

## Effect of Spraying Nano-Chitosan, Basil Oil and Lemon Grass Extract on Yield and Fruit Quality of Barhy Date Palms Grown Under Minia Region Conditions

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### Abstract

This investigation was executed during 2016 and 2017 seasons to test the impact of spraying nano-chitosan and lemon grass extract and basil oil each at 0.5, 1 and 2% on yield, bunch weight and both physical and chemical characteristics of fruits in date palm cv Barhy. These materials were added via foliage three times before hand pollination, just after fruit setting and at one month later. Single and combined applications of nano-chitosan and lemon grass extract and basil oil each at 0.5 to 2% were very effective in improving yield, bunch weight and both physical and chemical characteristics of the fruits in date palm cv. Barhy relative to the control treatment. Combined applications of these substances were preferable in enhancing the investigated parameters than using each material alone. Using lemon grass extract at 0.5 to 2% was measurably superior than using the other two materials namely basil oil and nano-chitosan at the same concentrations. Using lemon grass extract, nano-chitosan and basil oil, in descending order was accompanied with activating all the studied characteristics. Increasing concentrations from each material from 1 to 2% failed to exhibit any promotion on these aspects. Carrying out three sprays of a mixture of lemon grass extract, Nano-chitosan and basil oil each at 1% gave the best results with regard to yield as well as fruit quality parameters of Barhy date palms grown under Minia region conditions.

**Key words:** Barhy date palm, nano-chitosan, basil oil, lemon grass extract, yield, bunch weight, fruit quality parameters

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### Introduction

Date palm cv. Barhy as a prime cv. characterized by high sensitivity to unfavorable environmental conditions (biotic and abiotic stresses) consequently the yield and fruit quality were seriously affected. Therefore, it is necessary to find out the best friendly materials that are responsible for protecting our environment from pollution and at the same time alleviating the adverse effects of such stresses on the palm production (Simon, 1987 and Wrigley, 1995). The important recent substances used in this respect are chitosan and plant. One of the main disadvantages in fruit orchards is the occurrence of abiotic stresses which are responsible for preventing plant metabolism and blocking growth and fruiting. Chitosan as common polymer found in nature was materially used for counteracting the inferior effects of these stresses on productivity of fruit crops. It induces a high tolerance of fruit crop to all stresses (Hadwiger *et al.*, 2002; Xing *et al.*, 2015 and Malerbe and Cerana, 2016). Nowadays, several efforts were done for application of natural extracts as replacement for chemicals for enhancing production of different fruit crops. The reasons were the greater content of these plant extracts from fatty acids especially Omega 3 & 6 & 9, sulfide components, active ingredients like turemrone

methane, eugenol, theanine, caffeine, inanol and estrugal, nutrients, vitamin K, E, D and A, plant pigments, tannins, amino acids makes them very essential for protecting the plants against fungi and insects. They showed great potential system for reducing the risks of fungicides and insecticides. They are low in toxicity to mammals. These attributes make them wise and safe choice for the orchards of fruit crops. (Srivastava and Lal, 1997; Peng-Kong *et al.*, 2004; Burt, 2004; Koroch *et al.*, 2007; Akhila, 2010 and Dhekney, 2016). Lemongrass (*Cymbopogon citratus*) is an aromatic plant belonging to the gramineae family (Akhila, 2010). Essential oils are natural products obtained from plants. It contains mainly citral (Schaneberg and Khan, 2002) and 1 to 2% essential oil (Carison *et al.*, 2001 and Mighani *et al.*, 2010). The demand for lemongrass is for its high citral content (Tajidin *et al.*, 2012). *Ocimum basilicum L.* (Sweet basil) belongs to the family lamiaceae. It is popular culinary herb and a source of essential oils, vitamins, Mg, K, Fe and Ca (Nacar and Tansi, 2012). Using chitosan has many important functions in stimulating yield and fruit quality in different fruit crops especially date palms and mango cvs. (Zagzog *et al.*, 2007; Saied and Radwan, 2017; Ali *et al.*, 2017; El-Sayed *et al.*, 2018a and 2018b; Ayed, 2018). Previous studies carried out by Foleva *et al.*, (2002); Al-Wasfy *et al.*, (2013); Gouda-Fatma, (2016); Zagzog and Saied, (2017); Ahmed and Habasy-Randa, (2017); Ragab, (2018) and Akl *et al.*, (2018) emphasized the great merits of using different plant extracts on yield and fruit quality of citrus, mangoes, dates and other horticultural crops. The main target of this study was elucidating the beneficial effects of using nano-chitosan and the two plants extracts namely lemon grass extracts and basil oil on yield as well as physical and chemical characteristics of Barhy date palm grown under Minia region conditions.

