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PHYSIOLOGICAL STUDIES ON GERMINATION AND FERTILIZATION OF SOPHORA PLANT
2.EFFECT OF SOME FERTILIZATION TREATMENTS ON GROWTH AND CHEMICAL COMPOSITION Of *Sophora secundiflora* SEEDLINGS

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ABSTRACT

An investigation was conducted at the nursery of Al-Zohriya Garden, Hort. Res. Inst., ARC, Giza, Egypt during 2018 and 2019 seasons to evaluate the positive effects of both Kristalon (20 N: 20 P: 20 K + microelements) and Active Grow a commercial liquid nutritive product that contains macro and micro-elements, GA_3, amino acids, vit. B. and molas) when applied at 0, 1, 2, 3 and 4 g /ml, or ml for Kristalon /l for Active Grow as foliar spray, biweekly on growth and quality of Mescal-bean (*Sophora secundiflora* (Ort.) Lag ex.DC.) during the growth period in the nursery. The obtained results showed that spraying plants with all fertilization treatments traits exhibited significant increasing in the average of vegetative and root growth compared to the control treatment where the treatments was of the integrated mineral fertilizer Kristalon (20: 20: 20) at the rate of 3 g/l, the best treatment ,which gave the highest values in all traits, in both seasons. On the other hand the lowest values were found in the untreated plants (control), followed by the plants treated with the high rate of Active Grow (4 ml/l) treatment . The same trend was observed with regard to the chemical components of the leaves, with the Kristalon treatment at the rate of 3 g/l, which gave the highest values for the leaf contents of photosynthetic pigments (chlorophyll- a, b and carotenoids), total soluble sugars, nitrogen, phosphorus, potassium, as well as iron, manganese, magnesium and zinc compared to other treatments for the mean of the two seasons. Accordingly, foliar spraying of Mescal-bean (*Sophora secundiflora*) seedlings with Kristalon compound (20 N: 20 P: 20 K + microelements) at the rate of 3 g/liter, once every two weeks during the growing season, can be recommended to obtain the fastest growth and high quality during the period of nursery care.

Key words: *Mescal-bean, Sophora secundiflora, vegetative and root growth, Kristalon, Active Grow, chlorophylls, carotenoids, total soluble sugars.*

1. INTRODUCTION

Sophora secundiflora ((Ort.) Lag ex. DC.), Mescal-bean or Texas mountain laurel is a small tree with evergreen compound leaves, that belongs to the pea family (Fabaceae). It is native to dry, rocky limestone soils from central Texas west to New Mexico and is drought-resistant after establishment. It bears beautiful lavender-amethyst colored clusters of pea-like, aromatic flowers. So, it makes a beautiful specimen plant either in the landscape or in containers. The beans contain the alkaloid sophorine, which is identical with cytosine (Huxley *et al*., 1992).

Mescal-bean is a slow- growth shrub, it may needs years before blooming. Thus, young plants require some extra nutrition to get quickly established. Information in the literature regarding *Sophora* nutrition are very limited. But, there are several studies on the other ornamental shrubs. In this concern, Shahin *et al*. (2012) found that dressing *Brassaia actinophylla* and *Euonymus japonicus* cv." Aureus" plants with 2 g/pot Kristalon + 5 g/l active dry yeast as foliar spray greatly improved vegetative and root growth of both plants, with increasing pigments, N, P and K concentrations in their leaves. Likewise, El-Fouly *et al*.(2014) reported that spraying the foliage of *Cordyline terminalis* monthly with humic acid + liquid fertilizer (10 N: 10 P: 10 K + microelements) and Citreen (a commercial nutritive and growth activator liquid product contains Fe, Zn, Mn, and organic acids)

at 5 ml/l for each markedly improved all vegetative and root growth characters and leaf properties of the mixture used in both seasons are shown in Table (a).

Table (a): Some physical and chemical properties of the soil mixture used in this study.

Soil mixture	Particle size distribution (%):			S.P.	E.C. (dS/m)	pH	Cations (meq/l)			
	Sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Sand + clay mixture (1:1, v/v)	39.0	37.5	23.5	27.0	3.4	7.58	13.5	10.5	18.8	0.65
	Anions (meq/l)				Macro and micro-elements (ppm)					
	HCO_3^-	Cl^-	SO_4^{--}	CO_3^{--}	N	P	K	Fe	Zn	Mn	Cu
	1.5	28.5	13.45	-	5.00	19.00	2.60	4.10	0.58	2.10	0.16

contents of chlorophylls a, b, carotenoids, anthocyanin, carbohydrates, Fe, Zn and Mn.

