SINAI Journal of Applied Sciences (ISSN: 2314-6079) Vol. (4) Is. (3), Dec. 2015 177-186

SINAI Journal of Applied Sciences

EFFECT OF PLANT GROWTH PROMOTING RHIZOBACTERIA AND SOME PLANT EXTRACTS ON ROOTABILITY OF AERIAL HAYANY DATE PALM OFFSHOOTS

B- VEGETATIVE GROWTH AND ECONOMIC REVENUE

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ABSTRACT

A pot experiment was carried out at the nursery of Faculty of the Environmental and Agricultural Sciences, El-Arish, North Sinai, Egypt., to study the effect of inoculation with the plant growth promoting rhizobacteria (PGPR), *i.e*. Rhizobactereien at 75g and Nitrobien at 65g and some plant extracts namely Gifert (Algae aqueous extracts), Ginger + Cinnamon extract and Roselle aqueous extract at 10% alone and/or in combination on the vegetative growth and economic revenue and profit of small high (unrooted) "Hayany" date palm (*Phoenix dactylifera* L.) offshoot (suckers). Results showed that, the highest vegetative growth and economic revenue and profit were gained by Rhizobacterien inoculated offshoots than Nitrobien inoculated ones. Moreover, treating the offshoots with Gifert (Algae extract) gave the highest values of vegetative growth and economic revenue and profit of small offshoots, followed by Roselle plant extract and Ginger + Cinnamon aqueous extract, respectively. The highest values of vegetative growth and economic revenue and profit were observed with Gifert (Algae extract) treated offshoots and inoculated with Rhizobacterien. While those treated with Nitrobien combined with Ginger + Cinnamon had the least values, the other interactions came in between.

Key words: Date palm, Rooting, Vegetative growth, Plant growth promoting rhizobacteria (PGPR), Rhizobacterien, Nitrobien, Plant extracts, Gifert (Algae extract), Roselle and Ginger + Cinnamon extract mixture.

INTRODUCTION

The date palm, (*Phoenix dactylifera* L.) belongs to the Arecoceae Family, is a monocotyledonous, dioecious palm and is considered the most important fruit tree in many Arab countries, such as Saudi Arabia, Iraq and Egypt.

Problems of breeding and propagating date palms arise from the fact that the tree has a long life cycle **(Ammar and Badeis, 1983)**, and that the number of offshoots produced by the mother tree is limited to a certain period in the tree life **(Barret, 1973)**. During recent years there has been a big demand for date palm offshoots. The use of small sized and aerial (high and unrooted) offshoots (suckers) is not practiced due to their low survival.

The rooting capacity has been correlated with their endogenous promoters and carbohydrate contents **(Reuveni and Adato, 1974)**. There are several other rooting co-factors that occur naturally in cuttings or offshoots of several plant species. These co-factors appearto act synergistically with auxin in root initiations **(James and Thurbon, 1981**).

The action of these co-factors in root promotion could be, at least protecting the root inducing. The rooting medium is an important factor in determining the extent of root formation offshoots **(Al-Mana *et al.*, 1996).** Different strains of rhizosphere bacteria, called plant growth promoting rhizobacteria,(PGPR) are a heterogeneous group of bacteria that can be found in the rhizosphere at root surfaces and associate with roots to improve the extent or quality of plant growth directly and or indirectly **(Gilick, 1995).**

The use of plant extracts that contain a lot of active compounds could be a successful alternative to chemical improving root formation on small high date palm offshoots **(El-Deeb *et al.*, 2008).**

Thus this study was carried out for evaluating the effect of plant growth promoting rhizobacteria and some aqueous plant extracts on vegetative growth and economic revenue and profit of small high" Hayany" date palm offshoots.

MATERIALS AND METHODS

In early April of 2010/2011 and 2011/2012 seasons, 120 "Hayany" date palm (*Phoenix dactylifera* L.), small high offshoots weighing about 2.15-3 Kg with 10-17 cm in stem diameter were used in this study. The tested offshoots were healthy and approximately similar in size and growth vigor.

