J. Plant Prod., Mansoura Univ., Vol. 1 (12): 1625 - 1635 , 2010

ENHANCED PRODUCTIVITY AND FRUIT QUALITY OF FLAME SEEDLESS GRAPEVINES TREATED WITH SEAWEED EXTRACT

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ABSTRACT

A field experiment was conducted during seasons of 2008 and 2009 on Flame Seedless grapevines. The vines were 12-years-old, cultivated at 2 x 2.5 m apart, trained as cordon system, and grown in a clay soil, and drip irrigation system was used, to study the effects of foliar applications of different concentrations of Goemar BM 86 and Acadian extracts on nutrient uptake, growth and yield of Flame Seedless grapevines. The foliar spray was replicated three times at four concentrations (0, 0.5, 1 and 2 %) of seaweed extracts. Foliar applications of seaweed extract significantly enhanced yield parameters. The highest yield weight was recorded with applications of 1 % Acadian extract, followed by 2 % Goemar extract that resulted in 59 % and 39 % increases, respectively compared to the control. The maximum fruit quality was achieved with 2% Goemar extract application. Improved nutrient uptake was also observed with seaweed extract applications. Thus, foliar application of Acadian extract could be a promising option for yield enhancement, and Goemar extract for fruit quality.

INTRODUCTION

Biostimulants are considered to be an environmental friendly, natural substances able to promote vegetative growth, mineral nutrient uptake and plant fitness under different climatic conditions and tolerate abiotic stresses (Vernieri *et al*., 2006). Seaweeds are a known as a source of plant growth regulators (Jameson, 1993), organic osmolites (e.g. betaines), amino acids, mineral nutrients, vitamins and vitamins precursors (Berlyn and Russo, 1990). More than 15 million metric tons of seaweed products are used annually as nutrient supplements and biostimulants in agricultural and horticultural crops production (FAO, 2006). Seaweeds and seaweed extracts have long been used in Canadian and European coastal agricultural zones as soil conditioners and foliar sprays to increase crop growth, yield, and productivity (Stephenson, 1974; Senn, 1987; Crouch and Van Staden, 1992; Verkleij, 1992; Norrie and Keathley 2006).

Exogenous applications of seaweed extracts have been observed to increase both yield and productivity of crop plants, but the mechanisms for such responses remain largely unknown (Blunden, *et al*., 1979; Abetz and Young, 1983; Featonby-Smith and van Staden 1987). Earlier studies have been reported positive effects of seaweed extracts on root growth when applied either to the rhizosphere or as a foliar spray (Blunden and Wildgoose 1977; Finnie and van Staden 1985). Chemical analysis of seaweeds and their extracts have revealed the presence of a wide variety of plant growth regulators such as auxins and cytokinins in varying amounts, vitamins, nucleotides and alginin acid (Senn and Kingman 1978; Jameson 1993; Zhang and Ervin 2004, 2008).

Seaweed extracts have been reported to stimulate the growth and yield of plants (Rama Rao, 1991), enhance tolerance to environmental stress

(Zhang and Schmidt, 2000; Zhang *et al*., 2003), increase nutrient uptake from soil (Verkleij, 1992; Turan and Köse, 2004) and enhance antioxidant capacity (Verkleij, 1992).

In recent years, use of seaweed extracts have gained in popularity due to their potential use in organic and sustainable agriculture (Russo and Beryln, 1990), as a means to avoid excessive fertilizer applications and to improve mineral absorption. Unlike, chemical fertilizers, extracts derived from seaweeds are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animals and birds (Dhargalkar and Pereira, 2005).

The aim of the present study was to investigate the effect of Goemar and Acadian extracts on the main vegetative, productive and quality parameters of Flame Seedless grapevine cultivar.

MATERIALS AND METHODS

This experiment was performed on 63 Flame Seedless grapevines during two seasons of 2008 and 2009 in a private vineyard located at Meniet Samanoud, Dakahlia Governorate, Egypt. The vines were 12-years-old, cultivated at 2 x 2.5 m apart, trained as cordon system, and grown in a clay soil, and the drip irrigation system was used. The vines were pruned in the first week of February with a load of 60 buds per vine. The experiment comprised of seven treatments, 0 (control, water spray), 0.5; 1 and 2 % of seaweed extracts in water. Three sprays of Goemar B M 86 or Acadian extract was applied. One at 20 cm of shoot length, the second at fruit set, the third at 5% of the berries showed coloring (5% veraison), each vine received one liter of each solution.

Table 1 : Chemical constituents of Acadian seaweed extract.

