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EFFECT OF FOLIAR SPRAYING WITH HUMIC ACID AND CHELATED MICROELEMENTS ON GROWTH AND QUALITY OF GOODLUCK (*CORDYLINE TERMINALIS* (L.) KUNTH.) PLANT

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ABSTRACT: *An investigations was experiments were conducted under the plastic house conditions at the Experimental Farm of Hort. Res. Inst., Giza, Egypt during 2010 and 2011 seasons to examine the effect of monthly foliar spraying with either a commercial humic acid liquid fertilizer (10 N : 10 P : 10 K + microelements) at the rate of 5 ml/l or citreen (a commercial nutritive and growth activator liquid contains 2 % from each of Fe , Zn and Mn in chelated form + 15 % organic acids + 3 % spreading agent) at the rates of 1, 3 and 5 ml/l on growth and quality of one-year-old transplants of Goodluck (Cordyline terminalis (L.) Kunth.) grown in 20-cm-diameter plastic pots filled with about 2.5 kg of sand+clay+peatmoss mixture (1:1:1, by volume). Effect of the interaction between each level of citreen and humic acid were also studied.*

The obtained results indicated that all fertilization treatments used in this study caused a marked increments in all vegetative and root growth parameters in both seasons , as well as in the leaves content of chlorophylls a and b, carotenoids and anthocyanin. Total carbohydrates, ferrous, zinc and manganese contents were also increased with various significant differences as compared to control. However, the superiority in all previous parameters was for the combined treatment between citreen and humic acid at 5 ml/l for each, as it gave the utmost high means in most cases of the two seasons . Citreen at 1 or 3 ml/l ,alone or interacted with humic acid at 5 ml/l improved some chatacters giving means closely near to those of the previous superior combined treatment . Likewise, humic acid alone at 5 ml/l improved some traits and elevated their means to a rank equal to that of superlative combined treatment , with non-significant differences among them .

From these results, it could be recommended to spray the foliage of one- year-old transplants of Cordyline terminalis, every month with citreen and humic acid solution at 5 ml/l for each to obtain the best performance and highest quality of such foliage plant .

Key words : *Fertilization, Humic acid, Citreen, chelated microelements, ornamental shrubs Cordyline terminalis (L.)*

INTRODUCTION

Cordyline terminalis (L.) Kunth.(Fam. Liliaceae), Goodluck plant, Hawaiian Goodluck plant , Tree of Kings , to 10 ft.; leaves petioled to 2.5 ft. long and 5 inch wide ; panicles to 1 ft. long; flowers yellowish , white or reddish . Native to E. Asia. Grown under glass and out of doors in warm climates for its beautiful colored foliage . Propagating by seeds , cuttings and root layering .The leaves may be removed from ripened stems , these stems cut into 2-4 inch lengths and laid in sand in a propagating bed with bottom heat . When the eyes have developed into shoots with about 6 leaves, the shoots should be cut off with an eye and put in a propagating bed until rooted, then transplanted into pots (Bailey, 1976) .

Humic acid and humates are being used widely now for enhancing growth and quality of most crops, as they provide soil microbs with energy, improve nutrients retention in the soil and increase the water holding capacity (Dorer and Peacock, 1997). Stevenson (1994) mentioned that humic substances are an extremely important soil component because they constitute a stable fraction of carbon (C), thus regulating the carbon cycle and release of nutrients,

including N, P and S . Moreover, the presence of humates improves water holding capacity, pH buffering and thermal insulation . In this respect, Evans and Li (2003) revealed that humic acid at 2500 ppm increased lateral root number and length, as well as roots dry weight of Chathranthus roseus , Pelargonium hortorum , Tagetes patula and Viola tricolor . Furthermore, El-Sayed and El- Shal (2008) declared that humic acid at either 5 ml/l as a foliar spray or 10 ml/l as a soil drench greatly improved vegetative and root growth of Schefflera plant, as well as leaves content of N, P, K, Zn, Fe and Mn . Analogous observations were also obtained by Aronaff (2006) on marigold, pepper and strawberry, Abdel-Fattah *et al.* (2009) on Dracaena and Ruscus, Ahmed *et al.* (2010) on Snap bean , Ahmed *et al.* (2011) on roselle and El-Sherbeny *et al.* (2012) who reported that the highest growth parameters or biomass represented by leaves and roots of turnip plants were obtained with NPK or humic acid , but it can recommended to use humic acid as an organic fertilizer to produce organic products. Also, humic acid increased carbohydrates, minerals, total lipids and fatty acids contents .

