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Improving Fruit Set, Yield and Fruit Quality of Barhee Date Palms Using Some Natural Plant Extracts

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Abstract

This experiment was conducted during two successive seasons (2020 and 2021). The aim of this research is to study the effect of spraying Barhee date palm with some natural plant extracts on fruit set, yield and fruit physical and chemical properties. Inflorescences were sprayed with moringa and garlic extracts at 2 or 4% for both, three times (one hour before pollination, one month after pollination and two months after pollination). The obtained results indicated that spraying date palm inflorescences with moringa and garlic extracts produced higher initial fruit set as compared with the untreated ones in the two seasons.

While all tested treatments improved fruit physical characteristics such as fruit weight, flesh weight, fruit length and diameter compared to the control treatment in the two

studied seasons; moringa extract recorded the heaviest bunches and yield/palm in both seasons. In addition, the results showed that moringa extract at 4% increased total soluble solids%, total sugars%, reducing and non-reducing sugars% in both seasons compared to the control. Meanwhile, the lowest fruit set, bunch weight, yield/palm and fruit physical and chemical properties were recorded due to the control in both seasons. Also, all treatments reduced significantly total acidity% in both seasons.

In addition, spraying moringa extract at 4% improved leaf mineral content (N, P, K, Ca and Mg) and gave the highest values followed by moringa extract at 2%, then garlic extract at 4% and 2%, respectively in both seasons.

Keywords: Moringa Extract, Garlic Extract, Barhee Date Palms, Fruit Set, Yield, Fruit Quality

Introduction

Date palm (*Phoenix dactylifera* L.) is concerned as one of the important fruit crops in arid and semi- arid regions of the world. It considers 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. In Egypt, the total number of planted date palms is about 15.5 million palms planted in approximately 135000 feddan produced 1.8 million ton of fresh, semi-dry and dry dates ^[1].

Moringa oleifera (family: *Moringaceae*) is one of such alternatives, being investigated to ascertain its effect on growth and yield of many crops and thus can be promoted among farmers as a possible supplement or substitute to inorganic fertilizers ^[2].

Moringa oleifera contents proteins, vitamins (such as A, B1, B2, B3, ascorbic acid and E), β carotene, amino acids, phenolic compounds, sugars and minerals (such as calcium, magnesium, sodium, iron, phosphorus and potassium) and several flavonoid pigments ^[3,4]. However, spraying moringa extract on Hollywood plum trees led to increase its productivity ^[5]. Also, spraying Selmy date palm inflorescences with moringa extract recorded the highest initial fruit set, fruit retention and the yield ^[6].

In addition, spraying Khadrawi date palms with moringa extract at 3% improved fruit physical characteristics such as fruit weight, flesh weight, fruit volume and fruit length compared to the control. Also, moringa extract increased TSS, total sugars and reducing sugars compared to the control ^[7].

Moringa extract at 4% improved leaf mineral content (N, P and K), yield/tree, number of fruit/tree, fruit length, diameter, weight and volume, TSS, total sugars, vitamin C and decreased total acidity of pear tree ^[8,9].

Foliar application of 6% moringa leaf extract was used effectively to improve fruit set, yield, fruit weight, total soluble solids content, vitamin C, anthocyanin content and antioxidant activity of Hollywood plum trees ^[5].

Moringa leaves extract could be used as an alternative treatment for enhancing the yield and quality of Thompson seedless grapevine^[10].

Garlic extract (*Allium sativum* L.) contains many vitamins (B₁, C, A), minerals (P, K, S, Ca, Mg, Mn, Fe), antioxidants, amino acid, flavonoids, also many chemical compounds, it includes volatile oil with sulfur and enzymes^[11].

Spraying garlic extract on Canino apricot trees improved the yield and fruit quality^[12]; moreover, garlic extract improved productivity and fruit quality when applied to grapevine^[13] and peach^[14].

Garlic extracts spray had also a noticeable positive effect particularly on some fruit physical and chemical characteristics of Fagi Kalon mango tress^[15].

Effect of garlic extract on leaf mineral content has been studied and showed a comparatively greater efficiency on nutrition status of pear, mango and apple, respectively^[8, 15, 16].

Abd El- Rzek found that spraying garlic extract at 8% combined with GA₃ at 100 ppm is recommended to improve productivity and fruit quality of "Le Conte" pear trees^[17].

Therefore, our study aimed to improve fruit set, productivity and fruit quality of Barhee date palms using some natural extracts such as moringa and garlic solely.

