Minia J. of Agric. Res. & Develop.
Vol. (40), No. 1, pp. 85-97, 2020

FACULTY OF AGRICULTURE

GROWTH AND PRODUCTIVITY OF ACID LIME (*CITRUS AURANTIFOLIA* L.) AS AFFECTED BY SPRAYING GIBBERELLIC ACID

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Received: 9 July (2020) Accepted: 5 August (2020)

ABSTRACT:

In order to study the effect of gibberellic acid concentration and frequencies of application on vegetative growth, leaves mineral content, yield, and fruit physical and chemical properties of acid lime trees (*Citrus aurantifolia* L), a field experiment was conducted in two successive seasons (2017 and 2018) at a private farm located at Derwa Village, Mallawy El-Minia Governorate, by using a randomized complete bloke design (RCBD). The obtained results confirmed that spraying with gibberellic acid at 10, 20, and 30 ppm significantly enhanced acid lime trees growth (shoot lengths, number of leaves/shoot, number of new shoots/tree, and leaf area), leaves chemical constituents (i.e. nitrogen%, potassium%, calcium%, and magnesium%), yield (kg)/tree and its component, as well as fruit physical and chemical properties (i.e. fruit dimension, TSS%, total acidity%, vitamin C (mg/100g F.W.)) compared to untreated trees. The maximum values in above mentioned parameters were observed in gibberellic acid treatment at 30 ppm three times, compared to the other ones and control treatment. However, non-significant differences were observed between the two higher concentrations (20 and 30 ppm). Generally, results of the present work demonstrated that application of gibberellic acid plays a remarkable role in improving growth parameters, leaves chemical composition, yield, and fruit physical and chemical properties of Balady acid lime trees under El-Minia Governorate conditions.

Key Words: Acid lime, *Citrus aurantifolia*, Gibberellin, Vegetative growth, yield, fruit quality.

INTRODUCTION:

Acid lime trees (*Citrus aurantifolia* L.) are widely grown in the tropical and subtropical zones. However, acid lime trees are the most important member of citrus acid group. Gibberellins (GAs) are a large family of tetracyclic diterpenoid plant hormones, that regulate many different aspects of plant growth and development through the entire life cycle of the plant, including promotion of cell division and elongation, seed germination, stem and hypocotyl elongation, root growth, and flowering induction (**Davenport, 1981; Looney et al., 1992; Sharma *et al.,* 2003** and **Yassen 2006**).

There are several effects due to treating fruit trees with gibberellin, the most important of them: Stimulation of vegetative growth. Whereas, growth is stimulated in the younger internodes and tissues and frequently the length of the individual internode is increased (**Sabagh & Ahmed, 2004 and Dilip *et al.,* 2017**). Also, temporary lightening of the leaves of many treated trees often is associated with the increase in leaf area. Gibberellin can induce flowering in many horticulture species requiring cold temperatures. The application of gibberellins to shoot system produces a pronounced increase in cell division in the sub-apical meristem (**Sagee & Erner 1991** and **Yassen 2006**). The rapid growth that occurs is a result of both the greater number of cells formed and an increased elongation of the individual cells. In many plants apical dominance is enhanced by treatment with gibberellins. Gibberellins increase the size of many young fruits, such as acid lime. Furthermore, exogenous gibberellins can increase the fruit size of fruits is the basis of an important commercial practice. In such fruit trees, gibberellins application results in greater yield increases than that produced by untreated plants.

The overall aim of this study is to improve understanding of the influence of spraying gibberellic acid at different concentration and frequencies of application on Balady acid lime trees growth and fruiting under Minia governorate condition. This includes vegetative growth leaves content of macro-nutrients and yields as well as fruit physical and chemical properties.

MATERIAL AND METHODS:

The present investigation was conducted during two successive seasons 2017 and 2018 on thirty uniforms in vigor Balady acid lime trees (*Citrus aurantifolia* L), grown in private orchard located at Derwa Village, Mallawy Distract, Minia Governorate (280km southern of Cairo city), where the soil texture is sandy and well drained water since water table depth is not less than two meters. The chosen lime trees are ten years old and planted at 4 X 4 meters apart. However, surface irrigation system carried by used water supply from underground well. The chosen trees are subjected to regular horticulture practices that were commonly applied in the orchard.

Soil and water analysis:

A composite samples of orchard soil and irrigation water were collected and subjected to Physical and chemical analysis according to the procedures outlined by **Walsh & Beaton (1986)** the data are shown in Table (1).