## Materials and methods

This study was conducted during 2016 and 2017 seasons on thirty-nine 15 years-old Barhy date palms in a private date palm orchard situated at West Samalout, Minia Governorate. These palms were produced through conventional propagation by off shoots as well as characterized by regular bearing. Also, they are uniform in vigour, healthy, good physical conditions, free from insects, diseases and damages. They planted at 7x7 meters apart and irrigated with well water through surface irrigation system. The texture of the tested soil is sandy clay. Soil analysis was done according to Wilde *et al.*, (1985) and the obtained data are illustrated in Table (1).

**Table (1):** Physical and chemical analysis of the tested soil

Parameters	Values
<b>Particle size distribution:</b>	
Sandy %	66.1
Silt %	13.9
Clay %	20.0
Texture	Sandy clay
pH (1:5 extract)	7.11
EC (1:5 extract) mmhos/1cm/25 <sup>0</sup> C	1.02
CaCO <sub>3</sub> %	3.99
Total N %	0.005
Available P (ppm)	3.2
Available K (ppm)	111.3
<b>EDTA extractable micronutrients (ppm)</b>	
Zn	1.5
Fe	1.4
Mn	1.7
Cu	0.5

All the selected palms (39 palms) received the common and usual horticultural practices that already applied in the orchard except those dealing with using chitosan combinations and plant extracts. Bunches /leaf were adjusted to 101.1 (according to Mohamed *et al.*, 2017). Hand pollination was carried out inserting five spaces into one female spathe after two days from spathe cracking.

**This study included the following thirteen treatments:**

- 1- Control (spraying with water/palms)
- 2- Spraying Basil oil at 0.5 % ( $5 \text{ g L}^{-1}$ )
- 3- Spraying Basil oil at 1.0 % ( $10 \text{ g L}^{-1}$ )
- 4- Spraying Basil oil at 2.0 % ( $20 \text{ g L}^{-1}$ )
- 5- Spraying nano-chitosan at 0.5 %
- 6- Spraying nano-chitosan at 1.0 %
- 7- Spraying nano-chitosan at 2.0 %
- 8- Spraying lemongrass at 0.5 %
- 9- Spraying lemongrass at 1.0 %
- 10- Spraying lemongrass at 2.0 %
- 11- Spraying all at 0.5 % ( $5 \text{ g L}^{-1}$ )
- 12- Spraying all at 1.0 % ( $10 \text{ g L}^{-1}$ )
- 13- Spraying all at 2.0 % ( $20 \text{ g L}^{-1}$ )

Each treatment was replicated three times, one palm per each. Chitosan concentrations (5, 10 and  $20 \text{ g L}^{-1}$ ) was prepared by dissolving the assigned amounts HCL 0.05 N and the pH solution was adjusted to 5.6 by adding sodium hydroxide 1.0 N. to the final concentration then adjusted by using distilled water (Malerbe and Cerana, 2016). Nano-chitosan and basil oil were purchased from National Research Center Laboratory. Lemongrass extract was prepared by boiling 5, 10 or  $20 \text{ g}$  dried leaves/ $\text{L}^{-1}$  water for twenty minutes then filtrating then these filtration was used to spray. Basil oil at the assigned amounts ( $5, 10$  and  $20 \text{ g L}^{-1}$ ) was easily solubilized in Triton B wetting agent. All the investigated materials were sprayed three times 14 days before hand pollination (1<sup>st</sup> week of Feb.), just after fruit setting (mid-April) and 45 days later (last week of May). Date in Tables (2 & 3) show the chemical composition of lemongrass and basil.

