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Effect of Foliar Spraying with Algae Extract and Potassium Nitrate on Yield and Fruit Quality of cv. Medjool Date Palm

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ABSTRACT

The objective of the present study is to investigate the impact of spraying algae extract and / or potassium nitrate on yield and fruit quality of cv. Medjool date palm. This study was carried out during 2014 and 2015 growing seasons. Inflorescences were sprayed with algae extract at (0.5 and 1%) and potassium nitrate at (1 and 2%) as individual application or in a combination between them. In general, results indicated that spraying inflorescences date palm with algae extract and / or potassium nitrate had a significant effect on yield, fruit physical and chemical characteristics of Medjool date palm when compared to the check treatment. The effective was in proportional to the increase in concentrations of both materials. The superior treatment concerning yield and fruit quality was spraying Medjool date palms two times with high doses of combined treatment (1% algae extract + 2% potassium nitrate) in the two experimental seasons.

Key words: Medjool date palm, yield, fruit quality, algae extract, potassium nitrate.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is concerned as one of the important crops in arid and semi-arid regions of the world. It concedes the ancient domestic fruit trees in the Middle East countries and their major food source of many people. Moreover, it has an important role in the economic and social life of the people of these regions. The total production of date fruits in Egypt is about 1.3 million tons [1].

Algae extract as a new bio-fertilizer containing macronutrients as well as micronutrients, some growth regulators, polyamines, proteins and vitamins applied to improve nutritional status, vegetative growth, yield and fruit quality [2-4]. Mode of action effect of algae on cell metabolism are mainly through the physiological action of major and minor nutrients, amino acids, vitamins, and also natural plant hormones like IAA, GA₃ and cytokinins affect cellular metabolism in treated plants leading to enhances growth and yield [5-7]. Growth and fruiting of fruit trees were greatly enhanced due to the application of bio fertilizer particularly algae extract [8, 9].

The positive effect of potassium spray on date palm was mentioned by many investigators. Spraying 0.4% potassium sulfate on Barhee date palm significantly increased fruit set, yield and improved physical and chemical fruit quality parameter [10]. Similarly, [11] spraying "Khalas" date palm bunches at the pre-bloom or bloom stages with 2% K-citrate significantly increased fruit set, yield and improved fruit quality. Also, [12] spraying date palm cv. Deglet Nour bunches; 6 weeks after of pollination with KNO₃ or K₂SO₄ increased retained fruits percentage, fruit weight, fruit length and fruit diameter, flesh weight and seed weight compared to the control. However, the same trend was noticed by other investigators, on olive. Potassium nitrate sprayed twice during the growth season at 4% enhanced

nutritional status, improved vegetative growth, reduced fruit drop and increased the productivity [13]. Spraying 2% potassium citrate + 0.45 m M putrescine at bloom improved fruit quantity and quality in date palm cv. Amhat [14].

This investigation aimed to study the effect of foliar spray of algae extract at (0.5 and 1%) and potassium nitrate at (1 and 2 %) as well as their combinations on yield and fruit quality of date palm cv. Medjool.

MATERIALS AND METHODS

This study was carried out during 2014 and 2015 seasons on 10 years old date palm “Medjool cv.” grown on sandy soil with 6 × 6 meters a part under drip irrigation system at a private orchard situated at point of 63 kilometer from Cairo-Alexandria desert road. The selected palms were healthy, nearly uniform in growth vigor and fruiting and received regular horticultural practices. Moreover, date palm thinned at one bunch per eight leaves rate (8 leaves / 1 bunch ratio). Pollination was carried out using the same pollen grain source. Twenty one palms were selected and divided into 7 treatments in three replicates (each is one palm) and arranged in a randomized complete block design; palms were subjected for the following spraying treatments:

- Control (water only).
- 0.5% algae extract.
- 1% algae extract.
- 1% potassium nitrate.
- 2% potassium nitrate.
- 0.5% algae extract + 1% potassium nitrate.
- 1% algae extract + 2% potassium nitrate.

All treatments were applied two times just at after fruit set and one month later. Bunches were sprayed using a small hand sprayer until run-off. The number of spathes per palm was adjusted ten bunches by removing earliest, latest and smallest inflorescence for each palm.

Yield was estimated as average bunch weight (Kg) for each treatment crossing the number of bunches/ palm.

The bunches were harvested at the second week of September in both studied seasons, at the peak of color picked at random from each bunch for determination of physical properties such as fruit weight (g), fruit dimensions (cm) [length and diameter], pulp weight (g) and seed weight(g). Also chemical properties i.e. total soluble solids %, acidity %, reducing sugars %, non-reducing sugars %, total sugars % and tannins % were measured as outlined in methods [15].