Components	Seaweed extract
	Acadian
Organic matter	13%
Total nitrogen	0.33%
Phosphorous	0.3
Potassium	4 %
Zinc	15 ppm
Manganese	44 ppm
Magnesium	2 ppm
Copper	0.1 %
Calcium	9 ppm
Boron	0.05 %
Sulfur	0.3 %
Sodium	1 %

Table 2: Chemical constituents of Goemar B.M 86 seaweed extract.

Components	Seaweed extract
	Goemar BM 86
Total nitrogen	2.4 %
Magnesium	4.86 %
Boron	2.04 %
Sulfur	9.56 %
Molybdenum	0.02 %

Seaweed extracts were used as Acadian or Goemar – BM 86, which contain major and minor nutrients, amino acids, vitamins, cytokinins, auxin and abscisic acid like growth promoting substances (Mooney and Van Staden, 1986, Jameson, 1993). The treatments were distributed in a randomized block design with three replications, three vines in each. The following parameters were measured:

Vegetative growth:

The average of leaf area values was calculated from 10 leaves per vine positioned opposite to the basal clusters using a planimeter. Shoot length, shoot diameter were measured at the final stage of growth.

Leaf analysis and Total chlorophyll

Petiole of leaves opposite to the clusters were collected at version for chemical analysis N (Pregl, 1945), P (Chapman and Pratt, 1961), K (Brown and Lilleland, 1946). Total chlorophyll as mg/g fresh weight was measures according to (Brown and Lilleland, 1946).

Yield components and fruit quality:

Yield per vine (kg) was recorded at the time of harvest (on the first week of June in both seasons). A sample of 18 clusters per treatment were picked up and weighed. Twenty berries were clipped from each cluster and kept for analysis of anthocyanins. Hundred additional berries were removed and used for determination the remaining fruit quality parameters.

The samples of one hundred berries were first weighed to obtain mean berry weight (g) and berry volume (ml). Berries were homogenized in a blender, whereupon the juice was filtered. Total soluble solids (TSS) of the juice were measured by using a hand refractometer. Total acidity was determined (as g tartaric acid per 100 ml juice) according to the AOAC (1995). The content of total anthocyanins in berry skin was determined according to Rabino *et al.* (1977). Nitrate and nitrite were determined according to (singh, 1988).

Total carbohydrates and pruning weight:

The weight of one-year – old pruning wood was determined on the first week of February. Total carbohydrates as g /100g dry weight was calculated according to Dubois *et al*. (1956), wood maturity was calculated by dividing length of the mature part by the total length of the shoot according to Bouard (1966).

Statistical analysis: Statistical analyses were performed using the method outlined by Waller and Duncan (1969). Means of data obtained were compared using the New Least Significant Difference method (NLSD).

RESULTS AND DISCUSSION

Vegetative growth:

Fig. 1 shows the effect of spraying various concentrations of Goemar BM 86 and Acadian on leaf area, shoot length and shoot diameter. In general, a gradual increase in growth parameters was observed with increasing seaweed extract applications. Leaf area was significantly increased by Acadian extract at all concentrations but was insignificant by Goemar extract. The largest leaf area was observed at 2 % Acadian extract which was significantly higher over all other treatments. Hetherington and Woodward, (2003) reported that seaweed extract enhanced stomata densities, and stomata control gas exchange between the interior of a leaf and the atmosphere. Therefore they mainly contribute to the ability of plants to control their water relations and to enhance the photosynthesis capacity.

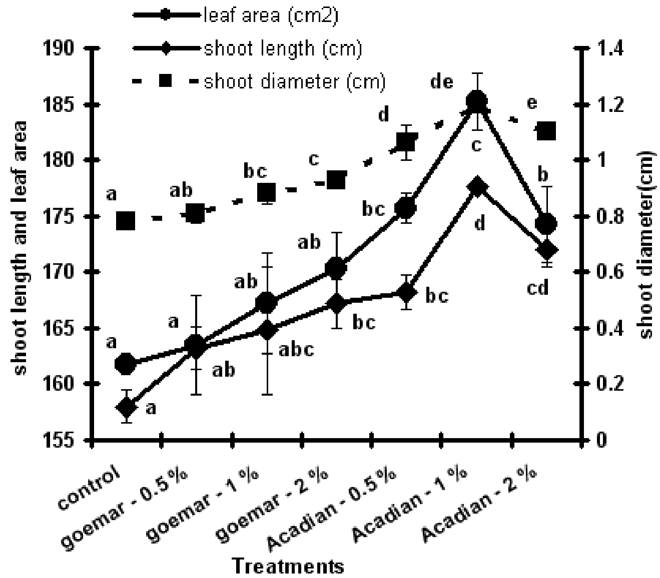

Fig 1: Effect of seaweed extracts on leaf area,shoot length and shoot diameter of Flame Seedless grapevines.