On the other hand, micronutrients play a vital role in activating most vital processes in plants, although they are needed in small quantities (Marschner, 1995) . This true was documented by Dickey (1971) on Viburnum suspensum, El-Naggar (2009) on Dianthus caryophyllus, Mazher *et al.* (2010) on chamomile, Khosa *et al.* (2011) on Gerbera jamesonii and Mohamadipoor *et al.* (2013) who found that EDDHA, nanoiron fertilizer and $FeSO_4$ teratments gave a similar improvement in the most growth traits of Spathiphyllum plant, but use of nanoiron fertilizer is the best as it reduces the harmful effects of the chemical fertilizers induced into the environment, in addition being of lower cost .

Several reports were also attained for other crops, such as those of Hassan *et al.* (2010) on "Hollywood" plum, Maeda *et al.* (2011) on pineapple, Sohrabi *et al.* (2012) on soybean, Sorrenti *et al.* (2012) on pear and Zhang *et al.* (2013) on ginseng .

However, the current work aims to detect the response of Goodluck plant to different levels of citreen (a micronutrients liquid fertilizer), either used alone or in combination with humic acid liquid organic fertilizer .

MATERIALS AND METHODS

Two pot experiments were carried out under the plastic house conditions (temperature, R.H. and light intensity inside the plastic house during the course of study were ranged between: 24.5-38.7^{0}C, 46.6-81.5% and 500-600 lux, respectively) at the Experimental Farm of Hort. Res. Inst., ARC, Giza, Egypt throughout the two consecutive seasons of 2010 and 2011 to study both the independent and combined effects of citreen micronutriets liquid fertilizer at various levels and humic acid on growth and chemical composition of Goodluck plant .

Therefore, one-year-old uniform transplants of Goodluck (Cordyline terminalis (L.) Kunth.) at 25$\pm$1 cm height, carry about 7-8 leaves were planted on March,20$^{th.}$ for the two seasons in 20-cm-diameter plastic pots (one transplant/pot) filled with about 2.5 kg of an equal mixture of sand, clay and peatmoss (1:1:1, by volume). The physical and chemical properties of the used sand and clay in the two seasons are shown in Table (a), while those of the used peatmoss are averaged in Table (b) .

After 10 days from planting (on April,1$^{st.}$), the transplants received the following fertilization treatments :

1- No fertilization (referred to as control) .
2- A commercial humic acid liquid organic fertilizer (10 N:10 P:10 K, 2.9% humic acid, 0.5% from each of Fe, Zn, Mn and Cu) was applied as foliar spray at the rate of 5ml/l till the solution was run-off .
3- Citreen (a commercial nutritive and growth activator liquid that contains 2% from each of Fe, Zn and Mn in chelated form,15% organic acids and 3% spreading agent) was also sprayed on the foliage at the rates of 1 , 3 and 5ml/l till the solution was run-off .
4- Each level of citreen was combined with humic acid at 5ml/l to create the following three combinations :

a- Citreen at 1ml/l + humic acid at 5ml/l .
b- Citreen at 3ml/l + humic acid at 5ml/l .
c- Citreen at 5ml/l + humic acid at 5ml/l .

Table (a): Some physical and chemical properties of the used sand and clay in both seasons.

Soil type	Particle size distribution (%)				S.P	E.C. (ds/m)	pH	Cations (meq/L)				Anions (meq/L)		
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
Sand	18.72	71.28	4.76	5.34	21.83	1.58	8.20	2.65	2.48	21.87	0.78	3.85	13.00	10.93
clay	7.46	16.75	34.53	40.89	41.76	2.18	8.33	16.93	9.33	20.44	0.37	3.82	1.46	41.79

Table (b): Some physical and chemical properties of the used peatmoss in both seasons.

Organic matter.....	90-95%	N	1.09%
Ash.....	5-10%	P	0.23 %
Density (vol. dry)	80-90mg/L.	K	1.77%
pH value.....	3.4	Fe	421 ppm
Water relation capacity...	60-75%	Mn	72 ppm
Salinity.....	0.3 g/l.	Zn	41 ppm

All previous treatments were applied every month during the growing season till the end of experiment on October, 30th ,while regular agricultural practices necessary for such plantation were done whenever needed . The layout of the experiments in the two seasons was a completely randomized design (Das and Giri, 1986) with 3 replicates , as each replicate contained 5 transplants .

At the end of each season , data were recorded as follows : plant height (cm) , number of leaves/plant , leaf area (cm^2) , stem diameter at the base (cm) , root length (cm) ,as well as leaves ,stem and roots fresh and dry weights (g) . In fresh leaf samples , photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) were determined according to the method of Saric *et al.* (1976) and anthocyanins content (mg/g f.w.) was also measured using the method described by Hisa *et al.* (1965), while in dry leaf samples , the percent of total carbohydrates (Herbert *et al.,* 1971) , as well as the contents of Fe, Zn and Mn as ppm (Jackson,1973) were evaluated .