Table (1): Physical and chemical analysis of experiment orchard soil and the irrigation water.

Soil analysis		Water analysis	
Constituents	Values	Constituents	Values
Sand %	78.5	E.C (mmhos/cm/25C)	1. 3
Silt %	10.8	Hardness	19.7
Clay %	10.6	pH	7.35
Texture	Sandy	Ca (mg/L)	40.4
EC (1:2.5Extract) mmhos/cm/ 25 C	1.4	Mg (mg/L)	24.3
Organic matter %	0.42	K (mg/L)	6.07
pH (1 : 2.5 extract)	8.62	Na (mg/L)	72.8
Active lime %	7.3% ($CaCO_3$)	Sum of Cations (mg/L)	8.16
N (mg/kg)	164	Alkalinity (mg/L)	165
Phosphorus (ppm)	6.53 ppm	Chlorides (mg/L)	118
Available Ca (meq/100g)	21.2	Nitrate (mg/L)	10.2
Available Mg (meq/100g)	3.03	Sulphates (mg/L)	43.2
Available K (meq/100g)	0.84	Sum of anions (mg/L)	7.72
C/N Ratio	17.2	SAR	1.97

Experimental work:

This study included ten treatments from GA_3 concentrations and frequencies. Four concentrations of gibberellic acid were examined: 0.0 ppm GA_3 (control), 10 ppm, 20 ppm, and 30 ppm, as well as the frequencies of gibberellic acid application, which included three levels, namely: spraying GA_3 one time/year (at Mid-February), two times/year (at Mid-February and 45 days later), and three times/year (at Mid-February and one month intervals). The experiment involved the following tenth treatments from the gibberellic acid concentration and frequencies:

1- Control, 0.0 ppm GA_3 (control trees, sprayed with water).
2- Spraying GA_3 at 10 ppm one time.
3- Spraying GA_3 at 10 ppm two times.
4- Spraying GA_3 at 10 ppm three times.
5- Spraying GA_3 at 20 ppm one time.
6- Spraying GA_3 at 20 ppm two times.
7- Spraying GA_3 at 20 ppm three times.
8- Spraying GA_3 at 30 ppm one time.
9- Spraying GA_3 at 30 ppm two times.
10- Spraying GA_3at 30 ppm three times.

Each treatment was replicated three times, one tree per each. Triton B as a wetting agent was added to all solutions at 0.05%. The experiment was performed using a randomized complete block design (RCBD), statistical analyses were performed with SPSS program (SPSS Inc., Chicago, USA). The data were analyzed by one-way ANOVA. Means of the treatments were compared using New LSD test, differences at $P<0.05$ were considered as significant (**Sendecor and Cochran** (**1980**).

Different measurements:

Vegetative growth characters:

At the first week of June during both seasons, twenty mature leaves from the medal part on the non-productive shoots were picked from each replicate **(**according to **Ibrahim, 2010)**, Leaf area (cm^2) was estimated in mature Balady lime leaves (full expended leaves). Leaf area was measured by using an area meter. The average spring growth cycle shoot lengths (cm) were recorded at the end of July. The average new shoots number per tree was recorded at the end of July.

Determination of leaves N, P and K contents:

- 16 leaves picked from the middle part of 8 main shoots for each tree (**Martin-Préval *et al.*, 1984)**, were taken at the middle of June during the two seasons.
- Nitrogen was determined by the modified microkejldahl method as described by **Martin-Préval *et al.*, (1984)**.
- Phosphorus was determined by using colorimetric method, by measuring the optical density of phosphor-molibdo-vanadate complex by Spectro-photometrically at wave length 430 nm. Method described by **Walsh and Beaton (1986)**.
- Potassium was flam-photometrically determined by using the method outlined by **Martin-Préval *et al.*, (1984)**.
- Magnesium and calcium content were determined by using atomic absorption methods described by **Martin-Préval *et al.*, (1984)**.

1- Measurement of yield as well as physical and chemical properties of fruit:

The fruits were harvested when the control fruit color start to turn on yellow and the juice % arrive to 30% from fruit weight, during the two experimental seasons. The yield (kg) per tree was recorded (as a result of multiply the number of fruits per tree X average fruit weight in gram).