Material and Methods

This study was conducted during two successive seasons (2020 and 2021) on 15 years old Barhee date palms grown in sandy soil with 6×6 meters apart 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 vigor and fruiting. All palms under investigation received the same regular horticultural practices. Moreover, date palms were thinned at one bunch per eight leaves rate (leaves/bunch ratio). Pollination was carried out using the same pollen grain source. The selected palms were divided into five treatments in three replicates (each is one palm) and arranged in a randomized complete block design, and the inflorescences of palms were subjected for the following treatments:

- 1- Control (spraying with water only).
- 2- Foliar spray with garlic extract at 2%.
- 3- Foliar spray with garlic extract at 4%.
- 4- Foliar spray with moringa extract at 2%.
- 5- Foliar spray with moringa extract at 4%.

All treatments were sprayed three times along each season (one hour before pollination, one month after pollination and two months after pollination). Preparing the garlic and moringa extracts were carried out prior the beginning of each spraying time.

The procedure of preparing the mentioned materials could be described as follow:

Garlic extract

The 2% and 4% garlic aqueous extract were prepared by blending 20g and 40g of fresh mature cloves in one liter of distilled water, frozen and thawed two times and then filtered and diluted by distilled water to one liter^[18].

Table 1: Nutritional composition of garlic

Nutritional composition of garlic	100 gr
Water (g)	59
Calories (kcal)	149

Lipids (g)	0.5
Carbohydrates (g)	33.07
Fiber (g)	2.1
Manganese (mg)	1672
Potassium (mg)	401
Sulphur (mg)	70
Calcium (mg)	181
Phosphorus (mg)	153
Magnesium (mg)	25
Sodium (mg)	17
Vitamin B6 (mg)	1235
Vitamin C (mg)	31
Glutamic acid (g)	0.805
Arginine (g)	0.634
Aspartic acid (g)	0.489
Leucine (g)	0.308
Lysine (g)	0.273

Source: Reyhaneh Mardomi^[19]

Moringa extract

100 gm of moringa (*Moringa oleifera* L.) leaves powder were bought from selling unit of moringa products, NRC, Dokki, Giza, Egypt, then added to 1 liter of distilled water. The mixture was kept for 24 hours, and Whatman filter paper No. 1 was used to filter the extract^[20]. Then after, water was used to dilute the extract to reach the concentrations of 2 and 4% which sprayed directly over the inflorescences.

Table 2: Chemical analysis of 100 gm *Moringa oleifera* leaves powder

Components name Leaf powder	Components name Leaf powder
Proximate content	Proximate content
Moisture% 07.5	Vitamins content
Carbohydrate(g) 38.4	A (B-carotene) mg16.3
Protein(g) 27.1	B1 (thiamine) mg2.60
Fat(g) 02.3	B2 (riboflavin) mg20.5
Fiber(g) 18.8	B3 (nicotinic acid) mg8.20
Mineral content	C (ascorbic acid) mg17.3
Ca (mg) 2.00	E (tochopherol acetate) mg113
Mg (mg) 368	Amino Acid composition of crude protein
P (mg) 204	Arginine (g/16g N) 1.33
K (mg) 1.32	Lysine (g/16g N) 1.32
Cu (mg) 0.60	Methionine (g/16g N) 2.00
Fe (mg) 28.2	Threonine (g/16g N) 1.19
S (mg) 870	Leucine (g/16g N) 1.95
	Tryptophan (g/16g N) 0.43
	Phenylalanine (g/16g N) 1.39
	Isoleucine (g/16 g N) 0.83
	Valine (g/16g N) 1.06
	Histidine (g/16g N) 0.61

Source: Thabet *et al.*^[6]

Fruit set percentage

Abnormal and normal fruit set for ten strands per spathe were recorded. Fruit setting percentage was calculated by using the following formula:

Fruit set % = (Total number of normal fruit set-Number of abnormal fruit set) / Total number of fruits ×100.

Yield (kg/palm) and bunch weight

At harvest time, average bunch weight were recorded and palm yield were calculated.

Thirty fruits were randomly picked to estimate physical and chemical characteristics:

Fruit physical characteristics

At baser stage fruit samples were randomly collected from

each replicate in both seasons and transported immediately to the laboratory to determine the fruit physical characteristics i.e. fruit weight (gm), length and diameter (cm), flesh weight and seed weight (gm) were determined.