The obtained data were statistically analyzed [16] using LSD parameter at 5% level for comparing the differences between the studied treatment means.

RESULTS AND DISCUSSION

Bunch weight and yield/palm

Bunch weight (Kg) as indication of yield of Medjool date palm as affected by algae extract and/or potassium nitrate spray is illustrated in Table 1.

Table 1. Effect of algae extract, potassium nitrate foliar spray and their combination on bunch weight and yield/palm of Medjool cv. date palm (2014 and 2015 seasons)

Treatments	Bunch weight (Kg)		Yield/palm (Kg)	
	1 st	2 nd	1 st	2 nd
Control	12.5	12.9	125.0	129.0
0.5% AE	13.5	13.8	135.0	138.0
1% AE	13.7	14.1	137.0	141.0
1% K ₂ NO ₃	14.9	15.3	149.0	153.0
2% K ₂ NO ₃	15.7	15.9	157.0	159.0
0.5% AE + 1% K ₂ NO ₃	16.0	16.9	160.0	169.0
1% AE + 2% K ₂ NO ₃	17.8	18.0	178.0	180.0
LSD _{0.05}	0.42	0.66	4.10	2.49

AE: Algae Extract, K₂NO₃: Potassium nitrate.

The results showed that all treatments had significant increased of bunch weight as compared with the control in both growing seasons. The heaviest bunch weights were obtained from the combined spraying with high levels between (1 % algae + 2 % potassium nitrate), followed by the combined low levels between them (0.5 % algae + 1 % potassium nitrate which recorded (17.8 & 18.0) and (16.0 & 16.9) Kg/bunch consecutively, in the two seasons. Meanwhile, the lightest bunch weight was coming from the control palms which recorded (12.5 & 12.9) Kg/bunch respectively, in both seasons.

The results are in harmony with [10] who found that potassium at 0.4 % significantly produced the highest bunch weight of date palm while the control gave the lowest in this respect.

Yield/palm (Kg), it has taken the same direction of the bunch weight. Moreover, it is worth mentioning that we say in this regard, the high level of the combined between (1 % algae extract + 2 % potassium nitrate) and the low level of the combined between them (0.5 % algae extract + 1 % potassium nitrate) treatments markedly produced higher yield (kg)/palm than untreated palms. These superior treatments increased the average of yield (kg)/palm than the control treatment by about (42.4 & 39.5 %) in the first season and (28.0 & 31.0 %) in the second season, respectively. In contrast the lowest value of yield/palm (Kg) was recorded with the untreated palms (125.0 & 129.0 kg/palm) consecutively, in the both seasons.

The increase in yield/palm of Medjool date palm was attributed to the increase bunch weight. Also, the beneficial influence of K on the yield might be attributed to their enhancing many metabolic processes like carbohydrate formation, translocation and accumulation then reflected on yield development [17]. In this respect the present results are in harmony with those [18-20].

In addition, the promotive effect of algae extract because their impact through it contains huge components affect cellular metabolism in treated plants leading to enhanced growth and crop yield [5]. In this regard our results are in agreement with those [21-24]. In addition, the promotive effect of algae extract because their impact through physiological action as it contains huge components affect cellular metabolism in treated plants leading to enhanced growth and crop yield [5].

Fruit physical characteristics

The effect of different foliar spray concentrations of algae extract and potassium nitrate either alone or in combined together on fruit dimension (cm) (length and diameter), weights (fruit and pulp) and seed weight are presented in Table 2.

Table 2. Effect of algae extract, potassium nitrate foliar spray and their combination on fruit physical characteristics of Medjool cv. date palm (2014 and 2015 seasons)

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit weight (g)		Pulp weight (g)		Seed weight (g)	
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
Control	3.2	3.6	2.5	2.4	19.0	19.1	16.8	17.0	2.2	2.1
0.5% AE	4.4	4.5	2.7	2.6	20.0	19.8	17.5	17.4	2.5	2.4
1% AE	4.4	4.5	2.9	2.7	21.2	19.9	18.5	17.4	2.5	2.5
1% K₂NO₃	5.2	5.0	3.2	3.4	22.2	22.3	19.8	20.0	2.4	2.3
2% K₂NO₃	5.5	5.4	3.3	3.4	23.8	23.5	21.2	21.0	2.6	2.5
0.5% AE + 1% K₂NO₃	5.6	5.6	3.5	3.4	25.3	25.4	22.7	22.8	2.6	2.6
1% AE + 2% K₂NO₃	5.8	5.9	3.9	3.8	27.7	27.6	25.1	25.0	2.6	2.6
LSD_{0.05}	0.29	0.22	0.14	0.18	0.73	0.70	0.47	0.46	0.1	0.1

AE: Algae Extract, K₂NO₃: Potassium nitrate.