Then, the lower layer of the leaves was removed and the base of the small high offshoots were cleaned and submerged for ten minutes in disinfection solution containing 1% cupper sulfate ($CuSO_4$) at 10 $g.l^{-1}$. Each offshoot was planted in a black plastic pot 30 cm in diameter filled with 4 kg sand: peatmoss: vermiculite mixture (3: 2: 1) by volume. Each pot was inoculated with 75 g Rhizobacterein or 65 g Nitrobein, except those of the control treatment. Rhizobacterein is a mixture of *Azotobacter chroococcum* and *Azospirillum barasilense*, while Nitrobein contains *Azospirillum* spp and *Azotobacter chroococcum*. Such products are produced by the Ministry of Agric., Egypt.

The small offshoots were treated with the following plant extracts by submerging them for 24 hours before planting, then after planting they were treated with the final extract at 100 ml/offshoot twice a week.

1. Gifert (Algae aqueous extract):

100 ml of algae aqueous extract was completed to one liter with distilled water.

2. Ginger plus cinnamon aqueous extract:

The extract was prepared by adding 50 grams of powdered ginger + 50 grams of powdered cinnamon to one litter of distilled water at temperature of 50^{o}C for 24 hours, then the extract was filtrated and adjusted to one liter to obtain a concentration of 10% *(W/V)*.

3. Roselle extract:

100 grams of powdered Roselle flowers were soaked in distilled water at 50^{o}C for 24 hours, then the extract was filtered and adjusted to one liter to obtain the concentration of 10% *(W/V)*.

4. Control:

Small high offshoots were watered twice weekly with tap water. The treatments were arranged as a factorial experiment in a completely randomized block design (2 factors) with three replicates for each treatment. Each replicate was represented by five offshoots.

Specific and interaction effects of the investigated factors and their combination were studied through the response of the following measurements:

1. Growth measurements:

One year after planting, the small offshoots were uprooted from the media and separated. Measurements were recorded for each offshoot as the new number of leaves, number of heart leaves and the longest leaf. All the new formed leaves were removed and their fresh weight was recorded. The total leaves weight was also calculated. Moreover, the separated leaves were dried in an oven at 70˚C for forty eight hours after cuttings into small parts to determine the dry weight and the total dry weight was calculated.

2. Economic revenue and profit:

After one year of treatment, offshoots growth was observed as survival percentage (%), then the total variable cost was calculated to obtained the total revenue and total profit.

Statistical analysis:

The obtained data were subjected to the analysis of variance according to **Snedecor and Cochran (1980)**. The means were compared using Duncan's multiple test at (0.05) level **(Duncan, 1955).** Computations were performed using MSTATC computer program package **(Russell, 1986).**

RESULTS AND DISCUSSION

1. Vegetative growth

Data in Tables (1) and (2) represent the specific effect and their interactions of plant growth promoting rhizobacteria (PGPR) and aqueous plant extracts on vegetative growth of small aerial "Hayany" date palm offshoots during 2010/2011 and 2011/2012 seasons.

1.1. Total number of heart leaves:

Table (1) show that the inoculated offshoots with Rhizobacterien had greater total number of heart leaves than Nitrobien inoculated ones in the two seasons.

Concerning the effect of aqueous plant extracts, the same Table clears that Gifert (Algae extract) treated offshoots gained the highest total number of heart leaves, while the untreated offshoot (control) induced the least heart leaf number. The other treatments came in between with significant differences among them.

The interaction between plant growth promoting rhizobacteria (PGPR) and aqueous plant extracts was significant. The inoculated offshoots with Rhizobacterien and treated with Gifert (Algae extract), recorded the highest total number of heart leaves, while untreated offshoots (control) had the least total number of heart leaves. The other interactions came in between with significant differences among them.