Fruit chemical characteristics

Chemical properties of fruit at baser stage namely total soluble solids (TSS) percentage was measured by a hand refractometer, acidity percentage was determined by titration according to A.O.A.C. [21], sugar contents (total sugars, reducing and non-reducing sugars) were determined according to Miller [22].

Leaf mineral content

At the end of each growing season, leaflet samples were collected, washed and dried at 70°C until constant weight and then grounded for determination the nutrient elements namely N, P, K, Ca, Mg (as dry weight) according to Wilde [23].

Statistical analysis

The obtained data of both seasons were subjected to analysis of variance according to Snedecor and Cochran [24] and the means were differentiated using Duncan multiple range test at 5% level [25].

Results

Fruit set percentage

Results in Table 3 shows that moringa and garlic extracts

treatments significantly increased fruit set compared to the control in the two seasons. In this concern, moringa extract gave the best results compared to garlic extract and control treatment in the first and second seasons, respectively.

Moreover, The highest fruit set percentage (75.1 and 75.3%) was obtained by spraying moringa extract at 4% in the first and the second seasons, respectively, followed by spraying moringa extract at 2% (72.7 and 73.2%) and garlic extract at 4% (70.0 and 71.4%), then garlic extract at 2% (69.0 and 70.5%) in both seasons of the study.

On the other hand, the control treatment gave the lowest values (53.1 and 53.6%) in the two seasons.

Bunch weight and yield/palm

It is evident from the results in Table 3 that bunch weight and yield/palm of Barhee date palms were significantly affected by all treatments in both seasons. In general, moringa and garlic extracts gave higher bunch weight and yield/palm compared to the control in both seasons of the study. In this respect, spraying inflorescence with moringa extract at 4% recorded the highest bunch weight (13.3 and 13.8 kg) and yield /palm (133.6 and 138.0 kg/palm) in the first and second seasons, followed by spraying moringa extract at 2%.

The lowest bunch weight (10.0 and 10.3 kg) and yield/palm (100 and 103 kg/palm) were recorded from the control in the two seasons of the study.

Table 3: Effect of moringa and garlic extracts on fruit set %, bunch weight and yield/palm of Barhee date palms during 2020 and 2021 seasons

Treatments	Fruit set%		Bunch weight (kg)		Yield/palm (kg)	
	2020	2021	2020	2021	2020	2021
1. Control	53.13d	53.66d	10.00e	10.30e	100.0e	103.0e
2. Garlic at 2%	69.00c	70.53c	10.40d	10.80d	104.0d	108.0d
3. Garlic at 4%	70.03c	71.43bc	10.86c	11.60c	108.6c	116.0c
4. Moringa at 2%	72.70b	73.23b	12.33b	12.80b	123.3b	128.0b
5. Moringa at 4%	75.13a	75.30a	13.36a	13.80a	133.6a	138.0a

Fruit physical characteristics

Results in Table 4 reveal that length, diameter, weight of the fruit, flesh and seed weight of Barhee date palms were significantly affected by all treatments as compared to the control in the two seasons.

It is clear that spraying inflorescences with moringa extract at 4% gave the highest values of fruit length (3.52 and 3.63 cm), fruit diameter (2.81 and 2.89 cm), fruit weight (17.36 and 18.0 gm), flesh weight (15.36 and 16.06 gm) and seed

weight (1.93gm) in the first and second seasons, respectively, followed by spraying moringa extract at 2% then spraying garlic extract at 4% and garlic extract at 2% in both seasons of the study.

Control treatment recorded the lowest fruit length (3.05 and 3.16 cm), fruit diameter (2.15 and 2.19 cm), fruit weight (14.2 and 14.4gm), flesh weight (12.05 and 12.26 gm) and seed weight (2.15 and 2.16 gm) in the first and second seasons, respectively.

Table 4: Effect of moringa and garlic extracts on fruit dimensions, fruit weight, flesh and seed weight of Barhee date palms during 2020 and 2021 seasons

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit weight (gm)		Flesh weight (gm)		Seed weight (gm)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
1. Control	3.05d	3.16e	2.15e	2.19e	14.20e	14.43e	12.05e	12.26e	2.15a	2.16a
2. Garlic at 2%	3.30c	3.26d	2.55d	2.66d	14.90d	15.30d	12.93d	13.33d	1.95b	1.93b
3. Garlic at 4%	3.40bc	3.36c	2.60c	2.70c	15.73c	16.13c	13.83c	14.13c	1.89b	1.96b
4. Moringa at 2%	3.46ab	3.53b	2.70b	2.76b	16.60b	16.93b	14.63b	14.93b	1.95b	1.96b
5. Moringa at 4%	3.52a	3.63a	2.81a	2.89a	17.36a	18.00a	15.36a	16.06a	1.93b	1.93b

