation (*F-ratio* = 4.779; $P \leq 0.05$) (Table 1). The fruits' weight were ranged from 0.071 kg to 0.107 kg (average 0.09 kg) and 0.072 kg to 0.140 kg (average 0.12 kg) in control and treated plants respectively with negatively correlated with leaves length (r = -0.794; P = 0.05), i.e., fruits weight increased to 33.33% as compared with control (Tables 1 and 2). In control, skin of fruit weight ranged from 16 g to 29 g (average 22 g) and in treated plants it ranged from 14 g to 27 g (average 15 g) with significant positive correlation with number of side suckers (r = 0.982; P = 0.001). Fruits length ranged from 10.32 cm to 14.35 cm (average 12.48 cm) in control plants and 9.37 cm to 14.42 cm (average 12.12 cm) treated plants (Table 1). Fruits circumference of control plants ranged from 8.48 cm to 13.96 cm (average 10.91 cm) and 11.52 cm to 13.81 cm (13.07 cm) in treated plants (Tables 1-3). In this present study, number of finger per bunch were 11.90%, 26.68% and 25.29% more in Rasthali, Naadu and Ottu respectively. Fruits weight was increased by 33.33%, 25.00%, 36.36% and 27.27% in Karpuravalli, Rasthali, Naadu and Ottu respectively. The maximum finger length (16.81%) and circumference (19.79%) were observed with treated plants of Ottu and Karpuravalli. Seaweed extract applied as foliar spray was found to enhance the yield, growth and quality of crops [12]. The present investigation had agreed with the literature report that banana when treated with extract of potassium silicate and seaweed at 0.05 to 0.1% showed increased bunch weight, flowering time, and growth characters as well as in physical and chemical characteristics of the fruits [13]. Karthikeyan and Shanmugam (2015) observed that the pod weight increased to peanuts when treated with 5% extract of *K.alvarezii* [14]. The number of pods increased to red gram when treated with 0.2% extract powder of *K.alvarezii* [15]. Norrie and Keathley (2006) had reported that *A.nodosum* extracts treated with Thompson seedless grape variety showed improved fruit size (13%), weight (39%) and yield (60.4%) when compared with control plants [16].

Moisture content in fruits of Karpuravalli, Rasthali, Naadu and Ottu were less in treated than fruits of control plants and it was 73.51%, 69.85%, 49.73% and 72.16% in treated and 75.89%, 73.14%, 68.33% and 84.30% in control plants respectively. Though there was not much difference in fiber and fat content of fruits from treated and control but protein (33.68%) and carbohydrate (23.55%) were found higher in treated plants. Some elements like potassium (5.46%), calcium (5.28%) and phosphorus (1.38%) were also higher in fruits of treated plants. Vitamin C (6.43%), riboflavin (19.48%) and Niacin (3.86%) was found more in treated plants however, there was no significant variation in the levels of other vitamins between control and treated plants (Table 2). Fenugreek treated with extract of seaweed showed higher shoot growth and biomass meanwhile carbohydrate, proteins, free amino acids, polyphenols and nitrogen content was also found increased [17].

Height and Leaves

Apart from the yield and quality of the fruits of the treated plants, vegetative growth in terms of tree height and width, number of leaves, leaves length and breadth were also found 20% more as compared with the control (Table 1). Similar positive results were also observed in other banana varieties in the present investigation, *viz*., in Rasthali (AAB), Naadu (ABB) and Ottu (AAB) as shown in Tables 1 and 2.