Several reports, by El-Mokadem and Sorour (2014) on *Petunia hybrida cv*. "Bravo White", Ibrahim *et al*.(2014) on *Tulbaghia violacea*, Abou-Dahab *et al*.(2015) on *Kochia scoparia*, Arab *et al*. (2015) on *Calendula officinalis*, El-Fouly (2015) on *Ochna serrulata*, Naseem *et al*. (2015) on *Murraya exotica*, Fayaz *et al*., (2016) on gerbera, Ali *et al*., (2017) on *Moringa oleifera*, Badran *et al*.(2017) on gardenia, Abdou and Badran (2018) on *Delonix regia*, El-Azzony *et al*. (2018) on *Jatropha curcas*, Shahin and Dorgham (2018) on *Browallia speciosa* and *Thevetia peruviana*, Arafa *et al*. (2019) on *Ixora coccinea* agree with Said and Shahin (2019), who mentioned that spraying the foliage of *Eucalyptus citriodora* seedlings with the aqueous solution of amino acids mixture at 1 g/l maximized the means of plant height, stem diameter, No. leaves/plant, root length, fresh and dry weights of different plant organs, as well as leaf content of pigments, total soluble sugars, P and K.

This trail was set out in order to investigate the response of the slow-growing Mescal-bean seedlings to some fertilization treatments, , *e.g*. foliar nutrition of Kristalon and Active Grow during the growth period in the nursery.

2. MATERIALS AND METHODS

The current work was carried out at the nursery of Al-Zohriya Garden, Hort. Res. Inst., ARC, Giza, Egypt during 2018 and 2019 seasons aiming to determine the positive effects of two commercial fertilizers on growth and chemical composition of Mescal-bean seedlings.

Therefore, uniform 6-month-old seedlings of *Sophora secundiflora* ((Ort.) Lag ex. DC.) at a length of about 10 cm with 8 leaves were individually transplanted on March,15^{th} (both seasons) into 16 cm diameter plastic pots, each filled with about 1.5 kg of sand and clay mixture (1:1, v/v). Some physical and chemical

After two weeks (on April, 1^{st} in every season), the seedlings received the following fertilization treatments.

1. Non fertilization, referred to as control.
2. The aqueous solution of either Kristalon fertilizer (20 N: 20 P: 20 K + microelements, produced by Agrico International Company, Dokki , Giza) at the rates of 1, 2, 3 and 4 g/l.
3- Active Grow (a liquid commercial nutritive product produced by Agro Egypt International, Al-Sadat city) at the rates of 1, 2, 3 and 4 ml/l. The chemical components of this product are listed in Table (b).

Table (b): The chemical components of the Active Grow commercial product used in the two seasons (2018 and 2019).

N	8.00 %	**B**	0.02 %
P	5.00 %	**S**	2.10 %
K	6.00 %	**GA_3**	0.001 %
Fe	3000 ppm	**free amino acids**	10.18 %
Mn	3000 ppm	**CPU**	0.001 %
Zn	3000 ppm	**Minatole**	3.00 %
Mg	5000 ppm	**Vitamin B complex**	0.01 %
Genk	15.00 %	**Molas**	5.00 %

The aqueous solution of the abovementioned products were sprayed on the seedling foliage at early morning till run-off point, every two weeks. The layout of the experiment was a completely randomized design, replicated thrice, and each replicate contained four plants (Mead *et al*., 1993). All plants received the necessary agricultural practices whenever needed.

At the end of each season (on October, 15^{th}), the data were recorded on the following traits: plant height (cm), number of leaflets/plant, stem diameter (mm), leaflet area (cm^2), root length (cm), as well as top growth and roots fresh and dry weights (g/plant).