Fruit chemical characteristics

Results in Table 5 indicate that all spraying treatments increased significantly total soluble solids percentage compared to the control in both seasons of the study. The highest soluble solids percentage (34.03 and 34.76%) was observed due to 4% foliar spray of moringa extract in the first and second seasons, respectively, followed by moringa extract at 2% (33.13 and 34.23%), and garlic extract at 4% (30.53 and 31.1%), then garlic extract at 2% (29.06 and 29.5%) in the first and second seasons. Whereas, the lowest soluble solids content was obtained by the control (27.3 and 28.8%) during 2020 and 2021 seasons, respectively.

As for titratable acidity percentage, it was decreased with all treated treatments than the control, and the increment was corresponding with increasing moringa or garlic extract concentrations. The highest titratable acidity percentage

(0.30 and 0.34%) was recorded with the control in the two seasons of the study.

Concerning total sugars, reducing and non-reducing sugars, results in Table 5 show that all treatments had a significant difference when compared with the control in both seasons. However, spraying inflorescences with moringa extract at 4% gave the highest value of total sugars (32.56 and 33.1%), reducing sugars (22.9 and 23.33%) and non-reducing sugars (9.66 and 9.76%), followed in decreasing order by spraying moringa extract with 2%, garlic extract at 4% and garlic extract at 2% in both seasons of the study. While, the lowest values of total sugars (26.13 and 26.73%), reducing sugars (20.16 and 20.63%) and non-reducing sugars (5.96 and 6.10%) were noticed in control results in the first and second seasons, respectively.

Table 5: Effect of moringa and garlic extracts on total soluble solids, acidity, total sugars, reducing and non-reducing sugars of Barhee date palms during 2020 and 2021

Treatments	TSS%	Acidity%		Total sugars%		Reducing sugars%			Non-reducing sugars%	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
1. Control	27.33e	28.80e	0.30a	0.34a	26.13e	26.73c	20.16e	20.63d	5.96d	6.10e
2. Garlic at 2%	29.06d	29.50d	0.26b	0.29b	29.70d	30.23abc	21.30d	21.36cd	8.40c	8.53d
3. Garlic at 4%	30.53c	31.13c	0.24bc	0.26c	30.93c	28.30bc	21.83c	22.00bc	9.10b	9.00c
4. Moringa at 2%	33.13b	34.23b	0.22c	0.23d	31.73b	31.90ab	22.43b	22.60ab	9.30b	9.30b
5. Moringa at 4%	34.03a	34.76a	0.19d	0.21d	32.56a	33.10a	22.90a	23.33a	9.66a	9.76a

Leaf mineral content

Concerning the results in Table 6 nitrogen, phosphorus, potassium, calcium, magnesium content in the leaves were significantly affected by all tested treatments as compared with the control in both seasons. However, spraying inflorescences with moringa extract at 4% gave the highest value of leaf nitrogen (1.89 and 1.98%), phosphorus (0.45 and 0.49%), potassium (1.79 and 1.93%), calcium (2.26 and

2.48%) and magnesium (0.48 and 0.53%) in the first and second seasons, respectively, followed by spraying moringa extract at 2%, garlic extract at 4% and garlic extract at 2%.

On the other side, the control scored the lowest percentage of leaf nitrogen (1.24 and 1.31%), phosphorus (0.26 and 0.24%), potassium (1.38 and 1.42%), calcium (1.67 and 1.72%) and magnesium (0.28 and 0.26%) in both seasons.

Table 6: Effect of moringa and garlic extracts on leaf mineral contents of Barhee date palms during 2020 and 2021

Treatments	N%		P%		K%		Ca%		Mg%	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
1. Control	1.24e	1.31e	0.26d	0.24e	1.38e	1.42e	1.67d	1.72c	0.28e	0.26e
2. Garlic at 2%	1.60d	1.71d	0.31c	0.38d	1.62d	1.70d	1.87c	2.20b	0.39d	0.41d
3. Garlic at 4%	1.66c	1.90c	0.36b	0.42c	1.66c	1.75c	1.96b	2.17b	0.44c	0.44c
4. Moringa at 2%	1.84b	1.95b	0.44a	0.45b	1.72b	1.84b	2.23a	2.42a	0.46b	0.50b
5. Moringa at 4%	1.89a	1.98a	0.45a	0.49a	1.79a	1.93a	2.26a	2.48a	0.48a	0.53a

Discussion

The obtained results in general show that all tested treatments either garlic or moringa extracts have positive effects on the fruit set, yield, and fruit quality, also leaf mineral contents of Barhee date palms comparing with the untreated ones.