1.2. Heart leaves fresh weight:

Data in Table (1) disclose that the Rhizobacterien inoculated offshoots induced significant increase in heart leaves fresh weight than those inoculated with Nitrobien in both seasons.

Concerning the effect of plant extracts, the date show that Gifert (Algae extract) exhibited the highest heart leaves fresh weight, followed by Roselle aqueous extract, while the untreated offshoots (control) had the least fresh weight in the two seasons. The other treatment came in between.

Regarding the interaction between plant growth promoting rhizobacteria (PGPR) and plant extracts, data in Table (1) clear that the inoculated offshoots with Rhizobacterien and treated with Gifert (Algae extract) resulted in the highest significant increase in heart leaf fresh weight (21.33 g), while the least values were observed with the untreated offshoots (control). The other interaction came in between with significant differences among them.

Table (1): Effect of plant growth promoting (Rhizobacteria and aqueous plant extracts) on number of heart leaves ,fresh weigh and dry weight of small aerial of 'Hayany' date palm offshoots during 2010/2011 and 2011/2012 seasons.

Plant extracts	Plant growth promoting rhizobacteria (PGPR)								
	Total number			Fresh weight (g)			Dry weight (g)		
	Rhizo.	Nitro.	Mean	Rhizo.	Nitro.	Mean	Rhizo.	Nitro.	Mean
	First seasons (2010/2011)								
Control (water)	2.33 d	1.41 d	**1.87**	4.40 f	2.77 g	**3.59**	2.10 f	1,18	**1.64**
Gifert (Algae extract)	13.50 a	7.50 ab	**10.5**	21.33 a	13.06 b	**17.19**	11.80 a	7.10 b	**9.45**
Roselle (aqueous extract)	5.50 b	4.50 b	**5.00**	10.77 c	9.80 d	**10.28**	4.37 c	4.32 d	**4.35**
Ginger+ cinnamon (aqueous extract)	3.97 c	3.89 c	**3.93**	8.67 de	6.67 e	**7.67**	3.50 e	3.00 e	**3.25**
Mean	**6.25**	**4.26**		**11.29**	**8.08**		**5.44**	**3.9**	
	Second seasons (2011/2012)								
Control (water)	2.65 d	1.98 d	**2.32**	3.20 e	1.99 e	**2.59**	1.93 e	1.1	**1.52**
Gifert (Algae extract)	24.17 a	13.00 ab	**18.58**	29.83 a	23.50 ab	**26.66**	14.07 a	12.47 b	**13.27**
Roselle (aqueous extract)	6.67 b	4.33 b	**5.5**	11.47 b	9.43 bc	**10.45**	5.67 bc	3.83 c	**4.75**
Ginger +cinnamon (aqueous extract)	3.67 c	3.00 c	**3.34**	7.63 c	6.53 d	**7.08**	2.23 cd	2.20 d	**2.22**
Mean	**9.29**	**5.67**		**13.03**	**10.36**		**5.98**	**4.9**	

Means followed by the same letter(s) within each column are not significantly different at the 0.05 level, according to Duncan's multiple range test.
Rhizo= Rhizobacterin and Nitro= Nitrobien

1.3. Heart leaves dry weight:

Data in Table (1) appear that the Rhizobacterien inoculated offshoots induced higher heart leaves dry weight than Nitrobien inoculated ones Data in Table (1) show also that Gifert (Algae extract) treated offshoots gained the highest heart leaves dry weight followed by those Roselle aqueous extract. The least heart leaves dry weight came from the untreated offshoots (control).The other extracted treatments came in between with significant differences between them.

The interaction between plant growth promoting rhizobacteria (PGPR) and plant extracts was significant and indicates that all tested plant extracts increased heart leaves dry weight than untreated offshoots. The highest values in both seasons were recorded for combinations of inoculated offshoots with Rhizobacterien and treated with Gifert (Algae extract), followed by Roselle aqueous extract .The least values of heart leaves dry weight were recorded for the untreated offshoots (control). The other interactions gained significantly different intermediate weight.