In the fresh leaf samples was taken from the middle parts of plants, the content of

photosynthetic pigments (chlorophyll a, b and carotenoids mg/g f. w.) Sumanta *et al*. (2014) the percent of total soluble sugars was determined according to the methods of Dubois *et al*. (1956). At the end of the two seasons, the percentages of nitrogen (Blacke, 1965), phosphorus (Luatanab and Olsen, 1965) as well as potassium (Jackson, 1973) were determine in the dry leaves. In the mean of both seasons, another dry leaf samples were digested in nitric and perchloric acids and analyzed to determine the contents of iron, manganese, magnesium, and zinc (as ppm) using Perkin Elmer 403 atomic absorption spectrophotometer as indicated by Jackson (1973).

Data obtained were then tabulated and statistically analyzed using computer program of SAS Institute (2009), which was followed by Duncan's New Multiple Range t-Test (Steel and Torrie, 1980) to compare means of treatments .

3. RESULTS AND DISCUSSION

3.1. Effect of fertilization treatments

3.1.1. Vegetative and root growth characteristics

It is evident from the data presented in Tables (1, 2 and 3) the most fertilization treatments applied in this study significantly increased the means of plant height (cm), number of leaflets/plant, stem diameter (mm), leaflet area (cm^2), root length (cm) as well as fresh and dry weights of top growth and roots as compared to control treatment with the superiority of Kristalon treatment (20 N: 20 P: 20 K) at 3 g/ l that gave the highest scores compared to other treatments in both seasons. On the other hand, increasing the Kristalon rate to 4 g /l did not caused any further improvement in the mean values of growth characteristics, which were lower than those achieved at the 3 g/l level.

Likewise, the Active Grow at 4 ml/l treatment had the lowest growth values compared to the 2 ml/l treatment in both seasons (Figs.1and 2).

Stimulation of plant growth by fertilization may be reasonable because different nutrients of fertilizers usually activate metabolism in plant cells, producing sugars, proteins, hormones, enzymes and energy-reverse materials necessary for good and healthy growth. This truth was documented by Ibrahim *et al*. (2014) who declared that fertilizing *Tulbaghia violacea* (flowering-pot-plant) with NPK mixture at 1 g/pot + foliar spray with humic acid at 2 ml/l greatly improved growth, flowering and leaf content of pigments, sugars, N, P and K; likewise, Fayaz *et al*.(2016) suggested that treatment composed of 20:20:15 NPK at g/m^2 could be useful for the best vegetative and reproductive characters of gerbera cv. Lanceolat. On *Delonix regia*, Abdou and Badran (2018) revealed that supplying with either medium or high NPK rate + Mn and Zn each at 75 ppm, resulted the best growth of seedlings grown in sandy soil. On the same results were achieved by Abou Dahab *et al*.(2015) on *Kochia scoparia*, Ali *et al*. (2017) on moringa, Badran *et al*. (2017) on *Gardenia jasminoides*, El-Azzony *et al*. (2018) on *Jatropha curcas* and Arafa *et al*. (2019) on *Ixora cocconea*.

Table (1): Effect of fertilization treatments on plant height, number of leaflets /plant and stem diameter of *Sophora secundifora* plants during 2018 and 2019 seasons.

Treatments	Plant height (cm)		No. leaflets /plant		Stem diameter (mm)	
	2018	2019	2018	2019	2018	2019
Control	13.90H	14.17I	13.33I	14.33I	2.89H	3.07G
Kristalon 1 g/l	19.77D	20.70D	26.33D	29.33D	4.38D	4.75D
Kristalon 2 g/l	23.17B	23.67B	33.67B	36.33B	5.30B	5.48B
Kristalon 3 g/l	25.27A	32.13A	44.00A	52.67A	5.90A	6.70A
Kristalon 4 g/l	18.57E	18.90E	22.83E	24.00E	4.15E	4.26E
Active Grow 1ml/l	16.87F	17.30G	18.33G	20.00G	3.84F	4.02EF
Active Grow 2 ml/l	20.70C	22.40C	27.67C	31.33C	4.86C	5.03C
Active Grow 3 ml/l	17.20F	18.13F	20.33F	21.72F	3.91F	4.08EF
Active Grow 4 ml/l	15.40G	16.17H	15.33H	16.33H	3.49G	3.86F

*Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

Table (2) : Effect of fertilization treatments on leaflet area and root length of *Sophora secundifora* plants during 2018 and 2019 seasons.

