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INFLUENCE OF FOLIAR APPLICATIONS OF YEAST EXTRACT, SEAWEED EXTRACT AND DIFFERENT POTASSIUM SOURCES FERTILIZATION ON YIELD AND FRUIT QUALITY OF 'FLAME SEEDLESS' GRAPE

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ABSTRACT

Using biofertilizers has been a good method in this respect. Field experiments were conducted in 2014 and 2015 on 6-year-old grapevine cv. "Flame Seedless" grown under arid conditions (Riyadh, Saudi Arabia) to evaluated the effects of foliar application with natural sources and chemical of fertilizer on yield and fruit quality. Eight different foliar spray treatments were applied at 4 weeks after fruit set and repeated after another 4 weeks. These treatments were yeast at 4, 6 or 8%; seaweed extract at 1 or 2%; potassium nitrate at 2%; potassium hydrogen phosphate at 2%, and the control (water only). Results indicated that the application of 8% yeast had improved fruit chemical characteristics (soluble solid content, reducing sugars and total sugars) and some physical characteristics (cluster width and weight of 100 berries). Application of 2% potassium nitrate had a significant effect on yield, cluster weight, cluster length, and volume of 100 berries.

Key words: grapes, yeast extract, seaweed extract, KNO_3, K_2HPO_4, yield and fruit quality

INTRODUCTION

Grapes (*Vitis vinifera* L.) are the second important crop of Kingdom of Saudi Arabia after date palm. Total cultivated area of grapes in Saudi Arabia has reached 12 408 ha and the producing 135 368 t [FAO 2012]. Cultivation of new grape varieties has been given great attention in Saudi Arabia. Flame seedless is one of these new varieties that has been introduced to Saudi Arabia and planted in Riyadh region [Al--Obeed et al. 2011]. The efficient use of fertilizers is the most important goal to improve yield and to reduce the production cost [Dong et al. 2005]. The ability of plant leaves to absorb nutrients [Swietlik and Faust 1984] has resulted in the efficient uptake of nutrients through foliar application rather than soil application [Weinbaum 1988, Ayed 2002, Fornes et al. 2002]. "Soil application and uptake of nutrients by vine roots is decisive for the macronutrients. Foliar application is a supplementary source of macroelements nutrition but may cover the demands of vine for micronutrients [Zatloukalová et al. 2011, Zlámalová et al. 2015]. A considerable part of Saudi Arabia vineyards usually suffers from the deficiency of most macro- and

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micronutrients due to the great depletion and exhaustion of these nutrients by vines as well as the neglecting of their use by growers.

Bio-fertilization is very safe for human, animals and the environment. It also saves fertilization cost [Fathy and Farid 1996, Hewedy et al. 1996, Mohamed et al. 1999, Sarker et al. 2012]. Bio-fertilizer extracts containing macro- and micronutrients, growth regulators, vitamins and antioxidants proved to be very effective in enhancing fruit repining and improving physical and chemical properties of the grapes. They are considered as potential biotical and pharmaceutical agents [Ito and Hori 1989, Ahmed and Ragab 2002]. Bread yeast *Saccharomyces cervisiae*, as a natural bio-stimulant, induced growth and yield of many crops, since it has various functions including the production of carbon dioxide, alcohol, acids and esters [Crouch 1990, Martinez-Anoya et al. 1990]. Spraying 'Valencia' orange trees with active bread yeast either once in March or August or twice in both months improved tree growth and fruit set. It also enhanced total yield and fruit quality parameters [Hegab et al. 2005]. Ahmed et al. [1995] reported similar findings on Picual olive trees. It has been reported that seaweed extracts enhanced the growth of vegetables and fruits, and can protect them from different pathogens either on plant or in storage [Washington et al. 1999, Khanzada et al. 2007]. Seaweed extracts, such as algae extract improved crop growth through certain mechanisms due to the high level of phytohormones (auxins, gibberellins, cytokinins and abscisic acid), macronutrients (N, P and K), 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, Haider et al. 2012]. The influence of mineral fertilizers on the yield and quality of grape vine were investigated by several investigators [Colapietra and Alexander 2006, Dobrei et al. 2009]. Potassium has also a great effect on fruit quality [Geraldson 1985], since potassium nutrition is directly linked to increased yield, fruit size, shelf life, soluble solids and higher levels of ascorbic acid in many horticultural crops. It is related to improved fruit color and shipping quality (Usherwood 1985, Rengel et al. 2008].