From each tree, twenty fruits were randomly harvested at maturation date, and the following physical characteristics of fruit were studied:

- Average fruit weight (g), fruit length without neck (cm), Average fruit diameter (cm). Fruit shape Index was mathematically calculated, using the following equation.

$$\text{shape Index} = \frac{Fruit\ Diameter\ (cm)}{Fruit\ Length\ (cm)}$$

Chemical Characteristics of juice:

- 10 fruits from each replicate were randomly chosen from homogenized sample, pressed by Electric Extractor for extracting the juice, the following chemical characteristics were determined:
- Percentage of total soluble solids (T.S.S %) were determined in juice obtained from each replicate, using a hand

refractometer according to **Ranganna (1977)**.

- Percentage of total titratable acidity (TA), expressed in grams citric acid per 100 grams of juice, by titration against with 0.1 N NaOH was determined. (**According to A.O.A.C, 2000)**.
- Vitamin C was determined by volumetric titration method using 2,6-Dichlorophynol Endophynol Pigment, according to **Ranganna (1977)**.

Results and discussion:

1- Vegetative growth characteristics

Data obtained during the two experimental seasons as shown in Table (2) displayed that, regardless the concentration used or frequencies of spraying, all spray treatments with GA_3 resulted an remarkable increase over control for the shoot lengths (cm), number of leaves per shoot, number of new shoots per tree, and leaf area (cm^2). It is clear from the obtained data that the trees received three sprays with GA_3 at 30 ppm present the highest shoot lengths, number of leaves/shoot, number of shoots/tree and leaf area, during the experimental seasons. However, non-significant differences were observed between the two higher concentrations. On the other hand untreated trees present the lowest values for all vegetative growth characteristics, during the two seasons.

The higher shoot lengths, number of leaves/shoot, number of new shoots/tree as well as enhanced leaf area in Balady acid lime trees as a result of spray gibberellic acid in our study may be due to increased cell elongation as gibberellic acid is known to stimulated the growth of plants by cell elongation (Turner, 1963). The present findings on better vegetative growth following gibberellic acid spray are in line with the results obtained by Sharma *et al.,* (2003); Sharma & Singh (2009); Sharma & Belsare (2011); Kumar *et al.,* (2012); Sekhar (2012);Saima *et al.,* (2014), and Al-Rawi, *et al.,* (2016) who obtained significantly more height and spread of fruit trees with the application of gibberellic acid.

2- Leaves N, P, K and Ca contents:

Data concerning the effect of different concentrations and frequencies of application of gibberellic acid on nitrogen, phosphorus, potassium, and calcium during 2017 and 2018 seasons are presented in Table (3). It is clear from this Table that treating Balady acid lime trees once, twice or thrice with gibberellic acid at 10, 20, or 30 ppm significantly was accompanied with improving leaves nitrogen, potassium and calcium contents (%) relative to the control treatment, during the two experimental seasons. However, non-significant differences were observed in leaves phosphorus content during both seasons.

Furthermore, the integrated treatment showed that, the trees received three sprays with gibberellic acid at 30 ppm produced the highest percentage of nitrogen, potassium and calcium in their leaves (Table 3). However, non-significant differences were observed neither between the two highest concentrations nor between the two highest frequencies.

Table (2): Effect of gibberellic acid concentration and frequencies on vegetative growth characteristics of Balady acid lime, during 2017 and 2018 seasons.

Treatment	Shoot lengths (cm)		Number of leaves/shoot		No. New shoots/tree		Leaf area (cm^2)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	8.2	8.3	6.2	7.0	66	69	11.2	11.1
GA3 at 10 ppm once	9.9	10.3	11.3	11.9	70	74	12.3	13.2
GA3 at 10 ppm twice	10.6	10.5	12.5	13.7	81	83	13.1	13.3
GA3 at 10 ppm thrice	11.5	11.7	13.9	14.5	86	86	13.3	13.6
GA3 at 20 ppm once	10.9	10.8	13.8	14.2	88	93	13.0	13.2
GA3at 20 ppm twice	11.9	12.1	14.8	14.9	99	97	17.0	16.8
GA3 at 20 ppm thrice	12.8	12.8	16.6	16.2	111	105	17.1	17.1
GA3 at 30 ppm once	12.9	13.4	15.6	16.0	96	98	16.7	16.7
GA3 at 30 ppm twice	13.9	14.4	16.0	16.7	107	110	17.2	17.1
GA3 at 30 ppm thrice	15.7	15.9	16.5	17.5	110	118	17.3	17.2
New LSD at 5%	0.42	0.53	0.54	0.69	10.2	9.7	0. 13	0.12

Table (3): Effect of gibberellic acid concentration and frequencies on leaves nitrogen, phosphorus, potassium and calcium contents of Balady lime, during 2017 and 2018 seasons.