Treatments	Leaflet area (cm^2)		Root length (cm)	
	2018	2019	2018	2019
Control	1.60H	1.74H	10.43I	14.93I
Kristalon 1 g/l	3.36D	3.90D	21.70D	22.50D
Kristalon 2 g/l	5.38B	5.94B	25.77B	27.77B
Kristalon 3 g/l	5.83A	7.28A	30.97A	36.23A
Kristalon 4 g/l	2.96E	3.11E	20.83E	21.13E
Active Grow 1ml/l	2.25G	2.65F	18.50G	19.33G
Active Grow 2 ml/l	4.20C	4.70C	22.80C	23.97C
Active Grow 3 ml/l	2.59F	2.82EF	19.57F	20.17F
Active Grow 4 ml/l	1.84H	2.19G	15.87H	17.67H

*Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

Table (3): Effect of fertilization treatments on top growth and roots fresh and dry weights of *Sophora secundifora* plants during 2018 and 2019 seasons.

Treatments	Top growth/plant				Roots\plant			
	Fresh weight (g)		Dry weight (g)		Fresh weight (g)		Dry weight (g)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	1.98I	2.93H	0.84G	1.30G	0.91I	1.03H	0.26I	0.40G
Kristalon 1 g/l	6.86D	7.20C	2.78CD	3.11C	2.41D	2.56D	0.95D	1.11D
Kristalon 2 g/l	8.51B	9.85B	3.65B	4.12B	3.52B	3.82B	1.34B	1.79B
Kristalon 3 g/l	11.42A	16.32A	4.73A	7.53A	4.27A	6.00A	1.87A	3.43A
Kristalon 4 g/l	6.01E	6.28D	2.52D	2.63D	2.06E	2.22E	0.82E	1.03D
Active Grow 1ml/l	4.23G	4.67F	1.88EF	2.00EF	1.49G	1.62G	0.52G	0.64F
Active Grow 2 ml/l	7.37C	7.66C	3.05C	3.25C	2.79C	3.09C	1.18C	1.46C
Active Grow 3 ml/l	5.00F	5.34E	2.10E	2.28DE	1.74F	1.93F	0.64F	0.82E
Active Grow 4 ml/l	3.65H	4.07G	1.59F	1.77F	1.14H	1.42G	0.40H	0.49FG

* Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

Fig. (1): Effect of Kristalon treatments on *Sophora secundifora* seedlings growth. Treatments from left to right: control. 1: Kristalon at 1 g/l .2: Kristalon at 2 g/l .3: Kristalon at 3 g/l and4:Kristalon at 4 g/l.

Fig. (2): Effect of Active Grow treatments on *Sophora secundifora* seedlings growth. Treatments from left to right: control.1: Active Grow at 1ml/l. 2: Active Grow at 2 ml/l. 3: Active Grow at 3mlg/l and 4: Active Grow at 4 ml/l.

3.1.2. Chemical composition of the leaves

The data in Tables (4, 5 and Fig. 3) showed that all Kristalon doses caused a significant increase in photosynthetic pigments content (chlorophyll a, b and carotenoids, mg/g f. w.), as well as the percentages of total soluble sugars, N, P, and K contents in the leaf tissue of treated with plants as compared with untreated plants (the control). The highest values in this regard were recorded by Kristalon-treated plants at 3 g/l. While, the lowest contents were found in the leaves of Kristalon-treated plants at 4 g/l. A similar response was also occurred regarding the concentrations of Fe, Mn, Zn and Mg .

Similarly, the Active Grow at 4 ml/l treatment had the lowest leaf chemical composition values compared to the 2 ml/l treatment in the mean of both seasons.

Generally, improving concentration of active constituents in plant tissues due to nutritive treatments is sensible because such treatments usually supply the plants with more available nutrients, which accelerate biosynthesis processes and lead finally to accumulate more active components in plant cells. In this respect, El-Fouly (2015) mentioned that spraying the foliage of *Ochna serrulata* seedlings with Vege Grow liquid fertilizer at 2 ml/l maximized leaf content of chlorophyll a, b, carotenoids, total soluble sugars, N, P, K, Fe, Zn, Cu, Mn and proteins. El-Azzony *et al*. (2018) pointed out that interacting between 75 % NPK from the recommended dose and EM1 at 100 ml/shrub of Jatropha increased fixed oil %, fixed oil weight/shrub, fixed oil yield/fed. and improved percentages of palmitic, oleic, stearic and linoleic acids in the resulted fixed oil.