The aim of this study was to evaluate the effect of foliar spray with bread yeast, seaweed extracts, potassium nitrate and potassium hydrogen phosphate on yield and fruit quality of 'Flame Seedless' grapes grown under Saudi Arabia conditions.

MATERIALS AND METHODS

Plant materials and spraying treatments. This research was conducted on 'Flame seedless' grapevines grown at 1.5 × 2 meters distance in a loamy calcareous soil under drip irrigation system at the Research and Agricultural Experimental Station in Dirab, King Saud University, Riyadh, Saudi Arabia during 2014 and 2015 seasons. Soil mechanical and chemical characteristics, and water characteristics were analyzed before the beginning of the experiment, and displayed in Table 1.

The bread yeast (Tab. 2) [Nagodawithana 1991], Seaweed extract [ALGA600 2012] (Tab. 3), potassium nitrate and potassium hydrogen phosphate treatments were applied individually in two times; 4 weeks after fruit set, and again after 4 weeks during both seasons.

Experimental design. The experiment was designed in randomized complete blocks with 8 treatments. Each treatment was replicated three times, and each replicate was represented by one vine (8 × 3 = 24 vines for each season). Six-years-old grapevines were selected uniform as possible. All vines of experiment were pruned to about 40–45 buds. During winter of both seasons, organic manure (10 kg/vine) was ditched in the soil at a depth of 20–25 cm from the soil surface and 30 cm away from the vine trunk. The eight treatments were as follow; 4% bread yeast (T_1), 6% bread yeast (T_2), 8% bread yeast (T_3), 1% seaweed extract (T_4), 2% seaweed extract (T5), 2% potassium nitrate (T_6), 2% potassium hydrogen phosphate (T_7), and the control (water only, T8). Grapevines were sprayed (5 l/vine) every once using a small motor sprayer, until run-off, with a wetting agent Tween® 20 (1%) added to the spraying solution.

Measurements yield and fruit quality. The crop was harvested in the second week of June at ripening stage. Clusters weight per vine was determined to calculate the total yield per vine during both seasons. A random sample of 8 clusters per replicate was collected to determined cluster weight and dimensions. A random sample of 100 berries per each replicate was

Table 1. Some physical and chemical characteristics of soil and water used

Parameter	Soil	Parameter	Soil	Water
Sand (%)	75.10	pH ($CaCo_3$)	7.50	6.87
Silt (%)	12.00	EC (dS/m)	1.00	1.68
Clay (%)	12.90	cations	(meq/l)	(meq/l)
Textural class	sandy loam	Ca2+	3.30	7.00
Organic matter (%)	0.40	Mg2+	2.50	3.60
Calcium carbonates (%)	18.79	Na+	5.60	9.80
Total N ppm	14	K+	0.30	0.50
P ppm	18.20	anions	(meq/l)	(meq/l)
K ppm	92.00	HCO_3	2.60	5.70
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----	----	Cl–	5.00	8.00
----	----	SO_4	3.60	7.30

Table 2. Chemical composition of bread yeast [Nagodawithana 1991]

Protein	47%	nucleic acids	8%
Carbohydrates	33%	lipids	4%
Minerals	8%		
approximate composition of vitamins (mg/g)			
Thiamine	6–100	biotin	1.3
Riboflavin	35–50	collin	4000
Niacin	300–500	folic acid	5–13
Pyridoxine HCl	28	vit-B12	0.001
Pantothenate	70		
approximate composition of minerals (mg/g)			
Na	0.12	Cu	8.00
Ca	0.75	Se	0.10
Fe	0.02	Mn	0.02
Mg	1.65	Cr	2.20
K	21.00	Ni	3.00
P	13.50	Va	0.04
S	3.90	Mo	0.40
Zn	0.17	Sn	3.00
Si	0.03	Li	0.17

Table 3. Alga 600™ (Pure Seaweed Extract)

Organic matter	45–55% (w/w)
Total Nitrogen	0.5–0.8% (w/w)
Potassium	17–19% (w/w)
Magnesium	0.34 % (w/w)
Calcium	0.6–1.8% (w/w)
Iron	0.15–0.30 %
Copper	7 ppm
Sulphur	1–1.4% (w/w)
Iodine	350–650 ppm

taken to measure the dimensions, weight and volume of 100 berries. Berries Chemical Characteristics: A random sample of 5 clusters from each vine was randomly collected to determine total soluble solids (SSC%) in a small sample of fruit juice using a hand held refractmeter, total acidity (as g tartaric acid/ 100 ml juice) by titration against NaOH using phenolphthalein as indicator [AOAC 1995], total and reducing sugars percentage using the method of Lane and Eynon [1965] and the volumetric method described by AOAC [1995].