Shoot length and shoot diameter was not significantly affected by foliar application of Goemar up to 1 % concentration. All concentrations of Acadian significantly increased shoot length and diameter, the maximum increases was observed at 1 %. The increased growth may be due to the presence of certain growth promoting substances present in the seaweed extract (Mooney and Van Staden, 1986; Blunden, 1991). In addition, the growth enhancing potential of the seaweed extract might be attributed to the presence of macro and micronutrients. A similar result was conducted by (Hamed, 2007) who found that spraying Thompson Seedless grapevines with seaweed extract significantly increased both shoot length and their diameter.

Leaf analysis and Total chlorophyll

Nitrogen uptake by leaves was not significantly influenced by seaweed extract applications. Whereas, P and K affected significantly (Fig. 2).

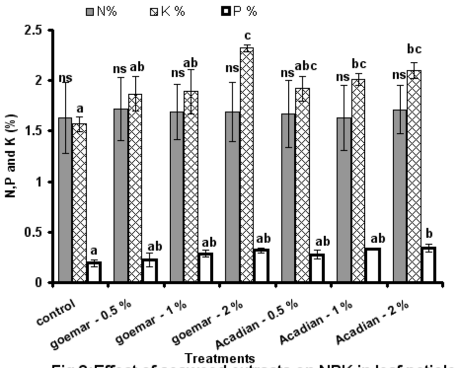

Fig 2:Effect of seaweed extracts on NPK in leaf petiole of Flame Seedless grapevines.

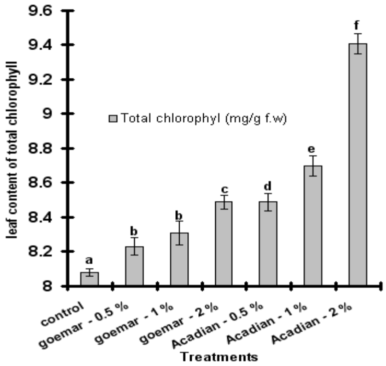

Fig 3: Content of chlorophyll in leaves treated with seaweed extracts of Flame Seedless grapevines.

Highest P and K contents uptake by leaves were observed at 2 % and followed by 1 % of seaweed extract. Our results confirm with those reported by Abd EL-Hamed (2007) on Red Roomy grapevine; EL-Boray *et al*. (2007) on Thompson seedless grapevine and Abbas *et al*. (2008), they found that spraying Flame seedless grapevine with seaweed extracts significantly increased N, P and K contents in the leaf petioles.

The presence of marine bioactive substances in seaweed extract improves stomata uptake efficiency in treated plants compared to non-treated plants (Mancuso *et al*., 2006).All treatments significantly increased total chlorophyll in the leaves. The higher chlorophyll concentrations resulting from the higher seaweed extract concentrations. Acadian extract at all concentrations was more effective on chlorophyll than Goemar extract. This increase in chlorophyll content was a result of reduction in chlorophyll degradation, which might be caused in part by betaines in the seaweed extract (Whapham *et al*., 1993 and Blunden *et al*., 1997).

Yield components and fruit quality :

- Yield components : The effects of seaweed extract on berries weight, volume, and juice and cluster weight are illustrated in Fig. (4). All treatments significantly increased berry weight, volume and juice compared with the control. A gradual increase in berry parameters and cluster weight were observed with increasing seaweed extract concentrations. The highest berry parameter and cluster weight resulted from Acadian extract at 1% (30 % increases in berry weight, 26 % in berry volume, 34 % in berry juice and 28 % in cluster weight, respectively over the control). Seaweed extracts have been found to contain significant amounts of cytokinins, auxins and betaines, which influence cell division during the early stages of growth along with the induction of flower formation (Roussos *et al*., 2009). Both of Goemar and Acadian extract showed positive effects on the yield especially at 2 % of Goemar and 1 % of Acadian extract (Fig. 5). Foliar application of Goemar extract enhanced Flame Seedless grape yield by 39 % and by about 59 % for Acadian extract over the control. Yield increases in seaweed-treated plants are thought to be associated with the hormonal substances present in the extracts, especially cytokinins (Featonby-Smith and Van Staden, 1984).