1.4. Total number of leaves per offshoots:

Table (2) clears that the inoculated offshoots with Rhizobacterien significantly increased total number of leaves than the Nitrobien inoculated ones.

The same Table indicates also that Gifert (Algae extract) treated offshoots gave the highest total No. of leaves per offshoot followed by Roselle aqueous extract treatment, The least ones induced from untreated offshoots (control). The interaction between plant growth promoting rhizobacteria (PGPR) and plant extracts was significant and confirm the effect of each individual factor on total leaf No. The highest total number of leaves per offshoot was recorded for the inoculated offshoots with

Table (2): Effect of plant growth promoting(Rhizobacteria and plant extracts) on fresh weigh and dry weight total number leaves of small aerial offshoots of 'Hayany' date palm during 2010/2011 and 2011/2012 seasons.

Plant extracts	Plant growth promoting rhizobacteria (PGPR)								
	Fresh weight (g)			Dry weight (g)			Total number of leaves		
	Rhizo.	Nitro.	Mean	Rhizo.	Nitro.	Mean	Rhizo.	Nitro.	Mean
First seasons (2010/2011)									
Control (water)	6.47 d	4.97 d	**5.72**	3.08 d	2.18 d	**2.63**	3.66 c	2.65 c	**3.21**
Gifert (Algae extract)	38.20 a	27.13 ab	**32.67**	21.10 a	14.93 b	**9.01**	21.00 a	14.39 ab	**17.71**
Roselle (aqueous extract)	23.64 ab	21.40 b	**11.26**	11.27 b	10.25 bc	**5.38**	12.33 ab	9.83 b	**11.08**
Ginger +cinnamon (aqueous extract)	19.97 bc	16.47 c	**9. 11**	8.50 c	7.10 c	**7.8**	8.72 b	8.22 b	**8.47**
Mean	**22.07**	**17.51**		**10.99**	**8.62**		**11.43**	**8.72**	
Second seasons 2 (2011/2012)									
Control (water)	5.90 d	3.98 d	**4.94**	3.20 c	2.16 d	**2.68**	3.53	2.23	**2.88**
Gifert (Algae extract)	45.70 a	37.43 ab	**41.57**	22.60 a	20.20 ab	**21.4**	31.34 a	19.50 b	**25.42**
Roselle (aqueous extract)	24.58 b	19.83 b	**22.21**	12.40 b	9.03 b	**10.72**	12.65 b	9.33 bc	**10.99**
Ginger+ cinnamon (aqueous extract)	17.16 bc	14.76 c	**15.96**	7.13 bc	4.43 c	**5.78**	8.34 bc	6.76 bc	**7.55**
Mean	**23.34**	**19.00**		**11.33**	**8.96**		**13.97**	**9.46**	

Means followed by the same letter(s) within each column are not significantly different at the 0.05 level, according to Duncan's multiple range test.
Rhizo= Rhizobacterin and Nitro= Nitrobien

Rhizobacterien and treated with Gifert (Algae extract)(21.0), followed by Roselle aqueous extract (12.33). The least total leaf No was gained by the untreated offshoot (control). The other interactions came in between with significant differences among them.

1.5. Total leaf fresh weight per offshoot:

Data in Table (2) indicate that the specific effect of plant growth promoting rhizobacteria (PGPR) on total leaves fresh weight per offshoot was significantly increased by inoculating offshoots with Rhizobacterien than inoculation with Nitrobien in both seasons.

Data also show that Gifert (Algae extract) treated offshoots gave the highest total leaves fresh weight, followed by those treated with Roselle aqueous extract. The least values resulted from untreated offshoots (control). The other treatment recorded intermediate fresh weight.