STATISTICAL ANALYSIS

A one way ANOVA test was applied using SAS program [SAS 2000], and means were compared using the least significant differences (Duncan) at $P \leq 0.05$ [Snedecor and Cochran 1980].

RESULTS

Yield and fruit physical characteristics. Data in Tables 4 and 5 indicated that the yield, cluster weight and dimensions, and 100 berries weight, volume and dimensions were greatly affected by foliar spray of yeast, seaweed extract, potassium nitrate and potassium hydrogen phosphate during both seasons. Application of KNO_3 showed the highest yield compared to other treatments during both seasons (Tab. 4). The highest significant values in cluster weight, weight of 100 berries and volume of 100 berries (405.33 g, 320.27 g and 301.67 cm^3) were recorded with 2% KNO_3 (T6) as compared with other treatments during 2014 and 2015, respectively. Cluster length increased significantly with all spraying treatments in both seasons, as well as cluster diameter in first season only. Spraying

Table 4. Effect of foliar spray yeast, seaweed extract, potassium nitrate and potassium hydrogen phosphate spraying on yield (kg/vine), cluster weight (g), weight100 berries (g) and volume 100 berry (cm^3) of 'Flame Seedless' grapevine during 2014 and 2015 seasons

Treatments	Yield (kg/vine)		Weight of 100 berries (g)		Cluster weight (g)		Volume of 100 berries (cm^3)	
Treatments	2014	2015	2014	2015	2014	2015	2014	2015
	cluster length (cm)		cluster diameter (cm)		berry length (cm)		berry diameter (cm)	
Yeast 4%	8.55d	8.70e	199.47de	214.47cd	285.00e	290.00e	193.33c	210.33cd
Yeast 6%	8.84d	9.30d	185.07e	217.97cd	294.67e	310.00d	180.00c	213.33cd
Yeast 8%	9.34d	9.47d	190.93e	225.8cd	327.33d	315.67d	186.67c	223.33bc
Seaweed 1%	11.04c	10.34c	212.67d	255.17bc	368.00c	345.67c	206.67bc	248.33bc
Seaweed 2%	11.88b	11.12b	241.00c	280.03ab	396.00b	369.67b	235.00b	263.33b
KNO_3 2%	12.82a	12.16a	320.27a	299.77a	427.33a	405.33a	280.00a	301.67a
K_2HPO_4 2%	12.46ab	11.40b	273.73b	249.0bc	415.33a	380.00b	268.33a	248.33bc
Control	7.84e	7.70f	166.27f	184.13d	261.33f	256.67f	161.67d	180.33d

Means followed by a common letter in the same column are not significantly different by Duncan (P ≤ 5%)

Table 5. Effect of foliar spray yeast, seaweed extract, potassium nitrate and potassium hydrogen phosphate spraying on cluster length (cm), cluster width (cm), berry length (cm) and berry diameter (cm) of 'Flame Seedless' grapevine during 2014 and 2015 seasons

Treatment	2014	2015	2014	2015	2014	2015	2014	2015
	SSC		acidity (%)		reducing sugars (%)		total sugars (%)	
Yeast 4%	16.88e	15.20e	11.83e	10.73cd	1.33b	1.27d	1.23b	1.17d
Yeast 6%	17.40e	15.80e	12.40cd	11.13bcd	1.43ab	1.40c	1.20b	1.17d
Yeast 8%	17.80de	17.27d	13.37bc	11.87abcd	1.53ab	1.37c	1.27b	1.17d
Seaweed 1%	18.53d	17.93d	13.37bc	12.60abc	1.63a	1.47bc	1.40b	1.27cd
Seaweed 2%	20.87c	18.73c	13.30bc	13.07ab	1.67a	1.53a	1.37b	1.33bc
KNO_3 2%	24.27a	22.73a	14.53a	13.53a	1.70a	1.67a	1.63a	1.50a
K_2HPO_4 2%	21.80b	21.80b	13.72ab	11.03abcd	1.47ab	1.63a	1.30b	1.43ab
Control	15.33f	14.20f	10.80f	9.97d	1.30b	1.23d	1.20b	1.13d

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

Table 6. Effect of foliar spray yeast, seaweed extract, potassium nitrate and potassium hydrogen phosphate spraying on SSC (%), acidity (%), total and reducing sugars (%) of 'Flame Seedless' grapevine during 2014 and 2015 seasons