**Table (2):** Chemical composition of lemongrass plant (fresh leaf sheath and the blade) extract 7.5 months after planting

Components	%
B- Myrcene	3.18
3- Undecyne	1.46
Neral	31.05
Geranial	43.95
Geranyl acetate	1.06
Cadinene	0.95
Carodionl	1.30
Juniper camphor	1.56
Nerol	3.14

Source: Carlson *et al.*, (2001) and Tajidin *et al.*, (2012)

**Table (3):** Chemical composition of (main components) basil oil (Nacar and Tansi, 2012)

Components	%
Cineol 1 & 8	2.1
Terpinolene	7.7
$\alpha$ -Terpinol	1.0
$\alpha$ -Terpineol	1.0
Methyl chavicol	38.3
Eugenol	4.5
Methyleugenol	39.3
Cubanol	1.9
Camphor	0.6
Chavicol	0.6
Borneol	0.5
Carbohydrates	2.65
Total fiber	1.6
Total proteins	3.15
Total fats	0.64
Vitamin A	264 mg
Vitamin B <sub>1</sub>	0.034 mg
Vitamin B <sub>2</sub>	0.076 mg
Vitamin B <sub>3</sub>	0.902 mg
Vitamin B <sub>5</sub>	0.209 mg
Vitamin B <sub>9</sub>	68 mg
Vitamin C	18 mg
Vitamin E	0.8 mg
Vitamin K	0.8 mg
Calcium	177 mg
Fe	3.17 mg
Mg	64 mg
Mn	1.15 mg
P	56 mg
K	295

### Bunch weight and yield/palm

At ripening, bunch weight was recorded 100 fruits and from each bunch were randomly selected to determine fruit weight (g.); flesh %; T.S.S.%; total reducing and non-reducing sugars (Lane and Eynon, 1965 and A.O.A.C., 2000), total acidity % (as g malic acid/100 g pulp), total fibre % (A.O.A.C., 2000) and total soluble tannins % (Balbaa, 1981). This experiment of variance was set up in a randomized complete block design (RCBD). The analysis various (ANOVA) was used according to Mead *et al.*, (1993). Treatment means of the thirteen treatments were compared using new L.S.D test at 5 % level.

## Results and discussion

### 1- Bunch weight

As shown in Table (4) single and combined applications of basil oil, nano-chitosan and lemon grass extract each at 0.5 to 2% significantly was responsible for increasing bunch weight relative to the control treatment. The promotion on bunch weight was significantly in proportional to the increase in concentrations of basil oil, nano-chitosan and lemongrass extract from 0.05 to 1%. Increasing concentrations of these plant extracts and nano-chitosan from 1 to 2% failed to show significant promotion on bunch weight. Treating the palms with

basil oil, nano-chitosan and lemongrass extract at 0.5 to 2%, in ascending order was very effective in enhancing bunch weight. Combined applications were significantly favorable than using each alone in enhancing bunch weight. The highest values of bunch weight (17.5 & 18.2kg) were recorded on the palms fertilized with all materials together at 1% during both seasons, respectively from the economical point of view. The untreated palms produced the lowest values (11.5 & 11.6 kg) during both seasons, respectively. These results were true during both seasons.

## 2- Yield/palm

As shown in Table (4) yield/palm was significantly improved in response to treating the palms three times with basil oil, nano-chitosan and lemongrass each at 0.5 to 2% relative to the control. The promotion on the yield was significantly associated with increasing concentrations of these materials from 0.5 to 2%. Increasing concentrations from 1 to 2% from any material failed to cause significant stimulation on the yield. From economical point of view, the best results were recorded on the palms that received three sprays of a mixture of basil oil, nano-chitosan and lemongrass extract at 1%. Under such promised treatment the yield per palm reached 176 and 183kg compared to the yield of the control that reached (115 & 116 kg) during both seasons, respectively. These results were true during both seasons.