With regard to the interaction effect between plant growth promoting rhizobacteria (PGPR) and plant extracts, Table (2) appears that the inoculated offshoots with Rhizobacterien and treated with Gifert (Algae extract) induced the highest total leaf fresh weight, while the least values resulted from untreated offshoots (control). The other interactions came in between with significant differences among them.

1.6. Total leaf dry weight:

It is evident from Table (2) that the specific effect of the tested factors (PGPR and plant extracts) on total leaf dry weight and their interaction followed the same trend of the aforesaid fresh weight parameter.

Generally, the root formation will proceed according to a genetically determined pattern as modified by each of chemical, physical and bio-environmental factors. Among physical factors the plant growth promoting rhizobacteria (PGPR) and plant extracts which greatly affect both root development and distribution patterns. All treatments induced drastic modifications in the hormonal patterns at different stages of root formation. On the other hand, the cut surface of the offshoots (the attachment point with the mother palm) is accompanied by secretion of some substances into the medium, such as phenols, may have profound physiological effect on the cultured offshoot. These results are in line with those reported by **El-Hamady *et al*. (1992) and Hodel and Pittenger (2003)**.

On the other hand, browning of the tissue and adjacent medium is assumed to be due to the ordination of polyphenoles and formation of quinines which are aerial reactive and toxic to the tissues.

A side from, several enzymes which are widely distributed in plant oxides phenols to quinines *e.g* monophenol oxidase (tyrosinase and polyphynol oxidase (catchall oxidase). Furthermore, adding Gifert (Algae extract), Roselle and Ginger + cinnamon aqueous extracts plus the plant growth promoting rhizobacteria (PGPR) (Rhizobacterien or/and Nitrobien) for curtailing the oxidations of the phenolic compounds.

In other words, (plant growth promoting rhizobacteria (PGPR)) may prevent or minimize releasing and oxidation of endogenous phenolic compounds, which included either through antioxidant or absorbent substance. **Al-Mana *et al*., 1996; Sourour, 2001; Okawara *et al*., 2003; Qaddoury and Amssa ,2003;Vezvaei, *et al*., 2003; Rizk and El Sayed, 2004; Qaddoury and Amssa ,2004; El-Assar *et al*., 2004;Al-Obeed, 2005.**

2. Economic revenue and profit:

2.1. Total variable cost:

Respecting the specific effect of plant growth promoting rhizobacteria (PGPR), Table (3-a) show that the inoculated offshoots with Nitrobien significantly increased the total variable cost with a bout (450 LE) than the Rhizobacterien inoculated ones as an average of the two seasons.

Concerning the effect of plant extracts, data in Table (3-a) indicates that the highest values of total variable cost (360 LE) was recorded for offshoots treated with Roselle aqueous extract, followed by Gifert (Algae extract) (350 LE) then Ginger +cinnamon aqueous extract (290LE), while the least cost (50 LE) was recorded for untreated offshoots.

Data in Table (3-b) present the interaction between plant growth promoting rhizobacteria (PGPR) and plant extracts, and clear that the inoculated offshoots with Nitrobien as plant growth promoting rhizobacteria (PGPR) plus Roselle aqueous extract recorded the highest variable cost (810 LE), followed by Gifert (Algae extract) with values (800 LE) with Nitrobien then Ginger + Cinnamon aqueous extract plus inoculation with Nitrobien (740 LE). The least cost was resulted from untreated offshoots (control). The other interactions came in between effect.

2.2. Total revenue

Data in Table (3-a) disclose that the inoculated offshoots with Rhizobacterien induced a significant increase in the total revenue values (3000 and 3438.05 LE) than the inoculated ones with Nitrobien with values (2560.5 and 2844.1 LE) in the first and second season, respectively.

Table (3-a) show that Gifert (Algae extract) treatment gained the highest total revenue values (2965.5 and 3500 LE), followed by Roselle aqueous extract (2860.5 and 3367.35 LE) while the untreated

(1) (2) (3) (4)

Fig. (1): Vegetative growth in Gifert (Algae extract) × Rhizobacterien.

