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Influences of Seaweed Extract and Potassium Nitrate Foliar Application on Yield and Fruit Quality of Date Palms (*Phoenix dactylifera* L. cv. Sukary)

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ABSTRACT

This study was carried out during 2012 and 2013 seasons on date palms cv. Sukary, to study the effect of seaweed extracts and KNO_3 spray (1 and 2%) on fruit yield and quality characters. Five spraying treatments were applied as follow: KNO_3 at 1% and 2%, seaweed extracts at 1% and 2%, and the control (water). Results showed that both seaweed extracts and KNO_3 at 2% level improved fruit yield and quality of Sukary dates. Spraying of 2% seaweed extracts resulted in the highest bunch weight, fruit yield, fruit and flesh weight, soluble solids content and reducing and total sugars content. On the other hand, spraying of 2% KNO_3 showed the highest fruit volume, fruit diameter and fruit moisture. This study indicated that seaweed extracts improved fruit yield and quality as compared to KNO_3. In addition, seaweed extracts are more favorable to the consumer rather than chemical spray with KNO_3.

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Introduction

Date palm (*Phoenix dactylifera* L.) is one of the ancient domestic fruit trees in the Middle East countries and their fruit play an important role in the nutrition pattern of many people (Harhash and Abdel-Nasser, 2010 and Sarrwy *et al.*, 2012). Saudi Arabia is the largest country of the Arabian Peninsula and occupies about 80% of its area Abdullah and Al-Mazoui 1998. In Saudi Arabia, the total dates yield is estimated to be 1.2 million tons (FAO, 2014). In recent years, chemical pesticides and fertilizers were extensively applied to maintain high crop yield (Sarker *et al.*, 2012). Environmental pollution associated with hazardous chemical usage for crop protection and weed control have attracted the attention of scientists worldwide, because microbial diseases, insects and weeds have become more resistant to chemical pesticides and herbicides (Hegab *et al.*, 2005; DeSouza *et al.*, 2006). The excessive application of chemical nitrogen fertilizer not only

accelerated soil acidification, but also contaminated groundwater and the atmosphere and weakened the roots of the plant making them vulnerable to several diseases (Ayed, 2002; Fornes *et al.,* 2002). Seaweed extracts are rich and varied source of bioactive natural products which have been used for decades in agriculture (Crouch, 1990). They are considered as potential biotical and pharmaceutical agents (Ito and Hori 1989; Ahmed and Ragab 2002). It has been reported that seaweed extracts enhance the growth of vegetables and fruits, and also can protect them from different pathogens either on the plant or in storage (Washington *et al.,* 1999 and Khanzada *et al.*, 2007). Moreover, seaweed extracts such as algae extract as a new bio-fertilizer improve crop growth through certain mechanisms, due to the high level of phytohormones (auxins, gibberellins, cytokinins and abscisic acid), macronutrients (N, P and K), certain micronutrients (Fe, Cu, Mo, Mn, Zn, Co, and Ni), and other secondary metabolites such as amino acids and vitamins (Challen and Hemingway, 1965; Fornes *et al.,* 2002; Abd El-Migeed *et al.,* 2004; Spinelli *et al.,* 2009; and Haider *et al.,* 2012). Potassium influences fruit quality (Geraldson 1985), since its nutrition is directly related to high yield, fruit size, long shelf life, high level of soluble solids and ascorbic acid in many horticultural crops (Lester *et al.*, 2005, 2006). It is also related to fruit color and shipping quality (Usherwood, 1985; Rengel *et al.*, 2008). The aim of this study was to evaluate the effect of foliar application with seaweed extract and potassium nitrate (KNO_3) on yield and fruit quality of Sukary date palms grown under the conditions of Saudi Arabia.

Materials and methods

Plant materials and treatments

This experiment was carried out during two successive seasons (2012 and 2013) on 13 years old female date palms (*Phoenix dactylifera* L.) of Sukary cultivar, grown in the Agricultural and Research Station-Dirab, College of Food and Agricultural Sciences, King Saud University, Riyadh, Saudi Arabia. Fifteen uniform palms which were grown in sandy soil at 10 m apart and subjected to the same management and cultural practices (irrigation, pest and weed control), were selected for this study. Bunches were thinned to 10 bunches per palm and pollinated from one 'Meghal' male palm by placing 10 fresh male strands among female flower clusters in both seasons. A commercial Seaweed extract (ALGA600; chemical analysis is displayed in Table 1), KNO_3 at 1% or 2%, and control were applied twice (4 weeks after pollination and 4 weeks after the first spray). Bunches were sprayed using a small spraying motor, until run-off stage, with 1%Tween® 20 added to the spraying solution. Five treatments (three palms for each treatment) in each spray were applied as follow: 1% KNO_3 (T_1), 1% seaweed extract (T_2), 2% KNO_3 (T_3), 2% seaweed extract (T_4) and the control (water only, T_5).

