

Spraying Seaweed Extract and Hand Trimming to Improved Yield and Fruit Quality of Grand Nain Banana Plants

El-Kholy, M. F. A.

Tropical Fruit Dept., Horticulture Research Institute, ARC, Giza, Egypt.



ABSTRACT

This experiment was carried out during 2013- 2014 (first ratoon) and 2014-2015 (second ratoon) seasons to study the effect of spraying seaweed extract at three concentration 0, 0.1, 0.2 % and/or trimming (without one & two hand) on Grand Nain banana bunches in sandy soil. Trimming of hands was done after bunch shooting, seaweed extract sprayed three times: 1) after bunch shooting directly, 2) 15 days later 3) 30 days later. Time to harvesting, bunch weight (kg), estimated yield (ton), estimated increasing rate of yield (%), finger diameter (cm), finger weight (g) finger length (cm), soluble solids content (SSC) and titratable acidity percentage were determined. Obtained results showed that trimming with two hands gave the highest values for the above mentioned characters compared with one hand. Time of harvesting tended to decrease with hand trimming of banana. The highest values of bunch weight, yield, increasing rate of yield and finger parameters were obtained from Grand Nain banana plants trimming two hands with spraying seaweed extract at 2% . Seaweed (*Ascophyllum nodosum* L.) is a known source of plant growth regulators which an important roles in metabolism and productivity of plants. Moreover, hand trimming is practiced to increase the finger parameters. From the obtained results it could be concluded that, spraying seaweed extract at 2% with trimming two hands improved time to harvesting, yield as well as physical and chemical characteristics of the fruits of Grand Nain banana plants. A superior effect was attributed to using seaweed extract and trimming rather than control.

Keyword: Grand Nain, banana, seaweed extract, trimming, yield, fruit quality

INTRODUCTION

Banana is a climacteric fruit that is economically important for local and export markets worldwide. Banana is also considered a high energy food source due to elevated levels of antioxidant vitamins, vitamin A and C (ascorbic acid), and phenolics, which are related to high antioxidant capacity (Thaipanit and Anprung, 2010). Banana plays an important role in tropical economics as a cash export and as complementary food in local sets. Improving fruit quality is a major factor for better marketability and highest cash return of fruit trees.

Seaweed (*Ascophyllum nodosum* L.) is a known source of plant growth regulators such as cytokinins, auxins and auxin-like compounds, organic matter, amino acids and vitamins, complex polysaccharides, betaines and betaine-like compounds and sterols which play an important roles in metabolism and productivity of plants (Khan *et al.*, 2009). Biological agriculture and horticulture are applied as a foliar spray increases uptake of plant nutrients, promotes growth and gives resistance to frost, fungal diseases and stress conditions. Moreover, it is effective for ripening of fruits, increasing post-harvest, shelf-life, improves the quality of the products and serves as an excellent soil conditioner (Zodape, 2001).

Many investigations cleared out that, application of seaweed extract as a foliar spray was found to increase growth, productivity and fruit quality of some fruit crops including banana (Roshdy, 2014), apple (Thanaa *et al.*, 2016) and Perlette grape (Khan *et al.*, 2012). Bunch trimming is practiced to increase the length of fingers on the remaining hands and to obtain better prices for the longer fruit (Stevenson, 1977 and Daniells *et al.*, 1987). In addition, Boncato (1967) noted a significant increase in bunch weight by bunch trimming.

The objective of this work is to study the effect of spraying seaweed extract and hand trimming to improved yield and fruit quality of Grand Nain banana plants.

MATERIALS AND METHODS

The present study was conducted in a private farm at Badr region, Behira governorate during two successive

seasons of 2013/2014 (first ratoon) and 2014/2015 (second ratoon) of Grand Nain banana plants (*Musa Cavendishii* L.) to study the effect of spraying seaweed extract and hand trimming to improved yield and fruit quality. The suckers were planted 3× 3.5 m. a part in March 2013, mother plant, similar in growth, free of diseases and received the same horticultural managements.

The experiment was designed to evaluate spraying seaweed extract at three concentrations (0, 1% and 2%), hand trimming (one hand (T1) and two hands (T2) and un treated.