Fig. (2): Vegetative growth in Ginger +cinnamon (aqueous extract) × Rhizobacterien.

Fig. (3): Vegetative growth in Roselle (aqueous extract) × Rhizobacterien.

Fig. (4): Control offshoots (untreated).

Table (3-a): Specific effect of plant growth promoting rhizobacteria (PGPR) and plant extracts on economic revenue and profit of small aerial offshoots 'Hayany' date palm during 2010/2011 and 2011/2012 seasons.

Treatment	Economic revenue and profit							
	Number of offshoots. Year-^{1}	Variable cost Year-^{1} (LE)	Survival percentage (%)		Revenue per 100 offshoots (LE)		Profit per 100 offshoots (LE)	
			2010/ 2011	2011/ 2012	2010/ 2011	2011/ 2012	2010/ 2011	2011/ 2012
1.	**Specific effect of plant growth promoting rhizobacteria (PGPR)**							
Rhizobacterien	100	340	100	98.23	3000.0	3438.05	2660.0	3098.05
Nitrobien	100	450	85.35	81.26	2560.5	2844.1	2110.5	2394.1
2.	**Specific effect of plant extracts (antioxidant)**							
Control(water)	100	50	20.12	19.22	603.6	672.7	553.6	622.7
Gifert (Algae extract)	100	350	98.85	100	2965.5	3500	2615.5	3150
Roselle (aqueous extract)	100	360	95.35	96.21	2860.5	3367.35	2500.5	3007.35
Ginger +cinnamon (aqueous extract)	100	290	90.95	92.10	2728.5	3223.5	2438.5	2933.5

Where: Unit price was 30 and 35 LE. offshoot^{-1} in the first and second seasons ,respectively.

Table (3-b): The effect of interaction between plant growth promoting rhizobacteria (PGPR) and plant extracts on economic revenue and profit of small aerial 'Hayany' date palm offshoots during 2010/2011 and 2011/2012 seasons.

Treatment		Number of offshoots. Year^{-1}	Variable cost year^{-1} (LE)	Economic revenue and profit					
				Survival percentage (%)		Revenue per 100 offshoots (LE)		Profit per 100 offshoots (LE)	
				2010/ 2011	2011/ 2012	2010/ 2011	2011/ 2012	2010/ 2011	2011/ 2012
Rhizo.	**Control**(water)	100	50	34.86	35.15	1045.8	1230.25	995.8	1180.25
	Gifert (Algae extract)	100	690	100.00	99.22	3000	3472.7	2310	2782.7
	Roselle (aqueous extract)	100	700	98.25	97.12	2947.5	3399.2	2247.5	2699.2
	Ginger+Cinnamon (aqueous extract)	100	630	93.22	79.31	2796.6	2775.85	2166.6	2145.85
Nitro.	**Control** (water)	100	50	34.86	35.15	1045.8	1230.25	995.8	1180.25
	Gifert (Algae extract)	100	800	100.00	99.22	3000	3472.7	2200	2672.7
	Roselle (aqueous extract)	100	810	98.25	97.12	2947.5	3399.2	2137.5	2589.2
	Ginger +Cinnamon (aqueous extract)	100	740	93.22	89.31	2796.6	3125.85	2056.6	2385.85

Where: (1)Unit price was 30 and 35 LE. offshoot^{-1} in the first and second seasons, respectively.

offshoots (control) gave the least (603.6 LE and 672.7 LE)in the first and second seasons, respectivcly. The other treatments gained intermediate values.