## 3-Fruit characteristics

It is evident from the data in Tables (4 to 6) that single and combined applications of basil oil, nano-chitosan and lemon grass each at 0.5 to 2 % were significantly very effective in improving fruit quality in terms of increasing fruit weight, fruit flesh %, T.S.S. %, total and reducing sugars and reducing total acidity %, total fibre % and total soluble tannins relative to the control. The promotion was significantly associated with increasing concentrations of each material from 0.5 to 2 % had meaningless promotion on the fruit characteristics. The best materials in improving fruit quality were basil oil, nano-chitosan and lemon grass extract each at 0.5 to 2 %, in ascending order. Significant differences on fruit characteristics were observed among the three materials from economical point of view. The best results with regard to fruit quality characteristics were obtained with using a mixture of basil oil, nano-chitosan and lemongrass extract at 1 %. The untreated palms produced the worst results with regard to fruit quality characteristics. These results were true during both seasons.

## Discussion

The previous outstanding effects of nano-chitosan on yield and fruit quality of Barhy date palms are mainly attributed to its positive effects on enhancing the tolerance of plants to biotic and abiotic stresses which resulted in enhancing growth and palm nutritional status (Hadwiger *et al.*, 2002; Xing *et al.*, 2015 and Malerbe and Cerana, 2016). The results of Zagzog *et al.*, (2007); Saied and Radwan, (2017); Ali *et al.*, (2017); El-Sayed *et al.*, (2018a and 2018b) and Ayed, (2018) emphasized the present results. The outstanding effects of basil oil and lemon grass on fruiting of Barhy date palms might attributed to the greater content of plant extracts from fatty acids active ingredients vitamins, nutrients and antioxidants Srivastava and Lal, (1997); Peng-Kong *et al.*, (2004); Korocho *et al.*, (2007); Akhila, (2010) and Dhekney, (2016). The promoting effect of plant extracts on yield and fruit quality in our results are in concordance with those obtained by Foleva *et al.*, (2002); Al-Wasfy *et al.*, (2013); Gouda-Fatma, (2016); Zagzog and Saied, (2017); Ahmed and Habasy-Randa, (2017); Ragab, (2018) and Akl *et al.*, (2018)

## Conclusion

Carrying out three sprays of a mixture of lemon grass extract, nano-chitosan and basil oil each at 1% gave the best results as regard to yield as well as fruit quality parameters of Barhy date palms grown under Minia region condition

**Table (4):** Effect of spraying lemongrass extract, nan-chitosan and basil oil alone or in combinations on bunch weight, yield/palm, fruit weight and fruit flesh % of Barhy date palms during 2016 and 2017 seasons.

Treatments	Bunch weight (kg)		Yield/palm (kg)		Fruit weight (g)		Fruit flesh %	
	2016	2017	2016	2017	2016	2017	2016	2017
Control (spraying with water)	11.5	11.6	115	116	16.9	17.0	88.0	88.0
Spraying Basil oil at 0.5 % (5 g L <sup>-1</sup> )	12.1	12.1	121	121	17.3	17.3	88.4	88.5
Spraying Basil oil at 1.0 % (10 g L <sup>-1</sup> )	13.0	12.9	130	129	17.9	18.0	90.1	90.2
Spraying Basil oil at 2.0 % (20 g L <sup>-1</sup> )	13.1	13.1	131	131	18.0	18.0	90.2	90.3
Spraying nano-chitosan at 0.5 % (5 g L <sup>-1</sup> )	13.6	13.5	136	135	18.0	18.4	90.6	90.7
Spraying nano-chitosan at 1.0 % (10 g L <sup>-1</sup> )	14.2	14.1	142	141	18.4	18.9	91.0	91.3
Spraying nano-chitosan at 2.0 % (20 g L <sup>-1</sup> )	14.3	14.2	143	142	18.5	19.0	91.2	91.3
Spraying lemongrass at 0.5 % (5 g L <sup>-1</sup> )	15.0	15.1	150	151	18.9	19.5	91.7	91.8
Spraying lemongrass at 1.0 % (10 g L <sup>-1</sup> )	15.6	16.0	156	160	19.4	20.1	92.1	92.3
Spraying lemongrass at 2.0 % (20 g L <sup>-1</sup> )	15.7	16.1	157	161	19.5	20.2	92.1	92.4
Spraying all at 0.5 % (5 g L <sup>-1</sup> )	16.9	17.4	169	174	22.0	21.0	92.4	92.0
Spraying all at 1.0 % (10 g L <sup>-1</sup> )	17.5	18.2	175	182	23.0	21.2	92.8	93.4
Spraying all at 2.0 % (20 g L <sup>-1</sup> )	17.6	18.3	176	183	23.3	21.3	93.0	93.5
New L.S.D. at 5 %	0.6	0.7	4.5	4.4	0.3	0.3	0.4	0.4