SSC (%)		Acidity (%)		Reducing sugar (%)		Total sugars (%)	
2014	2015	2014	2015	2014	2015	2014	2015
16.53c	17.67c	0.32c	0.34ef	12.53abc	10.10a	14.31c	14.92bc
18.20b	18.07b	0.33c	0.33ef	13.19ab	10.46a	16.35b	15.41b
19.20a	18.53a	0.29e	0.31f	13.84a	11.47a	17.81a	16.20a
14.80d	16.47d	0.37b	0.38b	11.29cd	10.57a	13.23d	13.92d
15.07d	16.60d	0.34c	0.36b	11.37cd	10.31a	13.52d	14.57cd
15.27d	17.40c	0.32c	0.35cd	12.12bc	10.68a	13.50d	14.77bc
16.20c	17.53c	0.32c	0.35cde	12.66abc	9.92a	14.45c	14.52cd
14.13e	15.67e	0.42a	0.41a	10.62d	9.76a	11.59e	12.98e

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

2% of KNO_3 resulted in the maximum cluster length (24.27 cm) and diameter (14.53 cm) in 2014 season, respectively. Control showed the lowest values of cluster length during both seasons. While berries dimensions (cm) had not the same trend as cluster dimensions. The highest significant berries diameters (1.63 and 1.50 cm) were obtained when 2% of KNO_3 was sprayed in the 2014 and 2015 seasons, respectively.

Fruit chemical characteristics. Data in Table 6 showed the effect of foliar spray of yeast extract, seaweed extract, KNO_3 and K_2HPO_4 on fruit chemical characteristics of 'Flame Seedless' grape cultivar in the two seasons (2014 and 2015). The present data clearly indicated that foliar spray of yeast extract at 8% significantly increased the SSC (%). Reducing sugars and total sugars (%) contents than other treatments and control. Reducing sugars (%) content was not significantly affected by any of the experimental treatments in the second season (2015). Acidity was significantly percentage increased control as compared with other treatments in both seasons.

DISCUSSION

Nowadays, the link between food safety and human health is the major concern of the consumer. Natural

sources (yeast, seaweed extracts, compost etc.) have an important role in this regard [Fornes et al. 1995, Kullk 1995, Howgate 1998, Massie 2003]. Farmers are more interested in using natural sources in agriculture, as bio-control agents for safe foods [Fleet 2007, Hassan-Hoda 2008]; however, food-treated using natural sources could be a source of infections and other adverse health responses in humans [Oros et al. 2003, Hanafy et al. 2012]. Results of 'Flame Seedless' fruit quality (physical and chemical characteristics) showed that all foliar application with potassium nitrate at 2% resulted in the highest values in all physical characteristics than the control and other treatments during both seasons. Application of 8% yeast had a positive effect on SSC and total sugars compared with the control and other treatments. These results agreed with previous reports of Fornes et al. [1995], Hegab et al. [2005], Spinelli et al. [2009], Abd El-Motty et al. [2010]. Yeast has a beneficial role in improving growth of vegetable [Fathy et al. 2000, Omer 2003]. Abd El-Motty et al. [2010] reported that spraying 'Keitte' mango trees once at full bloom with 0.2% yeast was very effective in improving yield and its components, and enhanced fruit quality. These effects of yeast extract may be due to that yeast is a natural component (safe and non-pollutant) contains considerable amount of nutrients such as cytokinins, amino acids; minerals, carbohydrates, reducing sugars, enzymes and vitamins (B1, B2, B3, and B12) that can improve physical and chemical characteristics of the fruit [Fathy and Farid 1996, Khedr and Farid 2000]. Carbohydrates, vitamins such as thiamine, riboflavin, B12, folic acid in seaweed extract spraying solution may have a positive effect on fruit yield and quality of 'Flame Seedless' grapes [Chouliaras et al. 2005, Hegab et al. 2005, Spinelli et al. 2009, Elham et al. 2010]. This could be due to the influence of such treatments on nutritional status of the grapevine, which has been reflected on fruit yield and quality.

CONCLUSION

Foliar application with yeast extract (8%) 4 weeks after fruit set and again after another 4 weeks had a positive affect 'Flame Seedless' grapes yield and fruit quality as improved fruit chemical characteristics (soluble solid content, reducing sugars and total sugars) and some physical characteristics (cluster width and weight of 100 berries). Application of 2% potassium nitrate had a significant effect on yield, cluster weight, cluster length, and volume of 100 berries. In addition, yeast is very safe for human, animals and the environment in terms of less pollution via the reduction of chemical fertilization. Moreover, it reduces the total production cost.

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