Concerning the interaction between plant growth promoting rhizobacteria (PGPR) and plant extracts, data in Table (3-b) clear that the inoculated offshoots with either Rhizobacterin or Nitrobien treated with Gifert (Algae extract) treatment caused the highest significant increase in the total revenue(3000 and 3472.7 LE), followed by offshoots treated with Roselle aqueous extract (2947.5 and 3399.2 LE), while the least values (1045.8 and 1230.25 LE) were recorded for the untreated offshoots (control). On the other hand, the other interactions came in between with significant differences among them.

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الملخص العربي

تأثير بكتريا الريزوسفير المحفزة لنمو النبات وبعض المستخلصات النباتية على المقدرة التجذرية لفسائل نخيل البلح الهوائية (الرواكب) للصنف الحياني

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أجريت هذه التجربة في بداية شهر ابريل لموسمي ٢٠١١/٢٠١٠ و٢٠١٢/٢٠١١ لعدد ١٢٠ فسيلة صغيرة الحجم عديمة الجذور (سرطانات) من نخيل البلح لصنف الحياني خالية من الأمراض، متشابه في الحجم والوزن وقوة النمو إلى حد كبير لدراسة مدي تأثير استخدام بكتريا الريزوسفير المشجعة لنمو النبات (الريزوبكترين بمعدل٧٥ جرام/لتر، النتروبين بمعدل ٦٥ جرام/لتر) والمستخلصات النباتية مثل الجيفرت (المستخلص المائي للطحالب البحرية) تركيز ١٠%، المستخلص المائي للكركدية تركيز ١٠%، المستخلص المائي للجنزبيل + القرفة تركيز ١٠%) حيث لقحت الفسائل بأحد النوعين من أنواع بكتريا الريزوسفير المشجعة للنمو تم نقعت الفسائل الصغيرة لمدة ٢٤ ساعة في أحدى المستخلصات النباتية ثم زرعت مباشرا في اكياس بلاستيك سوداء بقطر ٣٠سم ثم رويت مرتين أسبوعياً بماء الصنبور وقد تم معاملة الفسائل الصغيرة بإضافة إحدى المستخلصات النباتية سابقة الإعداد بمعدل ١٠٠ مل لكل فسيلة مرتين أسبوعياً ماعدا معاملة المقارنة حيث تم إضافة ماء فقط ، تم تصميم التجربة من خلال نظام تصميم القطاعات كاملة العشوائية في ثلاث مكررات وتمثل كل مكررة بخمس فسائل وقد تم تقييم التأثير النوعي لكل من العوامل المختبرة والتفاعل بينهما بعد مرور عام على زراعتها ، ولقد أظهرت النتائج المتحصل عليها خلال موسمي الدراسة التفوق المعنوي الواضح للفسائل الملقحة ببكتريا الريزوبكترين في كل الصفات الخضرية والعائد الاقتصادي وصافي الربح عن مثيلتها الملقحة ببكتريا النتروبين، كما أظهرت النتائج أن معاملات الجيفرت (مستخلص الطحالب البحرية) والمستخلص المائي للكركديه بالإضافة إلى مستخلص القرفة والجنزبيل أحدث زيادة معنوية في عدد أوراق القلب، الوزن الطازج والجاف لأوراق القلب، الوزن الطازج والجاف للأوراق الكلية على الترتيب ، ذلك بالإضافة لصافي الربح والعائد الاقتصادي مقارنة بالفسائل غير المعاملة (كنترول). وكان التفاعل بين عوامل الدراسة معنويا حيث كانت الفسائل التي لقحت بالريزوبكترين وعوملت بالجيفرت (مستخلص الطحالب البحرية) الأكثر تفوقاً وبفروق معنوية واضحة لجميع القياسات الخضرية والعائد الاقتصادي وتلاها المستخلص المائي للكركديه ثم المستخلص المائي لمخلوط القرفة والجنزبيل بالمقارنة بالفسائل غير المعاملة (الكنترول).

الكلمات الاسترشادية: نخيل البلح، النمو الخضري، بكتريا الريزوسفير، مستخلص الكركدية والقرفة.

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