**Table (5):** Effect of spraying lemongrass extract, nan-chitosan and basil oil alone or in combinations on flesh/seed, T.S.S. %, total and reducing sugars in the fruits of Barhy date palms during 2016 and 2017 seasons.

Treatments	Flesh/seed		T.S.S. %		Total sugars %		Reducing sugars %	
	2016	2017	2016	2017	2016	2017	2016	2017
Control (spraying with water)	9.9	9.8	28.0	28.1	22.9	23.0	17.1	17.1
Spraying Basil oil at 0.5 % (5 g L <sup>-1</sup> )	10.3	10.2	28.5	28.6	23.2	23.5	17.5	17.5
Spraying Basil oil at 1.0 % (10 g L <sup>-1</sup> )	10.7	10.6	29.0	29.0	23.7	24.0	18.0	18.0
Spraying Basil oil at 2.0 % (20 g L <sup>-1</sup> )	10.8	10.7	29.1	29.1	23.8	24.1	18.1	18.1
Spraying nano-chitosan at 0.5% (5g L <sup>-1</sup> )	11.2	11.1	29.7	29.6	24.2	24.6	18.5	18.6
Spraying nano-chitosan at 1.0 % (10g L <sup>-1</sup> )	11.5	11.6	30.2	30.1	24.7	25.1	19.0	19.1
Spraying nano-chitosan at 2.0% (20 g L <sup>-1</sup> )	11.6	11.7	30.3	30.2	24.8	25.2	19.1	19.2
Spraying lemongrass at 0.5 % (5 g L <sup>-1</sup> )	12.0	12.1	31.0	31.0	25.3	26.0	19.5	19.6
Spraying lemongrass at 1.0 % (10 g L <sup>-1</sup> )	12.3	12.5	31.4	31.5	25.9	26.4	20.0	20.0
Spraying lemongrass at 2.0 % (20 g L <sup>-1</sup> )	12.3	12.6	31.5	31.6	26.0	26.5	20.1	20.1
Spraying all at 0.5 % (5 g L <sup>-1</sup> )	12.6	13.0	32.0	32.2	26.5	27.0	20.6	20.8
Spraying all at 1.0 % (10 g L <sup>-1</sup> )	12.8	13.4	32.5	32.6	27.4	27.5	21.0	21.3
Spraying all at 2.0 % (20 g L <sup>-1</sup> )	12.9	13.5	32.6	32.7	27.5	27.6	21.1	21.4
New L.S.D. at 5 %	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3

**Table (6):** Effect of spraying lemongrass extract, nan-chitosan and basil oil alone or in combinations on the percentages of non-reducing sugars, total acidity, total crude fibre and total soluble tannins of Barhy date palms during 2016 and 2017 seasons.