Regarding the fruit set percentage, the increment in fruit set could be due to reach of moringa extract with proteins, vitamins such as A, B₁, B₂, B₃, C and E, minerals such as potassium, calcium, magnesium, phosphorus and iron, gibberellins and cytokinins which regulate internal mechanism for controlling fruit set^[26].

Our results are in agreement with those obtained on Navel orange, Hollywood plum and Khadrawi date palm trees sprayed with moringa extract which increased fruit set and decreased fruit drop percentage comparing with the control treatment^[9, 5, 7].

On the other hand, the obtained results concerning the bunch weight and yield/palm could be explained due containing

moringa extract a high zeatin amount, since zeatin is the most common form of naturally occurring cytokinin in the plants and plays an important role in cell division and cell elongation that led to promote the growth and having anti-aging potential and protective effects in the plants. Also, *Moringa oliefera* extract contains proteins, vitamins (A, B₁, B₂, B₃, E, and ascorbic acid), β carotene, amino acids, sugars and minerals (calcium, magnesium, sodium, iron, phosphorus and potassium) and several flavonoid pigments. In this concern, ascorbic acid improved growth and yield of various crops. In addition, calcium and potassium play essential roles in crop growth and development through osmoregulation, enzyme activation, photosynthesis and various physiological processes^[27, 3].

The obtained results concerning the effect of garlic extract are in harmony with those obtained by El-Sharony^[15], who reported that spraying Fagri Kalan mango trees with garlic extract at 5% increased yield significantly as compared to the control. Also, spraying garlic extract improved the yield

of Keitte mango ^[28], Canino apricot ^[12] and Le Conte pear trees ^[17].

As for the effect of tested treatments on fruit physical and chemical characteristics, the obtained results are in agreement with those obtained by Abd El-Rzek ^[12] on Canino apricot and Faissal ^[28] on Keitte mango, since spraying garlic extract increased fruit weight, flesh weight and decreased seed weight.

Also, spraying moringa extract on "Kinnow" mandarin increased fruit weight and pulp weight ^[29]. In addition, Moustafa ^[7] reported that spraying date palm inflorescences with moringa extract or garlic extract improved fruit physical characteristics i.e. fruit weight, flesh weight, fruit length and diameter compared to the control treatment in both seasons.

Dyer ^[30] reported that, the enhancement in total soluble solids content and titratable acidity in "Hollywood" plum as a response to applications with moringa extract could be due to the high sugar and starch content in *Moringa oleifera* leaves. Besides that, the leaves extract have high levels of cytokinins, which promote carbohydrate metabolism and create a new source sink relationship that leading to increase fruit soluble solids content.

Moustafa ^[7] found that moringa extract increased TSS% significantly compared to garlic extract and control treatments.

In respect to leaf mineral content, the obtained results could be returning to the content of garlic extract, such as vitamins, minerals, flavonoids, ascorbic acid, sulphur and trace of iodine. However, seventeen amino acids are found in garlic, including eight essential ones. Our results are parallel with Jamali ^[31] who found that spraying olive transplants with garlic extract at 50mg l⁻¹ potentially increased the content of nitrogen and potassium in leaves, also Abd El-Hamied and El-Amari ^[8] who found that spraying pear transplants with garlic extract at 4% potentially increased the content of N and K in leaves. Moringa extract at 4% improved leaf mineral content of N, P and K ^[8]. Moreover, our results are in agreement with those reported by Mostafa and Saleh ^[32] on Balady mandarin ^[8, 9, 16].

Conclusion

Generally, the obtained results clear that spraying moringa extract at 4% for three times (one hour before pollination, one month after pollination and two months after pollination) gave the highest fruit set, bunch weight, yield/palm and improved fruit physical and chemical characteristics and leaf mineral content of Barhee date palms in both seasons of the study. In this respect, the use of such materials on date palms will improve the physiological and nutritional status of the palms and increase the yield and enhance fruit quality.

Also, natural plant extracts seem be as a positive application to provide the plants in general with the nutrients and different compounds that need to grow healthy and give a good yield with high fruit quality. On the other hand, natural plant extracts usually contain many trace elements which plants are not found in most chemical formulations.

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