Table (4): Effect of fertilization treatments on pigments of *Sophora secundifora* plants during 2018 and 2019 seasons.

Treatments	Chlorophyll a mg/gm f.w		Chlorophyll b mg/gm f.w		Carotenoids mg/gm f.w	
	2018	2019	2018	2019	2018	2019
Control	0.443E	0.446H	0.068E	0.134F	0.159F	0.176F
Kristalon 1 g/l	0.612B	0.654D	0.186C	0.214B	0.259B	0.260BC
Kristalon 2 g/l	0.616B	0.721B	0.219B	0.234B	0.271B	0.300A
Kristalon 3 g/l	0.641A	0.762A	0.256A	0.368A	0.383A	0.307A
Kristalon 4 g/l	0.595B	0.608E	0.185C	0.209BC	0.237C	0.241CD
Active Grow 1ml/l	0.470D	0.484G	0.138D	0.175DE	0.207D	0.217DE
Active Grow 2 ml/l	0.614B	0.672C	0.192BC	0.221B	0.265B	0.267B
Active Grow 3 ml/l	0.529C	0.562F	0.154D	0.184CD	0.225C	0.227DE
Active Grow 4 ml/l	0.450DE	0.459H	0.136D	0.149EF	0.182E	0.205E

*Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range t-Test at 5 % level.

Table (5): Effect of fertilization treatments on total soluble sugars, N, P, K and Mg concentrations in the leaves of *Sophora secundifora* plants (average of the two seasons).

Treatments	Total soluble sugars % (f. w.)	N % (d.w.)	P% (d.w.)	K % (d.w.)	Mg % (d.w.)
Control	4.609I	1.52H	0.20G	0.52H	1.44H
Kristalon 1 g/l	6.667D	2.10D	0.32CD	0.62D	1.80D
Kristalon 2 g/l	7.781B	2.81B	0.34B	0.65B	2.10B
Kristalon 3 g/l	8.151A	2.95A	0.37A	0.67A	2.30A
Kristalon 4 g/l	6.622E	1.97E	0.31D	0.61DE	1.73E
Active Grow 1ml/l	5.367G	1.81F	0.27F	0.58F	1.70F
Active Grow 2 ml/l	7.358C	2.52C	0.30BC	0.64C	2.05C
Active Grow 3 ml/l	5.833F	1.81F	0.29E	0.60E	1.71F
Active Grow 4 ml/l	5.254H	1.76G	0.26F	0.57G	1.65G

*Means within a column having the same letters are not significantly different according to Duncan's New Multiple Range t-Test as 5 % level.

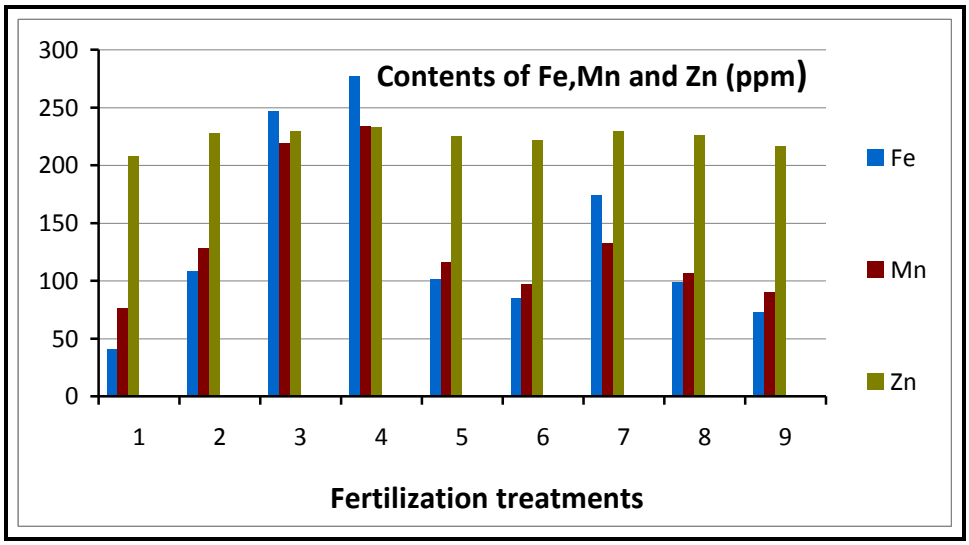

Fig.(3): Contents of Fe, Mn and Zn in response to the fertilization treatments of kristalon and active grow (average of two seasons).