Table 1: Effect of biostimulant from seaweed on vegetative growth and fruits yield of some tropical and subtropical varieties of banana

Variety name	Karpuravalli		Rasthali		Naadu		Ottu	
Treatment	Control	Treated	Control	Treated	Control	Treated	Control	Treated
Date of plantation	22.08.12	22.08.12	22.08.12	22.08.12	22.08.12	22.08.12	22.08.12	22.08.12
Date of harvest	16.10.13	16.10.13	06.08.13	16.08.13	25.07.13	25.07.13	25.07.13	25.07.13
Bunch weight (kg)	17.71±3.26	21.85±2.70	14.25±1.39	18.53±0.99	20.34±4.74	28.53±6.69	17.17±3.35	21.74±3.82
No. of hands per bunch	10.86±8.32	12.00±0.93	5.92±1.47	6.92±0.67	7.67±0.75	9.50±0.76	8.571±1.18	9.86±0.99
No. of fruits in bunch	184.40±14.41	205.4±18.59	84.83±21.72	94.00±13.12	103.67±11.09	131.33±15.91	101.43±22.86	127.00±13.67
Hands weight (kg)	1.26±0.19	1.74±0.19	0.52±0.14	0.62±0.12	1.87±0.28	2.22±0.16	1.51±0.23	1.88±0.42
Fruits weight (kg)	0.09±0.01	0.12±0.02	0.04±0.01	0.05±0.02	0.11±0.02	0.15±0.02	0.11±0.01	0.14±0.03
Fruits skin weight (g)	22.00±0.01	15.00±0.01	8.81±0.02	9.80±0.03	32.00±0.02	33.00±0.02	29.61±0.01	29.80±0.02
Fruits length (cm)	12.48±0.98	12.12±1.53	9.52±0.86	9.65±0.71	13.86±1.76	16.19±1.58	14.03±1.73	15.17±2.81
Fruits circumference (cm)	10.91±1.74	13.07±0.74	10.36±0.97	10.94±1.16	13.65±1.86	15.39±1.27	13.22±1.46	15.26±1.47
Tree height (m)	2.72±0.26	2.76±0.19	1.90±0.14	1.91±0.31	2.42±0.27	2.44±0.24	2.35±0.35	2.45±0.39
Tree girth (m)	0.77±0.07	0.77±0.09	0.58±0.04	0.58±0.07	0.69±0.04	0.69±0.04	0.69±0.05	0.69±0.04
No. of side suckers	11.29±1.67	9.43±2.26	12.43±3.06	12.29±2.19	9.67±1.49	9.83±1.46	10.00±1.51	9.43±2.32
No. of leaves	20.14±1.25	19.00±1.51	17.43±1.83	18.28±3.89	18.17±1.34	17.83±2.54	17.86±2.64	17.29±2.37
Leaves length (m)	2.25±0.14	2.21±0.18	1.94±0.14	1.88±0.25	2.01±0.24	2.15±0.25	2.09±0.28	1.73±0.22
Leaves breadth (m)	0.61±0.04	0.65±0.03	0.54±0.02	0.57±0.03	0.59±0.73	0.66±0.06	0.67±0.06	0.62±0.05
Central axis weight (kg)	2.91±0.66	2.38±0.44	0.60±0.28	0.65±0.23	1.99±0.27	2.23±0.23	1.29±0.18	1.29±0.31

Table 2: Effect of biostimulant from seaweed on nutritional properties of some tropical and subtropical varieties of banana