Treatment	N %		P %		K %		Ca%	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	2.10	2.05	0.073	0.076	0.43	0.41	2.9	2.9
GA3 at 10 ppm once	2.21	2.14	0.086	0.089	0.50	0.51	3.1	3.0
GA3 at 10 ppm twice	2.29	2.24	0.093	0.094	0.53	0.54	3.3	3.5
GA3 at 10 ppm thrice	2.31	2.30	0.092	0.095	0.53	0.55	3.4	3.5
GA3 at 20 ppm once	2.32	2.35	0.095	0.093	0.53	0.56	3.5	3.7
GA3at 20 ppm twice	2.42	2.37	0. 092	0.095	0.57	0.59	3.7	3.9
GA3 at 20 ppm thrice	2.44	2.41	0.107	0.092	0.59	0.62	3.8	3.9
GA3 at 30 ppm once	2.42	2.43	0.098	0.099	0.54	0.55	3.8	4.1
GA3 at 30 ppm twice	2.49	2.49	0.097	0.098	0.55	0.56	4.2	4.3
GA3 at 30 ppm thrice	2.51	2.52	0.098	0.099	0.55	0.57	4.3	4.3
New LSD at 5%	0.09	0.08	NS	NS	0.036	0.031	0.29	0.32

GA_3 has an essential function in regulating plant developmental processes that affect nutrient uptake and their status. A clear involvement of gibberellic acid in the control of nutrient assimilation might be expected. Moreover, gibberellic acid contributes in the control of redox status of plants, most likely by regulating the synthesis of the antioxidant glutathione, which protects plant against oxidative stress that follows many nutritional deficiencies Thakur, (2016); Dilip et al., (2017), and (Bons *et al.*, 2015). The previous findings can be explained the stimulation effect of gibberellic acid on N, K, and Ca which founded in our study.

3- Yield and its components:

Data concerning the effect of different concentrations and frequencies of application of gibberellic acid on Balady acid lime trees yield (expressed in weight, kg/tree) and number of fruit/tree as well as fruit weight (g) during 2017 and 2018 seasons presented in Table (4). It is clearly shown from this Table that treating Balady acid lime trees once, twice or three times with gibberellc acid at 10 to 30 ppm significantly was accompanied with improving yield, number of fruit/tree and fruit weight relative to the control treatment.

The promotion on the yield and its component was proportional to increase the frequencies of applications of gibberellic acid from once to thrice as well as the concentrations of from 10 to 30 ppm. However, non-significant differences on these parameter were observed neither between the two higher frequencies of application (twice or thrice) nor between the two higher concentration (20 & 30 ppm).

This impact of enhancing yield per tree was associated with the improvement of leaf stimulatory effect on photosynthetic pigment biosynthesis as well as net photosynthetic rate (Thakur, 2016). The obtained results were accordance with those of Singh & Sharma (2005); Cline & Trought (2007); Ghosh *et al.*, (2009); Patel *et al.*, (2010); Bons *et al.*, 2015 and Dilip et al., (2017), whereas their results proved that application of gibberellic acid improved yield/tree, fruit weight and fruit volume.

4- Fruit physical properties:

Data concerning the effect of different concentrations and frequencies of application of gibberellic acid on physical properties of Balady acid lime fruit during 2017 and 2018 seasons are presented in Tables (5). It worth to mention that, during the two experimental seasons, remarkable gradual promotions on the fruit height, fruit diameter, pulp diameter, and peel thickness. This increment was parallel with increase gibberellic acid concentration and frequencies of application of. However, increasing the concentrations of gibberellic acid from 20 to 30 ppm had non-significant promotion on this three studied characters.

Gibberellins are known for its ability to increase cell enlargement (Arteca, 1996), thus enhancing fruit growth in certain species such as citrus (El-Sese, 2005), litchi (Chang & Lin, 2006), guava (El-Sharkawy & Mehaisen 2005) and (Nguyen & Yen, 2013) on Wax apple, this can explain the positive effect fruit physical properties.The obtained results are accordance with those obtained by Guardiola *et al.,* (1982); Talon *et al.*, (1991); Ben-Cheikh *et al.*, (1997); Martinez *et al.,* (2004); Bons *et al.,* (2005); Lglesias *et al.,* (2007); Abd El-Rahman *et al.,* (2012) and GarmendiaI *et al.,* (2019).

Table (4): Effect of gibberellic acid concentration and frequencies on yield/tree (kg/tree), fruit numbers/tree and fruit weight (g) of Balady Lime trees, during 2017 and 2018 seasons.