Trimming of hands was done after bunch shooting; seaweed extract was sprayed three times: 1) after bunch shooting directly, 2) 15 days later 3) 30 days later.

Table 1. Analysis of seaweed extract (according to James1994).

Components	Value	Components	Value
Protein %	6-8	Cu %	1-6
Aliginic acid %	10-20	Fe %	50-200
Mannitol %	4-7	Mn %	5-12
Total N %	1-1.5	Zn %	10-100
P %	0.02-0.09	B %	20-100
K %	1-1.2	Mo %	1-5
Ca %	0.2-1.5	Cytokines (ppm)	0.02
S %	3-9	IAA (ppm)	0.03
Mg %	0.5-0.9	ABA (ppm)	0.01

The obtained data were used for determined the following parameters:

Time to harvesting: the period from bunch shooting to the date of harvesting (in days) was calculated.

Yield, bunch weight and finger properties:

At time of harvesting bunch weight (kg), estimated yield/fed. (ton), increasing rate of yield (%), finger weight (g), finger length and diameter (cm) were measured and recorded. As well as SSC (%), titratable acidity (%) (as g. malic acid/100 g. pulp) and total sugars (AOAC., 2000) were determined.

Statistical analysis:

The obtained data were subjected to analysis of variance, for factorial plot design in a randomized

complete block with ten replicates in each treatment (Snedecor and Cochran, 1980). The mean were compared by using the method of New Least Significant differences (New LSD at 0.05) as described by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Time to harvest (days):

The present investigation involved two main factors i.e. spraying seaweed extract and trimming. The actual treatments involved all the possible combinations of the two main factors (seaweed extract and hand trimming).

This part of study was concerned with the period from bunch shooting to harvesting date (time to harvest), bunch weight and yield in response to spraying seaweed extract and trimming treatments.

Data in Table 2 show that the time of harvesting, bunch weight and yield significantly varied due to spraying seaweed extract and/or trimming in the tested seasons.

Time to harvesting clearly decreased by spraying seaweed extract and hand trimming. In this respect, trimming one hand (T1) and two hands (T2) treatments were shortened the period to harvesting (103.0, 113.33, and 108.0, 116.0 days) than treatment was not trimming (control) (123.0, 125.67 days) in both tested seasons,

respectively. The tabulated data also show that, no clear differences could be defined between the concentrations of seaweed extract treatments regarding time to harvesting.

Trimming two hands decreased this period to the minimum than one hand trimming. In this respect, seaweed extract at high concentration (0.2 %) was shortened time to harvest compared with the lowest ones (1 % or control).

The interaction between the spraying seaweed extract at 2 % with trimming two hand treatments had the shortest period to harvesting (98.00 and 102.00 days) in both tested seasons, respectively.

Bunch weight and yield:

Data in Table 2 noted that, bunch weight/plant and yield/Fed. significantly varied in response to spraying with seaweed extract and hand trimming. In this respect, bunch weight were (23.33, 25.69 and 27.44 and 23.05, 24.84, 26.50 kgs) for seaweed extract concentrations (0, 1 or 2 %), respectively. As well as (21.88, 26.89, 27.87 and 20.66, 26.08, 27.65 Kgs. in treatments of trimming (without, one hand and two hands) in both tested seasons.

In this regard, yield/Fed. were (24.31, 27.88, 29.61 and 24.30, 26.84, 29.50 kgs) for different seaweed extract concentrations (0, 1 or 2 %), as well as (23.54, 27.89, 30.37 and 23.33, 27.42, 29.90 ton/Fed. in treatments of trimming (without, one hand and two hands) in both tested seasons.

Table 2. Effect of spraying seaweed extract (S), trimming hand (T) and interaction on time of bunch shooting to harvest (day), bunch weight and yield of Grand Nain banana plants in the two seasons of study (2013/2014 & 2014/2015).