Nutritional factors	UOM	Karpuravalli		Rasthali		Naadu		Ottu	
		Control	Treated	Control	Treated	Control	Treated	Control	Treated
Moisture	g/100g	75.89	73.5	73.14	69.85	68.33	49.73	84.30	72.16
Crude Protein (N×6.25)	g/100g	0.95	1.27	1.01	1.51	0.71	1.01	0.86	1.12
Crude Fiber	g/100g	0.41	0.48	0.41	0.35	0.39	0.46	0.41	0.49
Crude Fats	g/100g	0.12	0.15	0.14	0.13	0.15	0.11	0.28	0.24
Crude Carbohydrate	g/100g	18.13	22.40	24.37	27.77	29.58	34.24	23.41	26.75
Ash Content	g/100g	1.19	1.22	1.08	1.25	0.63	0.69	0.70	0.72
Potassium(K)	mg/100g	320.76	338.28	350.12	356.76	319.48	329.71	312.14	328.92
Sodium (Na)	mg/100g	39.24	37.34	56.39	53.61	57.15	56.11	50.17	55.22
Calcium (Ca)	mg/100g	26.50	27.9	31.19	29.19	20.24	27.59	23.31	29.92
Iron (Fe)	mg/100g	0.25	0.24	0.24	0.29	0.26	0.21	0.23	0.22
Phosphorus	mg/100g	29.74	30.15	31.10	32.33	26.04	21.68	24.64	25.74
Vitamin C	µg/100g	7.62	8.11	7.14	7.97	7.12	6.93	7.12	6.87
Cartotene (Vitamin A)	IU/100g	1.20	1.21	1.38	1.61	1.04	1.12	1.11	1.09
Thiamin	µg/100g	1.9	1.62	4.81	4.63	1.90	2.45	2.31	2.22
Riboflavin	µg/100g	2.31	2.76	2.77	2.36	4.41	3.99	4.32	4.14
Niacin	µg/100g	2.85	2.96	7.11	6.04	2.90	3.10	2.19	2.61

Table 3: ANOVA interpretation of control and biostimulant Aquasap treated plants of Karpuravalli.

S.No	Parameters	F-ratio	P
1	Bunch weight	5.734	0.034
2	No. of hands per bunch	5.053	0.044
3	No. of fruits in bunch	4.779	0.049
4	Hands weight	19.142	0.001
5	Fruits weight	6.151	0.033
6	Fruits skin weight	5.369	0.039
7	Fruits length	0.570	0.463
8	Fruits circumference	7.181	0.018
9	Tree height	0.102	0.755
10	Tree girth	0.025	0.878
11	No. of side suckers	2.627	0.131
12	No. of leaves	0.005	1.000
13	Leaves length	0.258	0.620
14	Leaves breadth	2.675	0.128
15	Central axis weight	0.005	1.000

Table 4: ANOVA interpretation of control and biostimulant Aquasap treated plants of Rasthali.

S.No	Parameters	F-ratio	P
1	Bunch weight	5.622	0.028
2	No. of hands per bunch	0.005	1.000
3	No. of fruits in bunch	1.476	0.237
4	Hands weight	3.591	0.071
5	Fruits weight	0.693	0.415
6	Fruits skin weight	0.225	0.641
7	Fruits length	0.140	0.713
8	Fruits circumference	1.445	0.243
9	Tree height	0.001	0.977
10	Tree girth	0.071	0.794
11	No. of side suckers	0.009	0.927
12	No. of leaves	0.239	0.634
13	Leaves length	0.257	0.621
14	Leaves breadth	3.696	0.079
15	Central axis weight	0.170	0.684

Table 5: ANOVA interpretation of control and biostimulant Aquasap treated plants of Naadu.

S.No	Parameters	F-ratio	P
1	Bunch weight	4.973	0.050
2	No. of hands per bunch	3.049	0.111
3	No. of fruits in bunch	10.176	0.010
4	Hands weight	6.360	0.030
5	Fruits weight	5.290	0.044
6	Fruits skin weight	0.017	0.898
7	Fruits length	4.848	0.052
8	Fruits circumference	2.975	0.115
9	Tree height	0.031	0.864
10	Tree girth	0.035	0.855
11	No. of side suckers	0.032	0.862
12	No. of leaves	0.067	0.801
13	Leaves length	0.749	0.407
14	Leaves breadth	2.011	0.187
15	Central axis weight	2.184	0.170