Norrie and Keathley (2006) have reported that seaweed extracts showed positive effects on the yield of Thompson seedless grape consistently over a 3-year period, and resulted in improving fruit size (13% increase), weight (39% increase), and yields (60.4% increase over the values of control).

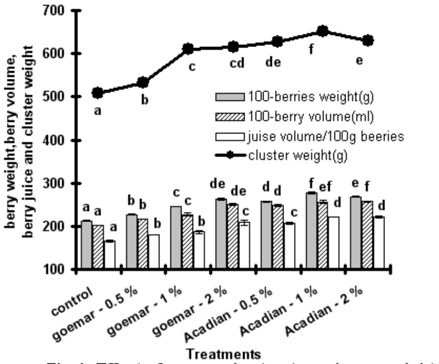

Fig 4: Effect of seaweed extracts on berry weight, berry volume, juice volume and cluster weight of Flame Seedless grapevines.

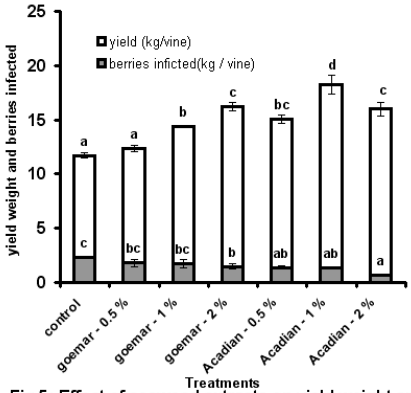

Fig 5: Effect of seaweed extracts on yield weight and berries infected of Flame Seedless grapevines.

- Fruit quality:

Data in Fig (6.A, B & C) showed that all treatments except 0.5% 0f Goemar significantly increased TSS %.The maximum TSS % was obtained from Goemar at 2 % followed by 1 % and 2 % of Acadian extract. All treatments significantly decreased total acidity %, the lowest acidity % was estimated in berries of vines treated with Goemar at 2 % and 1 %, respectively.

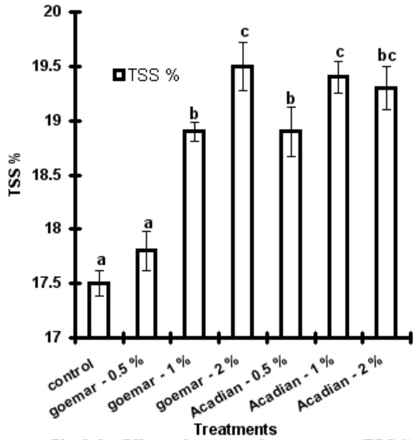

Fig 6.A : Effect of seaweed extracts on TSS % of Flame Seedless grapes.

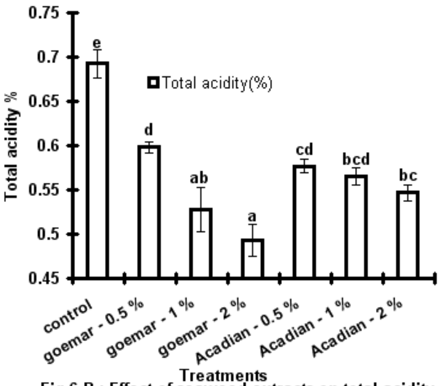

Fig 6.B : Effect of seaweed extracts on total acidity % of Flame Seedless grapes.

All treatments significantly increased the anthocyanins content in the skin of berries, especially at 2 % and1 % of Goemar and Acadian extract. Seaweed extracts are involved either in enhancing the mobilization of cytokinins from the roots to the developing fruit, or, more likely, improving the amount or synthesis of endogenous fruit cytokinins (Hahn *et al*., 1974). This increase in cytokinin availability will eventually result in a greater supply of cytokinins to the maturing fruit. Seaweed extracts had no effect on nitrate and nitrite in grape juice berries than the control (Fig.7).

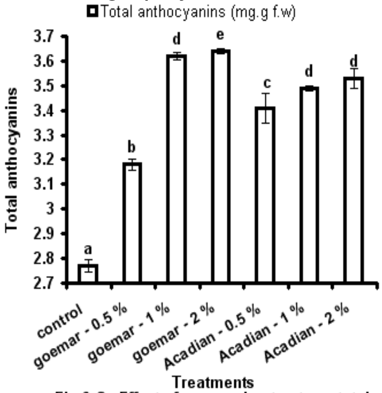

Fig 6.C : Effect of seaweed extracts on total anthocyanins of Flame Seedless grapes.