1-Time of bunch shooting to harvest (day)

Seaweed extract (S)	First ratoon				Second ratoon			
	0%	0.1%	0.2%	Mean	0%	0.1%	0.2%	Mean
Trimming (T)								
Without	125.00	121.00	123.00	123.00	130.00	122.00	125.00	125.67
One hand	121.00	109.00	110.00	113.33	130.00	108.00	110.00	116.00
Two hands	111.00	100.00	98.00	103.00	117.00	105.00	102.00	108.00
Mean	119.00	110.00	110.33		125.67	111.67	112.33	
New L.S.D at 5%								
T		4.15				4.23		
S		4.23				4.89		
Interaction	4.25			4.99				

2-Bunch weight (kg)

Seaweed extract(S)	First ratoon				Second ratoon			
	0%	0.10%	0.20%	Mean	0%	0.10%	0.20%	Mean
Trimming(T)								
Without	20.33	21.97	23.33	21.88	20.31	20.33	21.33	20.66
One hand	24.00	27.67	29.00	26.89	23.83	26.25	28.17	26.08
Two hands	25.67	27.95	30.00	27.87	25.00	27.95	30.00	27.65
Mean	23.33	25.86	27.44		23.05	24.84	26.50	
New L.S.D at 5%								
T		2.62				2.44		
S		2.82				2.49		
Interaction		3.11				3.53		

3-Yield/ Fed.(ton)

Seaweed extract(S)	First ratoon				Second ratoon			
	0%	0.10%	0.20%	Mean	0%	0.10%	0.20%	Mean
Trimming(T)								
Without	21.33	23.97	25.33	23.54	21.33	23.33	25.33	23.33
One hand	25.50	27.67	30.50	27.89	24.83	27.25	30.17	27.42
Two hands	26.10	32.00	33.00	30.37	26.74	29.95	33.00	29.90
Mean	24.31	27.88	29.61		24.30	26.84	29.50	
New L.S.D at 5%								
T		3.54				3.19		
S		3.75				2.25		
Interaction		3.9				5.94		

The heaviest bunches/plant (or yield/Fed.) were produced in plants trimmed two hands treatment with sprayed seaweed extract at 2% (30.0 and 30.0 kg. or 33.0 and 33.0 tons/Fed.) on both tested seasons, and the lightest bunches/plants or yield (ton/Fed.) were obtained from the plants untreated.

Tabulated data proved that spraying seaweed extract 2% gave the highest yields (bunch weight Kgs./plant or tons/Fed) compared with 1% concentrate. Interaction studies between the two main factors were statistically significantly which referred to spraying seaweed extract and trimming act dependently in this concern.

Finger parameters:

Data in Table 3 show that finger parameters (finger weight, finger length and diameter) were significantly varied due to spraying seaweed extract and trimming in both tested seasons. As such the highest values of finger parameters were noticed in plants sprayed with seaweed extract at 2% and trimming two hands treatment while the lowest values of finger parameters were noticed in plants untreated. The heaviest finger (173.7 and 169.5 g) and (179.0 and 177.7 g), longest finger (28.30 and 28.78 cm)

and (28.59 and 29.29 cm) as well as widest finger (3.55 and 3.50 cm) and (3.65 and 3.59 cm) for the specific effect of seaweed extract concentration by 2 % and trimming two hands treatment. Also, the interaction effect of finger parameters i.e., finger weight, finger length and finger diameter (184.9 & 183.9 g), longest finger (27.53 & 26.67 cm) and widest finger (3.73 & 3.7 cm) were obtained from plants seaweed extract at 2% and trimming two hands, whilst lightest finger (145.7 & 143.7g), the shortest finger (20.0 & 20.37 cm), narrowest ones and (2.93 & 2.73 cm) were obtained from plants untreated (control) in both tested seasons, respectively.

The advancing effect of seaweed extract on flowering time might be attributed to their essential role in balancing the ratio between carbohydrates and nitrogen in favor of flowering (Neumann and Zur-Nieden, 2001). While Daniells *et al.*, (1987) reported that did not significantly affect the duration from bunch emergence to harvest. The trimming of one hand and two hands per bunch decreased the fruit weight per bunch by 7% and 15% respectively. Bunch trimming caused a yield decline without an accompanying improvement in fruit grades.

Table 3. Effect of spraying seaweed extract, trimming hand and interaction on finger parameters of Grand Nain banana plants in the two seasons of study (2013/ 2014 & 2014/2015).