Measurements and determination

Bunch weight and total yield: To determine the total yield at harvest time (Tamr stage), each spathe was weighed separately using weighing balance and weight was expressed in kilogram (kg).

Fruit quality: One hundred fruit per bunch were randomly collected; 50 fruits at Bisir stage to determine physical characteristics and 50 fruits at Tamr stage to determine chemical characteristics. The dimensions (length and diameter) were measured using a digital caliper. Fruit and flesh weight were measured using a digital balance (AOAC, 2000). Fruit volume was measured using the water displacement method (AOAC, 2000). Each fruit was submerged in a container full of water and the volume of displaced water was measured using a 250 cm^3 graduated cylinder. Water temperature during measurements was 27 °C (AOAC, 2000). The percentage of soluble solids content (SSC) was determined in fruit juice using a BRX-242 digital refractometer. Titratable acid- it was determined in juice by titrating with 0.1-N sodium hydrox- ide in the presence of

Table 1. Chemical analysis of seaweed extracts (ALGA600 seaweed).

Analysis	(w/w)
Organic matter (%)	40–50
Alginic acid (%)	12
Total nitrogen (%)	0.6
Phosphorus (P_2O5) (%)	6
Potassium (K_2O) (%)	20
Mannuronic acid (%)	–
Amino acid (%)	4
Mannitol (%)	3
Mg (%)	0.06
Ca (%)	0.4–1.6
Fe (%)	0.15–0.3
Cu (ppm)	25–45
S (%)	1.0–1.5
I (ppm)	300–600
Soluble in water (%)	100
pH	9–10
Specific gravity (g cm23)	0.50–0.55
Odour	Seaweed-like
Appearance	Brownish powder

Table 2: Effect of seaweed extracts and potassium nitrate (1 and 2%) spray on bunch weight (kg), yield (kg/tree), fruit and flesh weight (g) of 'Sukary' date palm fruit during 2012 and 2013 seasons.

Treatments	Bunch weight (kg)		Yield (kg/tree)		Fruit weight (g)		Flesh weight (g)	
	2012	2013	2012	2013	2012	2013	2012	2013
1% KNO_3	14.00d	14.57d	140.00c	145.67d	14.83d	14.78c	13.01d	12.99c
1% seaweed extracts	14.23c	15.37c	142.33c	153.67c	15.34c	14.84c	13.53c	12.92c
2% KNO_3	16.27b	18.2b	162.67b	182.00b	16.27b	17.32b	14.46b	15.48b
2% seaweed extracts	17.27a	19.03a	172.67a	190.33a	16.92a	18.48a	14.87a	16.51a
Control	9.17d	10.9e	91.67d	109.00e	10.52e	12.74d	8.65e	11.06e
LSD 0.5%	0.45	0.40	4.48	3.99	0.23	0.44	0.29	0.39

Means followed by a common letter in the same column are not significantly different by LSD 0.5% ($P \leq 5\%$)

Table 3: Effect of seaweed extracts and potassium nitrate (1 and 2%) spray on fruit length (cm), fruit diameter (cm), fruit and flesh weight (cm), fruit volume(cm^3) and SSC (%) of 'Sukary' date palm fruit during 2012 and 2013 seasons.

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit volume (cm^3)		SSC (%)	
	2012	2013	2012	2013	2012	2013	2012	2013
1% KNO_3	3.47a	3.46a	2.87b	2.72d	14.83c	14.83c	60.47ab	60.4b
1% seaweed extracts	3.52a	3.52a	2.90ab	2.78c	15.5bc	15.17c	63.33a	59.67b
2% KNO_3	3.52a	3.45a	3.00a	3.01a	17.33a	18.67a	59.87ab	60.80b
2% seaweed extracts	3.51a	3.52a	2.98a	2.93b	16.33b	17.17b	62.4a	62.4a
Control	3.1b	3.1b	2.61c	2.73cd	11.00d	12.5d	57.67b	57.60c
LSD 0.5%	0.16	0.16	0.079	0.053	0.91	0.62	2.78	1.4

Means followed by a common letter in the same column are not significantly different by LSD 0.5% ($P \leq 5\%$)

phenolphthalein as an indicator and results were expressed as a percentage of maleic acid (Shaaban, *et al.*, 2006). Reducing, non-reducing, and total sugars were determined according (AOAC 2000).

Experimental design and statistical analysis

The experiment was set in a randomized complete block design with three replicates per treatment. One-way ANOVA was applied using SAS program (SAS, 2000). Means were compared using least significant differences (LSD) at $P \leq 0.05$ (Snedecor and Cochran, 1977).