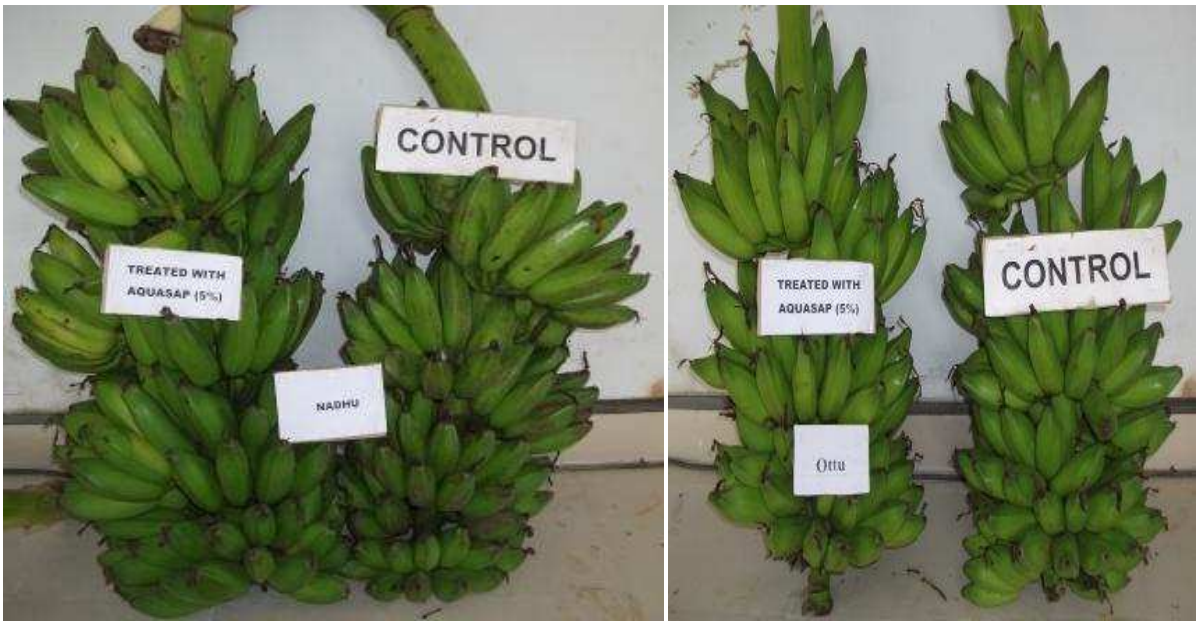
Table 6: ANOVA interpretation of control and biostimulant Aquasap treated plants of Ottu.

S.No	Parameters	F-ratio	P
1	Bunch weight	4.848	0.048
2	No. of hands per bunch	0.207	0.657
3	No. of fruits in bunch	5.531	0.031
4	Hands weight	20.301	0.001
5	Fruits weight	8.272	0.014
6	Fruits skin weight	0.004	0.951

7	Fruits length	0.712	0.415
8	Fruits circumference	5.855	0.032
9	Tree height	0.231	0.640
10	Tree girth	0.029	0.868
11	No. of side suckers	0.255	0.623
12	No. of leaves	0.155	0.700
13	Leaves length	6.110	0.029
14	Leaves breadth	2.918	0.113
15	Central axis weight	0.005	0.986

1 **2**

Figure 1: Fruits of control and biostimulant Aquasap treated Karpuravalli (1) and Rasthali (2)



3 **4**

Figure 2: Fruits of control and biostimulant Aquasap treated Naadu (3) and Ottu (4)

CONCLUSION

It can be concluded from the present investigation study that banana varieties of tropical and subtropical viz Karpuravalli (ABB), Rasthali (AAB), Naadu (ABB/AAB) and Ottu (ABB/AAB) had responded well to 5% of

biostimulant Aquasap from seaweed *K.alvarezii* with average yield increase of 23.38%, 30.03%, 40.26% and 26.61% respectively with improved the quality of fruits and leaves such as length, breadth and the numbers of all the four varieties of banana. Therefore, application of eco-friendly and natural seaweed plant nutrient to Aquasap can be applied to tropical and subtropical varieties of banana.

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