Treatment	No. of fruit/tree		Fruit weight (g)		Yeild/tree (kg)	
	2017	2018	2017	2018	2017	2018
Control	107	109	30.72	30.30	3.29	3.30
GA3 at 10 ppm once	112	122	30.34	31.90	3.40	3.89
GA3 at 10 ppm twice	125	129	31.73	32.28	3.97	4.16
GA3 at 10 ppm thrice	130	133	31.72	32.79	4.12	4.36
GA3 at 20 ppm once	140	143	31.11	31.98	4.36	4.57
GA3at 20 ppm twice	144	147	32.38	32.89	4.66	4.83
GA3 at 20 ppm thrice	146	149	32.99	33.28	4.82	4.96
GA3 at 30 ppm once	140	142	32.81	32.99	4.59	4.68
GA3 at 30 ppm twice	143	145	33.83	34.56	4.84	5.01
GA3 at 30 ppm thrice	145	147	33.99	34.78	4.92	5.11
New LSD at 5%	4.5	3.3	0.672	0.596	0.201	0.198

Table (5): Effect of gibberellic acid concentration and frequencies on fruit length. Fruit diameter, pulp thickness and peel thickness of Balady Lime trees, during 2017 and 2018 seasons.

Treatment	Fruit length (cm)		Fruit diameter (cm)		Pulp thickness (cm)		Peel thickness (mm)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	4.02	4.06	3.56	3.57	3.34	3.36	0.22	0.21
GA3 at 10 ppm once	4.22	4.24	3.66	3.71	3.23	3.47	0.23	0.23
GA3 at 10 ppm twice	4.34	4.40	3.75	3.79	3.49	3.52	0.26	0.27
GA3 at 10 ppm thrice	4.49	4.49	3.79	3.81	3.53	3.48	0.26	0.27
GA3 at 20 ppm once	4.46	4.47	3.77	3.85	3.52	3.59	0.25	0.26
GA3at 20 ppm twice	4.51	4.54	3.88	3. 94	3.60	3.66	0.28	0.28
GA3 at 20 ppm thrice	4.58	4.62	3.99	4.07	3.71	3.78	0.28	0.29
GA3 at 30 ppm once	4.58	4.59	3.88	3.92	3.62	3.66	0.26	0.26
GA3 at 30 ppm twice	4.61	4.66	4.01	4.02	3.73	3.74	0.28	0.28
GA3 at 30 ppm thrice	4.69	4.72	4.03	4.04	3.75	3.75	0.28	0.29
New LSD at 5%	0.32	0.34	0.27	0.29	0.26	0.28	0.012	0.013

5- Fruit chemical properties:

Data concerning the effect of gibberellic acid concentration and frequencies on fruit chemical properties of the Balady acid lime trees during 2017 and 2018 seasons are shown in Table (6). It is clear from the obtained data that spraying gibberellic acid once, twice and three times at 10 to 30 ppm significantly was responsible for improving chemical properties of acid lime fruit, in terms of increasing T.S.S. %, vitamin C (mg/100g juice) and decreasing total acidity % rather than non-application.

This favorable effect on chemical properties was associated with increasing GA_3 concentration from 10 to 30 ppm and frequencies from one to three times. However, non-significant effects on fruit chemical properties were observed due to increasing the concentration from 20 to 30 ppm. thee sprays of gibberellic acid at 30 ppm gave the best results with regard to T.S.S% and vitamin C (mg/100g juice). However, the statistical analysis of obtained data did not confirm a significant differences between the two higher gibberellic acid concentrations (20 and 30 ppm), during the two experimental seasons.

Gibberellins widely used on many commercial orchards for increase fruit size and fruit quality, (**Clayton *et al.*, 2006**). GA_3 increased the yield of fruit in Balady mandarin (**El-Sese, 2005**), and increases soluble solids as well as sugar contents in sweet cherry) **Basak *et al.*, 1998**). Furthermore, the effect of GA_3 marked reduced fruit drop, which is in agreement with the work of **Mehouachi (2000)**. The authors reported GA_3 has significant influences on the development of fruit and preventing the drop off of young fruits.

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CONCLUSION: The results of this investigation confirmed that It is strongly recommended to spray Balady acid lime trees grown under the experimental conditions (newly reclamation sandy soil at Minia Governorate) and resembling conditions with gibberellic acid at 20 ppm three times yearly, in order to improve the vegetative growth and production as well as fruit physical and chemical properties of Balady acid lime trees.