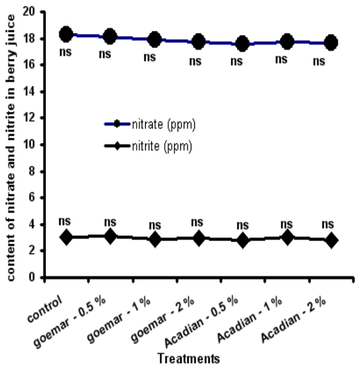

Fig 7: Effect of seaweed extracts on berry juice content of nitrate and nitrite of Flame Seedless grapevines.

Total carbohydrates, pruning weight and wood ripening

Data in Fig (8) showed that foliar application with Goemar extract had no effect on the content of total carbohydrates in canes. However, all concentrations of Acadian significantly increased total carbohydrates in canes compared with the control. Vines sprayed with Acadian extract at 1 % showed the highest percentage of total carbohydrates (13%) in comparison with other treatments. All treatments except 0.5 % of Goemar extract significantly increased coefficient of wood ripening than the control (Fig 9). Foliar application of Acadian at 1% showed the highest coefficient of wood ripening (14 %) over the control.

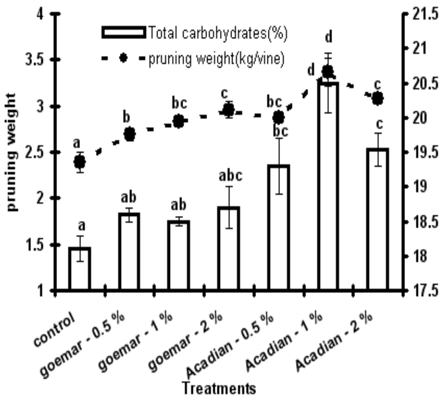

Fig 8: Effect of seaweed extracts on pruning weight and total carbohydrates of Flame Seedless grapevines.

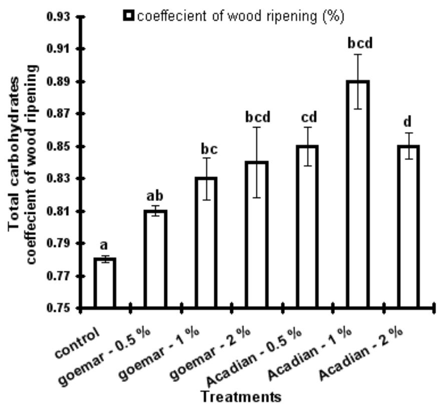

Fig 9: Effect of seaweed extracts on coeffecient of wood ripening of Flame Seedless grapevines.

In conclusion, Acadian extract is effective in increasing the growth parameters (shoot length, diameter, leaf are, and wood pruning weight), yield and enhancing total chlorophyll total carbohydrates, coefficient of wood ripening. While, Goemar extract is more efficient in improving fruit quality (TSS%, total acidity and total anthocyanin).

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تحسين انتاجية وجودة ثمار عنب الفيلام سيدلس المعامل بمستخلص الاعشاب البحرية

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أجريت هذه الدراسة خلال موسمى ٢٠٠٨ و ٢٠٠٩ على كرمات عنب فيلام سيدلس عمرها ١٢ سنة مزروعة فى أرض طينية ، تروى بالتنقيط على أبعاد ٢ فى ٢,٥ م ومرباة بالطريقة الكردونية لدراسة تاثير الرش بمستخلص الاعشاب البحرية (جيومار ب م ٨٦ و أكاديان) بتركيزات صفر، ٠,٥ ، ١ ، ٢ % وذلك فى ثلاث مواعيد (طول الفرخ ٢٠ سم – عند عقد الثمار – عند ٥ % من بداية التلوين) على الحالة الغذائية والنمو والمحصول وجودة الثمار لعنب الفيلام سيدلس . أظهرت النتائج أن الرش بمستخلص الاعشاب البحرية أدى لزيادة معنوية لكل من خصائص النمو وحسن الحالة الغذائية للكرمات. أعلى وزن للمحصول تم الحصول علية من المعاملة بتركيز ١ % من مستلخص أكاديان يلية ٢ % من مستخلص جيومار والذى سجل ٥٩ % و ٣٩ % زيادة عن محصول الكنترول على الترتيب. أفضل خصائص جودة كانت لكرمات العنب المعاملة بتركيز ٢ % من مستخلص جيومار. وعليه يمكن القول بان الرش بمستخلص الاعشاب البحرية أكاديان يمكن ان يكون اختيار جيد أدى إلى تحسين الانتاجية و أن مستخلص جيومار يكون مثالى لتحسين خصائص جودة الثمار لعنب الفيلام سيدلس.

قام بتحكيم البحث

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