1-Finger weight (g)								
Seaweed extract(S) Trimming(T)	First ratoon				Second ratoon			
	0%	0.10%	0.20%	Mean	0%	0.10%	0.20%	Mean
Without	145.7	155.7	161.4	154.3	143.7	149.8	153.5	149.0
One hand	167.6	173.0	174.9	171.8	154.1	173.9	171.0	166.3
Two hands	172.8	179.4	184.9	179.0	175.0	174.2	183.9	177.7
Mean	162.0	169.4	173.7		157.6	166.0	169.5	
New L.S.D at 5%								
T		3.5				3.5		
S		4.3				4.3		
Interaction		4.5				4.6		
2- Finger length (cm)								
Seaweed extract(S) Trimming(T)	First ratoon				Second ratoon			
	0%	0.10%	0.20%	Mean	0%	0.10%	0.20%	Mean
Without	20.00	23.58	25.97	23.18	20.37	23.22	26.33	23.31
One hand	24.70	27.33	28.40	26.81	25.33	28.15	29.00	27.49
Two hands	26.30	28.95	30.53	28.59	27.33	29.55	31.00	29.29
Mean	23.67	26.62	28.30		24.34	26.97	28.78	
New L.S.D at 5%								
T		1.4				1.5		
S		1.57				1.72		
Interaction		1.92				1.98		
3- Finger diameter (cm)								
Seaweed extract(S) Trimming(T)	First ratoon				Second ratoon			
	0%	0.10%	0.20%	Mean	0%	0.10%	0.20%	Mean
Without	2.93	2.90	3.30	3.04	2.73	2.81	3.27	2.94
One hand	3.47	3.61	3.63	3.57	3.17	3.48	3.53	3.39
Two hands	3.50	3.71	3.73	3.65	3.43	3.65	3.70	3.59
Mean	3.30	3.41	3.55		3.11	3.31	3.50	
New L.S.D at 5%								
T		0.45				0.48		
S		0.65				0.71		
Interaction		0.98				0.99		

Increasing rate (%) of yield and finger weight:

Results in Table (4) and Fig. (1) referrer that increasing rate of yield was significantly varied in response to hand trimming and seaweed extract. The heaviest average of increasing rate were produced with the plants trimmed one and two hands treatments which gave (30.75,

28.54% and 42.37, 40.16 %) on both tested seasons, and the lightest average of increasing rate of yield were obtained from the plants did not trimmed. Tabulated results prove that the high concentration of seaweed extract gave the heaviest increasing rate of yield compared with the lowest concentration (30.71, 25.85 and 38.82, 38.30 %) for

both concentrations (1 % or 2 %) from seaweed extract during two seasons of study. Interaction between the two main factors trimming and seaweed extract was statistically significant. Highest increasing rate of yield was obtained

due to the treatment of trimming two hand with spraying seaweed extract at 2 % (54.70 and 54.71 %) comparing with all other treatments.

Table 4. Effect of spraying seaweed extract, trimming hand and interaction on increasing rate of yield (%) of Grand Nain banana plants in the two seasons of study (2013/2014 & 2014/2015).

Seaweed extract(S) Trimming(T)	First ratoon				Second ratoon			
	0%	1%	2%	Mean	0%	1%	2%	Mean
Without	0.00	12.38	18.75	10.38	0.00	9.38	18.75	9.38
One hand	19.55	29.72	42.99	30.75	16.41	27.75	41.44	28.54
Two hands	22.36	50.02	54.70	42.37	25.36	40.41	54.71	40.16
Mean	13.97	30.71	38.82		13.92	25.85	38.30	
New L.S.D at 5%								
T		4.15				4.18		
S		4.25				4.25		
Interaction		4.78				4.9		