Regard to fruit length, all treatments significantly increased it as compared with the control in the two successive seasons. There are no statistical differences between algae extract at 0.5 and 1 % in both seasons. The tallest significant fruit length (5.8 & 5.9 cm) was obtained by application algae extract at 1 % mixed with 2 % potassium nitrate in the two seasons. It can be noticed that, no statistical result between that treatment and the other (0.5 % algae extract combined with 1 % potassium nitrate in both seasons. Whereas, the shortest fruit length (3.2 & 3.6 cm) was revealed by the control, it's true in the first and the second seasons.

The above reported results agree with [12] who mentions that spraying date palm with KNO_3 or K_2SO_4 increased fruit length. Also, fertilizer treatments exert higher positive effect on fruit length compared with control treatment [25].

As for fruit diameter, data in Table 2 illustrated that all treatments increased significantly fruit diameter as compared with the check one. The high concentration to the sole treatments of algae extract and potassium nitrate were more significantly effect on fruit diameter than the low concentration of them, which is true in the two seasons. Generally speaking the interaction between algae extract and potassium nitrate at the two concentrations were more effective on fruit diameter than the other treatments including the control, but the combined treatment of high rate was significantly obviously progress in this respect, that is hold true in both seasons.

The previous results are in line with [3, 7, 12].

Concerning fruit weight, results in Table (2) indicated that fruit weight (g) was significantly increased by foliar application algae extract and potassium nitrate alone or combination between them. It is worth mentioning could say, this parameter had effective in proportion to the increase in the concentration of each of the materials whether either the sole or the mixed treatments. The heaviest significant of fruit weight were found from the combined treatments which increased than the control by about (45.8 & 44.5 %) in case the high concentration and about (33.2 & 33.0 %) in case the low concentration, consecutively in the two experimental seasons. In contrast, the light statistical fruit weight was obtained by the check treatment which recorded (19.0 & 19.1 g) respectively, in the 1st and the 2nd seasons.

These results might be due to the enhancing effects by the interaction between algae extract and potassium nitrate, as a result of the mode of action which improving nutrition on cell metabolism. Our results are in agree with [26] who mentioned that foliar spraying of algae extract improved physical properties of Williams banana plants. Also, spraying date palm cv. Degla Nour bunches, 6 week after pollination with KNO_3 or K_2SO_4 increased fruit weight, length and diameter [12].

Pulp and seed weights, results showed that the same trend in the previous parameters (Table 2). The lowest weights of pulp and seed were obtained by the control treatments which recorded (16.8 & 17.0 g) and (2.2 & 2.1 g), sequentially in both seasons. The combined treatments between (algae extract and potassium nitrate) were given the best results on this respect, but without significant differ between the high and low concentrations on seed weight only.

The improving of pulp weight might be due to the enhancing of fruit weight as well as to increased cell size and number by nutrient elements [27]. Also, all tested Microorganisms (EM) and potassium sulphate treatment improved pulp and fruit weights of date palm cv. Hayany [25]. In this regard, the results are in line with [18, 19, 20, 22, 25, 24].

Fruit chemical characteristics

Date in Table (3) explained some chemical characteristics of Medjool cv. date palm.

As for TSS%, the high level algae extract and potassium nitrate was more effective on increasing significantly TSS content, flowed by the low concentration and that is true in the two seasons. On contrast the lowest value of TSS% was observed at the control which recorded (28.5 and 28.1%) respectively, in both seasons. Concerning the sole treatments of algae and potassium, it is clear that the high level was more effective than the low one on increasing TSS%. These results are going in line with [25] who mentioned that potassium sulphate exerted higher positive on fruit TSS contents as compared with control treatments.

Regarding to acidity %, are shown the opposite trend which produced/less acidic fruit than the control. Increasing potassium level gradually decreased the acidic and increase TSS [28]. The other hand, Microorganisms (EM) combined with potassium induced pronounced reduction effect on fruit total acidity [25]. These results may be due to the Algae extract which consider as a new biofertilizer to improving fruit quality [18, 4, 3, 29, 20]. Besides the positive effect of potassium nitrate on physical and chemical fruit date palm quality parameters [10].

Data presented in Table (3) indicated that reducing sugars and total sugars percentages were affected by different treatments in the two experimental seasons. Generally, all combinations between algae extract and potassium nitrate increase reducing sugars and total sugars percentages in both studied seasons compared to the control and separately treatments. Also, it can be noticed that the two combined treatments had no significant differences between them in this respect.