Treatments	Non-reducing sugars %		Total acidity %		Total crude fibre %		Total soluble tannins %	
	2016	2017	2016	2017	2016	2017	2016	2017
Control (spraying with water)	5.8	5.9	0.211	0.215	0.96	0.90	0.18	0.19
Spraying Basil oil at 0.5 % (5g L <sup>-1</sup> )	5.7	6.0	0.200	0.203	0.91	0.86	0.16	0.17
Spraying Basil oil at 1.0 % (10g L <sup>-1</sup> )	5.7	6.0	0.190	0.192	0.86	0.81	0.14	0.15
Spraying Basil oil at 2.0 % (20g L-1)	5.7	6.0	0.188	0.190	0.85	0.80	0.14	0.14
Spraying nano-chitosan at 0.5 % (5g L <sup>-1</sup> )	5.7	6.0	0.171	0.175	0.79	0.75	0.11	0.12
Spraying nano-chitosan at 1.0 % (10g L <sup>-1</sup> )	5.7	6.0	0.160	0.160	0.74	0.69	0.09	0.10
Spraying nano-chitosan at 2.0 % (20g L-1)	5.7	6.0	0.158	0.159	0.73	0.67	0.08	0.09
Spraying lemongrass at 0.5 % (5g L <sup>-1</sup> )	5.8	6.4	0.144	0.140	0.66	0.63	0.07	0.07
Spraying lemongrass at 1.0 % (10g L <sup>-1</sup> )	5.9	6.4	0.130	0.130	0.60	0.56	0.05	0.05
Spraying lemongrass at 2.0 % (20g L-1)	5.9	6.4	0.129	0.128	0.59	0.55	0.05	0.04
Spraying all at 0.5 % (5 g L <sup>-1</sup> )	5.9	6.2	0.118	0.115	0.50	0.41	0.05	0.05
Spraying all at 1.0 % (10 g L <sup>-1</sup> )	6.4	6.2	0.106	0.106	0.31	0.31	0.03	0.02
Spraying all at 2.0 % (20 g L <sup>-1</sup> )	6.4	6.2	0.105	0.105	0.30	0.30	0.03	0.01
New L.S.D. at 5 %	NS	NS	0.011	0.009	0.04	0.05	0.02	0.02

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## تأثير رش النانو شيتوسان، زيت الريحان ومستخلص حشيشة الليمون علي كمية المحصول وخصائص الجودة في نخيل البلح البحري النامي تحت ظروف منطقة المنيا

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### الملخص العربي

أجريت هذه الدراسة خلال موسمي ٢٠١٦، ٢٠١٧ وذلك لاختبار تأثير رش النانو شيتوسان، زيت الريحان ومستخلص حشيشة الليمون بتركيز من ٠.٥، ١، ٢ % لكل منهما علي كمية المحصول ووزن السوباطة وكلا من الخصائص الطبيعية والكيميائية للثمار في نخيل البلح صنف البحري. وقد تم اضافة هذه المواد من خلال الأوراق ثلاث مرات قبل التلقيح اليدوي بأسبوعين وبعد مرحلة عقد الثمار مباشرة وبعدها بشهر ب ٤٥ يوم. أشارت نتائج الدراسة الى ان الاستخدام الفردي والمشارك لمستخلص حشيشة الليمون والنانو شيتوسان وزيت الريحان بتركيز من ١ الى ٢ % لكل منهما كان فعالا جدا في تحسين كمية المحصول ووزن السوباطة والخصائص الطبيعية والكيميائية للثمار وذلك بالمقارنة بمعاملة الكونترول. وكان الاستخدام المشترك لهذه المواد افضل في تحسين الصفات تحت الدراسة مقارنة بالاستخدام الفردي ولقد تفوق استخدام مستخلص حشيشة الليمون عن استخدام زيت الريحان والنانو شيتوسان. ان استخدام مستخلص حشيشة الليمون والنانو شيتوسان وزيت الريحان مرتبة ترتيبا تنازليا كان مصحوبا بتحسين جميع الصفات المختبرة، وكان التحسن طفيفا في هذه الصفات عند رفع التركيز المستخدم لجميع هذه المواد من ١ الى ٢ % . امكن الحصول علي افضل النتائج بخصوص كمية المحصول وخصائص الجودة للثمار في نخيل البلح البحري النامي تحت ظروف منطقة المنيا وذلك عند استخدام خليط يتكون من مستخلص حشيشة الليمون والنانو شيتوسان وزيت الريحان بتركيز ١ %.

الكلمات الدالة: نخيل البلح البحري، زيت الريحان، مستخلص حشيشة الليمون، النانو شيتوسان، وزن السوباطة، كمية المحصول، خصائص الجودة للثمار.