Table (6): Effect of gibberellic acid concentration and frequencies on TSS%, Total acidity % and Vitamin C (mg/100g juice) of Balady Lime trees, during 2017 and 2018 seasons.

Treatment	T.S.S. (%)		Total acidity (%)		TSS/Acid Ratio		Vitamin C (mg/100g Juice)	
	2017	2018	2017	2018	2017	2018	2017	2018
Control	8.52	8.50	7.25	7.10	1.17	1.19	26	27
GA3 at 10 ppm once	9.24	9.20	6.77	6.79	1.36	1.35	27	29
GA3 at 10 ppm twice	9.47	9.48	6.54	6.78	1.44	1.39	30	33
GA3 at 10 ppm thrice	9.86	9.87	6.41	6.51	1.51	1.52	31	35
GA3 at 20 ppm once	9.97	9.99	6.34	6.45	1.57	1.54	33	37
GA3at 20 ppm twice	11.04	11.35	6.12	6.21	1.80	1.82	41	42
GA3 at 20 ppm thrice	11.59	11.48	6.12	5.98	1.89	1.88	42	43
GA3 at 30 ppm once	10.99	10.79	6.04	6.08	1.81	1.77	37	38
GA3 at 30 ppm twice	11.42	11.35	5.99	5.95	1.91	1.89	39	39
GA3 at 30 ppm thrice	11.54	11.47	5.93	5.88	1.94	1.96	40	41
New LSD at 5%	0.35	0.42	0.34	0.43	0.067	0.087	1.5	1.3

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تأثير الرش بالجبرلين على النمو والأثمار فى الليمون البلدى المالح

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أجريت هذه التجربة الحقلية بهدف دراسة تأثير التركيز وتكرار مرات الرش بالجبرلين على النمو الخضرى، المحتوى المعدنى للأوراق، كمية المحصول (بالكجم) للشجرة ومكوناتة، المواصفات الفيزيائية والكيميائية لثمار الليمون البلدى المالح. تم تنفيذ التجربة بمزرعة خاصة بقرية دروة مركز ملوى – محافظة المنيا، خلال موسمين متتاليين (2017 و 2018). وقد استخدم تصميم القطاعات كاملة العشوائية فى تنفيذ التجربة.

أكدت النتائج المتحصل عليها خلال هذه الدراسة أن رش الجبرلين بتركيزات 10 و 20 و30 جزء فى المليون قد حسن كلاً من: مقاييس النموالخضرى (متمثلة فى طول النموات بالسنتيمتر، عدد الأوراق على الفرع، وعدد النموات الحديثة على الشجرة) والتركيب المعدنى للأوراق (متمثلاً فى نسبة النيتروجين، نسبة البوتاسيوم، نسبة الكالسيوم، ونسبة الماغنسيوم فى الأوراق)، كمية المحصول لكل شجرة ومكوناته، وكذلك تحسين مواصفات الثمار الفيزيائية والكيميائية (أبعاد الثمرة، نسبة المواد الصلبة الذائبة بالعصير، نسبة الحموضة الكلية بالعصير، وكذلك محتوى الثمار من فيتامين ج) فى اشجار الليمون البلدى الملح. وقد أعطت الأشجار التى تمت معاملتها ثلاث مرات بالجبرلين بتركيز 30 جزء فى المليون افضل النتائج فى معظم الصفات التى تم دراستها وذلك بالمقارنة بأشجار الكنترول أو المعاملات الأخرى. ومن الجدير بالذكر أن الفروق بين التركيزين الأعلي للجبرلين (20 و 30 جزء فى المليون) كانت غير معنوية فى كلا موسمي الدراسة.

ومن خلال هذه الدراسة نجد أن رش الجبرلين قد لعب دوراً جوهرياً فى تحسين مواصفات النمو الخضرى، محتوى الأوراق من العناصر الغذائية الضرورية الكبري، كمية المحصول وكذلك المواصفات الفيزيائية والكيميائية لثمار أشجار الليمون البلدى المالح تحت ظروف محافظة المنيا. وللحصول على أفضل محصول، كمية وجودة، توصى هذه الدراسة برش اشجار الليمون البلدى المالح النامية فى الأراضى الرملية بمحافظة المنيا، والظروف المماثلة لها، ثلاث مرات سنوياً بالجبرلين بتركيز 20 جزء فى المليون.

الكلمات الدالة: الليمون البلدى المالح، الجبرلين، النمو الخضرى، المحصول، جودة الثمار