Concerning the reducing sugars, the highest percentage (48.7 and 48.3) consecutively, in both studied seasons, was detected by the combined treatment (1% algae extract + 2% potassium nitrate). Whereas, the lowest percentage was observed at the control it reached (43%) in the first season and (42.3 %) in the second one. The obtained data are in harmony with [27] who mentioned that the application of fertilization with different levels is of potassium enhanced the amount of reducing sugar in date palm fruits "Sayer" and increasing in reducing sugar content could be due to necessity of mineral element for synthesis of sugar products and photosynthesis [30].

Table 3. Effect of algae extract, potassium nitrate foliar spray and their combination on fruit chemical characteristics of Medjool cv. date palm (2014 and 2015 seasons)

Treatments	TSS %		Acidity %		Reducing sugars %		Non reducing sugars%		Total sugars %		Tannins %	
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
Control	28.5	28.1	0.28	0.29	43.0	42.3	10.0	10.0	53.0	52.3	0.19	0.20
0.5% AE	29.3	29.2	0.24	0.25	44.0	43.0	11.3	11.0	55.3	54.0	0.12	0.11
1% AE	29.9	30.3	0.23	0.22	45.7	43.3	10.7	10.3	56.4	53.6	0.13	0.11
1% K₂NO₃	30.9	30.9	0.25	0.25	47.7	46.0	10.0	10.7	57.7	56.7	0.11	0.11
2% K₂NO₃	31.6	31.7	0.24	0.25	47.0	46.0	10.0	11.0	57.0	57.0	0.11	0.11
0.5% AE + 1% K₂NO₃	32.5	32.5	0.23	0.22	48.3	47.0	11.0	11.7	59.3	58.7	0.10	0.12
1% AE + 2% K₂NO₃	33.5	33.4	0.21	0.20	48.7	48.3	12.0	11.3	60.7	59.6	0.10	0.09
LSD_{0.05}	0.51	0.60	NS	NS	1.0	1.80	NS	NS	1.23	1.64	NS	NS

AE: Algae Extract, K₂NO₃: Potassium nitrate.

As for total sugars, the increases were account as (60.7 and 59.6) respectively, in the two seasons by the high concentration of the combination treatment. On the contrary, the lowest total sugars content were (53.0 and 52.3%) sequential, in both seasons was obtained in the control. The same trend was notice [19, 11] who mentioned that application of potassium fertilization increased total sugars content. The previous results might be due to the important role of potassium and algae extract. These results are due to the fact that potassium activates the enzymes involving in sugar biosynthesis and helps in translocation of sugars [31]. Potassium is necessary for basic physiological functions, such as the formation of sugars and starch [32]. The enhancement effect of the combination between Micro organisms (EM) and potassium sulphate produced high positive effect on fruit total sugars [25].

As for non reducing sugars, although all single and combined treatments of algae extract and potassium nitrate increased this character, but no significant differences were observed among all treatments in both seasons. On the other hand, the non- reducing sugar content was increased by potassium fertilization [19].

Tannins content, it ranged from 0.10 to 0.13 and 0.09 to 12 for the first and second seasons, respectively as compared with the control (0.19 & 0.20) consecutively, in the two seasons. From (Table 3) worth mentioning could say that all treatments had positive effect on fruit tannin contents where their led to a decline in fruits proportion of tannins compared with the control. Also, results obviously that no significant differences between all treatments including the control. These hold true for both seasons. The previous results are in accordance with [19] an obvious decrease in fruit tannin was observed with potassium fertilization in both seasons. Potassium sulphate at 0.2% decreased the total tannins of date palm [10]. In addition, no significant differences were observed on Zaghoul fruit quality among the higher two concentrations (2 & 4 %) of seaweed extract [33].

The beneficial supplying date palm of potassium nitrate results may be attributed to the physiological role of potassium in enhancing many metabolic processes such as carbohydrate formation; translocation and accumulation as well as application of algae extract it may be due to inclusion on vitamins, natural hormones and some antioxidants could explain the previous positive action. So, it is suggested to improve yield and fruit quality of cv. "Medjool" date palms with using algae extract combined with potassium nitrate.

The results in case potassium of [34] on Seweda date palm and [35] on Sewi date palm, regard in algae extract of [24] on orange trees and as for potassium mixed with algae extract of [25] on Hayany date palm emphasized the present results.

CONCLUSION

Our results demonstrated that algae extract (0.5 and 1%) and potassium nitrate (1 and 2%) alone or combination enhanced bunch weight, yield/palm and fruit quality. Consequently, it preferable to foliar spray "Medjool" cv. date Palm with 1% algae extract combined with 2% potassium nitrate foliar spray at two times a year i.e., just after fruit setting and one month later to enhance yield and fruit quality.

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