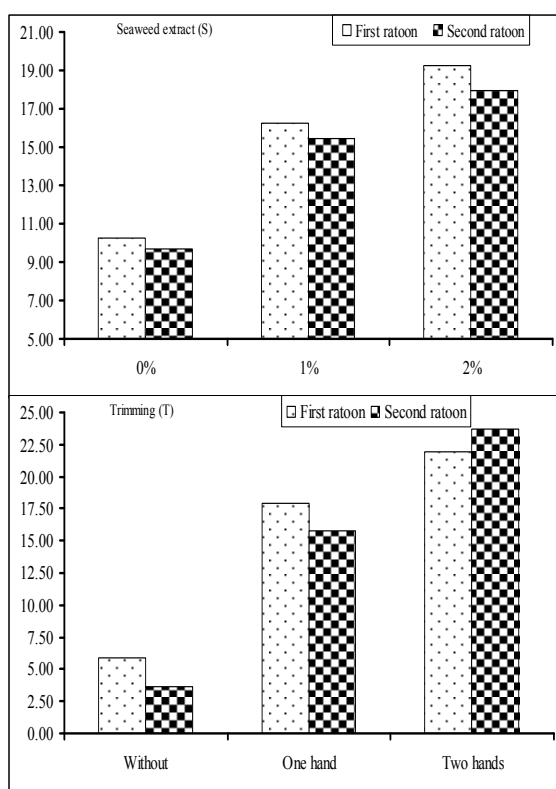


Fig. 1. Effect of spraying seaweed extract and trimming hand on increasing rate of finger weight (%) of Grand Nain banana plants in the two seasons of study (2013/2014 & 2014/2015).

These results were in line with those reported by Roshdy (2014). Also, Abd El-Moniem *et al.* (2008) noted that spraying seaweed extract at 25 to 100% considerably improved bunch weight and yield compared to control plants. These results may explain due to the great benefits of seaweed extract on amending the plants with their requirements from organic and mineral nutrients.

The advancing effect of seaweed extract on flowering time might be attributed to their essential role in balancing the ratio between carbohydrates and nitrogen on flowering (Neumann and Zur-Nieden, 2001). The

stimulating effect of seaweed extract on growth characters might be attributed to its essential action on enhancing cell division because it contains higher amounts of nutrients, natural hormones like cytokines, IAA and GA₃, amino acids, vitamins and antioxidants (James, 1994), these constituents play an important roles in protecting plants cells from damage and all stresses around plants and improving cell division and the biosynthesis of organic foods (Kulk,1995 and Strick *et. al.*, 1997).

The trimming of one hand and two hands per bunch decreased the fruit weight per bunch by 7% and 15% respectively. Bunch trimming caused a yield decline without an accompanying improvement in fruit grades.

Chemical properties:

Soluble solid content (SSC %) and Titratable acidity percentage:

Total soluble solids percentage (SSC) and titratable acidity percentage at ripening stage are presented in Table 5. Soluble solid content (SSC %) of fruits gradually increased with the spraying seaweed extract and hand trimming. The highest values of SSC% were noticed in plants treated with the specific effect for seaweed extract (0, 1 or 2 %) and trimming (one hand and two hands) treatments i.e., (22.21, 22.40 and 22.23, 22.70 %) and (21.53, 21.97 and 21.83, 22.23 %), respectively. While the interaction effect for this study seaweed extract 0.2 % + trimming two hand treatment (23.0 and 23.30), while the lowest values was (19.2 and 19.9) noticed in untreated plants (control) during the two seasons of study.

This increase in SSC% may be due to water loss during storage (Gamal, 2012) and may possibly be due to hydrolysis of starch into sugars. As the hydrolysis of fruit starch is completed, no further increase in TSS could be detected and subsequently a decline in this parameter predictable since sugars along with other organic acids is primary substrates used for respiration (Gerasopoulos and Drogoudi, 2005). Moreover, Gouble *et al.* (2005) reported that the increase in SSC during fruit development is normally linked to changes in fruit color and ethylene production.

Seaweed extract can be a powerful and environmental friendly approach to improve ‘William’s’ fruit size and total yield by increasing fruits’ cell number early in the growth season. The positive effect could be

affected by the temperature at the time of and in the days after the spray application. In our region the optimal applications period seems to be extended and starting the treatments late in the flowering period seems to be effective too. Further analysis is planned in order to confirm the effects on maturity indices at harvest and after the storage period and in promotion of growth in the vegetative parameters (Colavita *et al.*, 2017). Regarding, the effect of spraying seaweed extract and hand trimming on titratable acidity the results in Table (6) did not showed

any significant effect in both seasons as compared with control treatment.