Where: treatment 1:control; treat.2: kristalon 1g/l, treat.3: kristalon 2 g/l,treat.4: kristalon 3 g/l ,treat.5: kristalon 4 g/l, treat.6: active grow 1 ml/l,treat.7: active grow 2 ml/l; treat.8: active grow 3 ml/l and treat.9: active grow 4 ml/l.

Furthermore, Shahin and Dorgham (2018) postulated that spraying the foliage of *Browallia speciosa* and *Thevetia peruviana* with potassein-N at 2 ml/l level raised chlorophyll a, b, carotenoids, N, P and K concentrations in the leaves of both plants.

The previous gains are in parallel with those detected by El-Fouly *et al*. (2014) on *Cordyline terminalis*, Arab *et al*. (2015) on *Calendula officinalis*, Naseem *et al*. (2015) on *Murraya exotica* and Arafa *et al*. (2019) on *Ixora coccinea*.

According to the abovementioned results, it can be proposed to fertilize the Mescal-bean (*Sophora*) seedlings with Kristalon (20 N: 20 P: 20 K + microelements) at 3 g/l as foliar spray, once every two weeks, to accelerate their growth with high quality during the rearing period in the nursery.

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دراسات فسيولوجية على إنبات وتسميد نبات السوفورا
2- تأثير بعض معاملات التسميد على النمو والتركيب الكيماوي لشتلات السوفورا
(*Sophora secundiflora*)

أحمد وهبة سيد

قسم بحوث نباتات الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر.

ملخص

أجري هذا البحث بمشتل حديقة الزهرية، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر، خلال موسمي 2018، 2019 لتقييم التأثيرات الإيجابية لكل من سماد الكريستالون (20 ن: 20 فو: 20 بو + عناصر صغرى) وأكتيف جرو (سماد مغذي سائل يحتوى على عناصر كبرى وصغرى، حمض جبريلليك، أحماض أمينية، فيتامين ب المركب ومولاس) عند إضافة كل منهما على حدى بمعدلات: صفر، 1، 2، 3 و 4 جم / لترماء(للكريستالون) أو مل / لتر ماء (للأكتيف جرو) لكل لتر ماء رشاً على الأوراق، مرة كل أسبوعين، على نمو وجودة شتلات السوفورا (*Sophora secundiflora*) خلال فترة الرعاية بالمشتل. أوضحت النتائج المتحصل عليها أن جميع معاملات التسميد المستخدمة بهذه الدراسة أحدثت زيادة معنوية في متوسطات قياسات النمو الخضري والجذري مقارنة بمعاملة الكنترول، حيث تفوقت المعاملة بالسماد المعدني المتكامل كريستالون (20: 20: 20) بمعدل 3 جم/لتر، والتى أعطت أعلى القيم في جميع الصفات المدروسة مقارنة بالمعاملات الأخرى في كلا الموسمين . بينما سجلت أقل القيم فى نباتات المقارنة (الكنترول) وتليها النباتات المعاملة بالتركيز المرتفع من معاملة أكتيف جرو بمعدل 4 مل/لتر. و قد لوحظ هذا الإتجاه مع المكونات الكيميائية للأوراق ،حيث سجلت أيضاً معاملة السماد المعدني المتكامل كريستالون (20 : 20: 20) بمعدل 3 جم/لتر أعلى القيم لمحتوى الأوراق من صبغات البناء الضوئى (كلوروفيللى أ، ب والكاروتينويدات)، السكريات الذائبة الكلية ، وعناصر النتروجين، الفوسفور، البوتاسيوم، وكذلك الحديد ، المنجنيز، المغنسيوم والزنك مقارنة بالمعاملات الأخرى لمتوسط الموسمين . **وعليه؛** يمكن التوصية بالرش الورقي لشـــتلات السوفــورا (*Sophora secundiflora*) بسماد الكريستالون المركب (20 ن: 20 فو: 20 بو + عناصر صغرى) بمعدل 3 جم/لتر، مرة كل أسبوعين خلال موسم النمو للحصول على نمو سريع وجودة عالية خلال فترة رعايتها بالمشتل.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (71) العدد الرابع (أكتوبر 2020): 357-364.