Results

Bunch weight, yield, fruit weight and flesh weight

The highest significant values in bunch weight (19.03kg), yield (190.33kg/palm), fruit weight (18.48g) and flesh weight (16.51g) were recorded with 2% seaweed extract (T_4) as compared with other treatments and the control during both seasons (Table 2). T_3 (2% KNO_3) followed T_4 (2% seaweed extract) in terms of improving yield and the other fruit characteristics, as compared to other treatments. Control treatment recorded the lowest values during both seasons.

Fruit length, fruit diameter, flesh weight and SSC

The effect of seaweed extracts and potassium nitrate (1 and 2%) spray on some physical characters and SSC percentage during 2012 and 2013 are illustrated in Table 3. T_3 (2% KNO_3) recorded the highest significant values of fruit diameter during 2013, and the highest fruit volume in both seasons. T_2 (1% seaweed extract) recorded the highest significant SSC during 2013 season only as compared to other treatments during both seasons. Control recorded the lowest significant fruit length and volume in both seasons, the lowest diameter in 2012 season, and the lowest SSC content in 2013 season.

Acidity, reducing sugars, total sugars and fruit moisture

The control (T_5) recorded the lowest significant values of total sugars (43.81 and 41.31) and fruit moisture content (13.58 and 14.66 %) during 2012 and 2013 seasons, respectively (Table 4). T 3 (2%KNO_3) and T4 (2% seaweed extract) showed the highest significant reducing sugars content during 2013 season. T 3 (2% KNO_3) showed the highest significant fruit moisture during 2013 season.

Discussion

The link between food safety and human health is the major concern of the consumer. Natural sources (seaweed extracts, compost and yeast) have an important role in this regard (Kullk, 1995; Howgate, 1998; Massie, 2003; Fornes *et al.*, 2005). Farmers are more interested in using natural sources (seaweed extracts) in agriculture as biocontrol agents for the nutrient formation of the foods (Verkleij, 1992; Fleet 2007; Hassan-Hoda, 2008). Results of some physical characteristics (fruit weight, flesh weight, bunch weight and total yield), as well as some chemical characteristics (SSC, reducing and total sugars) in both seasons of this study (Table 2, 3 and 4) showed that the application of 2% seaweed extract (T_4) had a positive effect on these characteristics, while treatments 2% KNO_3 and 1% seaweed extract had a positive effect only on some physical and chemical characteristics (Total and reducing sugars). All foliar applications with seaweed extract or KNO_3 at 2% recorded a higher value in most characteristics than 1% $KNO_3$and the control during both seasons. The results of the present study confirmed similar findings by previous reports (Metting *et al.*, 1990; Umer *et al.*, 1999; Abd El-Migeed *et al.*, 2004; Chouliaras *et al.*, 2005; Fornes *et al.*, 2005; Hegab *et al.*, 2005; Spinelli *et al.*, 2009; Elham *et al.*, 2010; Hanafy *et al.*, 2012). They study concluded that, the presence of some nutrients and growth regulators in seaweed extract, in addition to protein, carbohydrates, vitamins such as thiamine, riboflavin, vit-B12, folic

Table 4: Effect of seaweed extracts and potassium nitrate (1 and 2%) spray on acidity (%), reducing sugars (%), total sugars (%) and fruit moisture (%) of 'Sukary' date palm fruit during 2012 and 2013 seasons.

Treatments	Acidity (%)		Reducing sugars (%)		Total sugars (%)		Fruit moisture (%)	
	2012	2013	2012	2013	2012	2013	2012	2013
1% KNO_3	0.89a	0.81a	30.72b	29.47ab	50.73a	45.91c	17.67b	16.57c
1% seaweed extracts	0.83a	0.83a	34.10b	31.40a	54.08a	47.25c	17.13ab	17.63b
2% KNO_3	0.81a	0.92a	37.10a	28.61b	53.70a	49.17b	17.67a	18.57a
2% seaweed extracts	0.87a	0.93a	37.40a	31.05a	55.08a	53.34a	18.07a	17.34b
Control	0.92a	0.95a	29.21b	27.79b	43.81b	41.31d	13.58c	14.66d
LSD 0.5%	0.109	0.034	3.98	2.25	4.67	1.78	0.92	0.62

Means followed by a common letter in the same column are not significantly different by LSD 0.5% ($P \leq 5\%$)

acid in seaweed extract spraying solution may have a positive effect on increasing fruit yield and improving fruit quality (physical and chemical characteristics) of Sukary dates. This may be due to the effect of such treatments on nutritional status of the palms, which has been reflected on fruit yield and quality.

Conclusions

Foliar application of seaweed extract twice (4 weeks after pollination and 4 weeks after the first spray) at 2% followed 1%, have a positive effect than KNO_3, on yield and fruit quality of Sukary date palm grown under Saudi Arabia conditions. In addition, seaweed extract is very safe for human, animal and the environment in terms of less pollution and low soil salinity via the reduction of fertilization; in addition, it reduces the total production cost.

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