Seaweed (*Ascophyllum nodosum* L.) is a known source of plant growth regulators, which play an important roles in metabolism and productivity of plants. Moreover, hand trimming is practiced to increase the finger parameters. From the obtained results it could be concluded that, spraying seaweed extract at 2% with trimming two hands improved time to harvesting, yield as well as physical and chemical characteristics of the fruits of Grand Nain banana plants.

Table 5. Effect of spraying seaweed extract, trimming hand and interaction on SSC% and titratable acidity % of Grand Nain banana plants in the two seasons of study (2013/2014 & 2014/2015).

1-Soluble solid content (SSC%)								
Seaweed extract(S)	First ratoon				Second ratoon			
Trimming(T)	0%	0.10%	0.20%	Mean	0%	0.10%	0.20%	Mean
Without	19.20	21.52	21.71	20.81	19.90	21.30	21.90	21.03
One hand	19.90	22.20	22.50	21.53	20.10	22.50	22.90	21.83
Two hands	20.00	22.90	23.00	21.97	20.50	22.90	23.30	22.23
Mean	19.70	22.21	22.40		20.17	22.23	22.70	
New L.S.D at 5%								
T		0.19				0.21		
S		0.21				0.25		
Interaction		0.29				0.3		
2- Titratable acidity								
Seaweed extract(S)	First ratoon				Second ratoon			
Trimming(T)	0%	0.10%	0.20%	Mean	0%	0.10%	0.20%	Mean
Without	0.170	0.150	0.150	0.157	0.160	0.140	0.130	0.143
One hand	0.170	0.150	0.140	0.153	0.160	0.130	0.140	0.143
Two hands	0.170	0.140	0.140	0.150	0.160	0.140	0.140	0.147
Mean	0.170	0.147	0.143		0.160	0.137	0.137	
New L.S.D at 5%								
T		N.S.				N.S.		
S		N.S.				N.S.		
Interaction		N.S.				N.S.		

CONCLUSION

From the obtained results it could be concluded that, spraying seaweed extract at 2% with trimming two hands improved time to harvesting, yield as well as physical and chemical characteristics of the fruits of Grand Nain banana plants

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رش مستخلص الطحالب وخف الكفوف لتحسين الإنتاج وجودة ثمار الموز صنف جرانندان

محمد فاروق عبد الفتاح الخولي

قسم بحوث الفاكهة الاستوائية، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر

أجري هذا البحث علي نباتات الموز صنف جرانندان خلال موسمي ٢٠١٣/٢٠١٤ (خلفة أولي) و ٢٠١٤/٢٠١٥ (خلفة ثانية) نامية في ارض رملية لدراسة تأثير خف الكفوف (بدون وكف وكفين) والرش بمستخلص الطحالب (صفر و ١% و ٢%) تم إجراء الخف بعد اكتمال وخروج الكفوف مباشرة والرش بمستخلص الطحالب (٣ رشات) وذلك في المواعيد التالية: (١) بعد اكتمال وخروج الكفوف مباشرة. (٢) بعد أسبوعين من الرش الأولي. (٣) بعد شهر من الأولي. ومن النتائج المتحصل عليها: معاملات خف الكفوف والرش بمستخلص الطحالب أدت إلي تقصير المدة من اكتمال خروج السوباطة حتى اكتمال النمو بفارق زمني ٢٧، ٢٨ يوم من معاملة الكنترول خلال موسمي الدراسة. وقد اتضح أن اعلي القيم في زيادة وزن السوباطة والمحصول وأفضل مواصفات السوباطة والأصابع للنباتات الموز صنف جرانندان تحققت عند إزالة كفين من السوباطة + الرش بمستخلص الطحالب بتركيز ٠.٢% مقارنة بباقي المعاملات كما وجد أن استخدام الطحالب أدت إلي زيادة المحصول ووزن الإصبع من الكنترول وان معدل الزيادة وصل إلي ٣٥% في المحصول و ٢٦-٢٧% للإصبع في كلا الموسمين كما وجد أن التفاعل بين استخدام مستخلص الطحالب وخف الكفوف كان له نتائج ايجابية علي تقصير فترة الجمع ومواصفات الإصبع والمحصول وكانت أفضل النتائج عند الرش بمستخلص الطحالب بتركيز ٢% مع خف كفين من السوباطة.