Data were then tabulated and statistically analyzed according to SAS Institute program (1994) using Duncan's Multiple Range Test (Duncan, 1955) for elucidating the significancy between various treatments .

RESULTS AND DISCUSSION

Effect of fertilization treatments on:

1- Vegetative and root growth characteristics :

It can be seen from data presented in Tables (1 and 2) that all fertilization treatments applied in this study markedly improved all vegetative and root growth traits, expressed as plant height (cm), No. leaves/plant, leaf area (cm^2), stem diameter and root length (cm), as well as fresh and dry weights of leaves,stem and roots (g) . However, the dominance in both seasons was for the interaction between citreen and humic acid at 5 ml/l for each, as such combination increased the means of all previous parameters to the highest values comparing with control and other individual or interaction treatments, with few exceptions in the two seasons . Citreen alone at 1ml/l or combined with humic acid at 5 ml/l improved some characters giving means closely near to those of the previous dominant interaction with non-significant

differences among them in both seasons . That was also true for citreen at 3 ml/l alone or interacted with humic acid at 5 ml/l . The individual application of humic acid at 5 ml/l gave values of fresh and dry weights of roots in the 1st. season and of leaves dry weight in the 1st. and 2nd. ones equal to those of the dominant combination mentioned above .

Improvement vegetative and root growth due to fertilization treatments used in such trial may indicate the role of humic acid in improving nutrients retention in the growing medium and increasing the water holding capacity (Dorer and Peacock, 1997). Stevenson (1994) stated that humates constitute a stable fraction of carbon, thus regulating the carbon cycle and release of nutrients, including N, P and S. Humates improve pH buffering and thermal insulation . As for microelementes, Jakobseen and Dertili (1956) reported that ferrous is necessary for oxidation-reduction reactions, respiration, nitrate reduction, RNA and prolin metabolism . Zinc is essential for metabolism of carbohydrates,proteins, phosphates, RNA synthesis, trptophan (the precursor of IAA) and its role as a co-factor of several enzymes which act on phosphorylated substrates (Mohr and Schopter, 1995). The best defined function of Mn is participating in the photosynthetic reactions in which oxygen is proudued from water (Marschner, 1995). It regulates the level of auxin, respiration and N metabolism . Enzymes of the Kreb's cycle require Mn as an activator (Devlin, 1975). Manganese may be involved in the destruction or oxidation of IAA (Goldcare, 1961) .

Table (1): Effect of fertilization treatments on some vegetative and root growth parameters of *Cordyline terminalis* (L.) Kunth. plant during 2010 and 2011 seasons.

Fertilization treatments	Plant height (cm)	No. leaves/plant	Leaf area (cm^2)	Stem diameter (cm)	Root length (cm)
	First season: 2010				
Control	31.30d	12.36c	46.10e	0.50c	28.50f
Humic acid at 5ml/L (A)	34.16c	13.97b	65.80b	0.61b	32.73de
Citreen at 1ml/L (C1)	35.20bc	15.50a	67.00ab	0.70ab	37.00c
Citreen at 3ml/L (C3)	36.31b	14.76ab	66.48ab	0.73a	31.29e
Citreen at 5ml/L (C5)	34.37cb	13.65bc	65.40b	0.59bc	34.13d
C1+A	37.50ab	15.00a	63.80c	0.65b	43.80ab
C3+A	34.71cb	13.89b	55.21d	0.70ab	45.00a
C5+A	38.50a	15.50a	68.00a	0.75a	40.33b
	Second season: 2011				
Control	32.86d	13.25c	49.80e	0.56c	30.32d
Humic acid 5ml/L (A)	35.10c	14.85b	63.76c	0.73ab	33.79c
Citreen at 1ml/L (C1)	37.31bc	15.78ab	65.57b	0.79a	36.96b
Citreen at 3ml/L (C3)	38.20b	15.60ab	66.50ab	0.80a	33.08c
Citreen at 5ml/L (C5)	35.00c	14.53bc	65.79b	0.67b	36.10b
C1+A	38.33b	15.91a	64.18c	0.70b	41.82ba
C3+A	37.10bc	14.73b	58.30d	0.73ab	43.18a
C5+A	40.33a	16.40a	68.76a	0.83a	44.15a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

Table (2): Effect of fertilization treatments on leaves, stem and roots fresh and dry weights of *Cordyline terminalis* (L.) Kunth. plant during 2010 and 2011 seasons.

Fertilization treatments	Fresh weight (g)			Dry weight (g)		
	Leaves	Stem	Roots	Leaves	Stem	Roots
	First season: 2010					
Control	18.00d	3.70d	11.73c	4.19c	0.86c	5.28d
Humic acid at 5ml/L (A)	21.92c	4.08cd	20.45a	5.13a	0.91bc	10.36a
Citreen at 1ml/L (C1)	22.00bc	5.05c	21.10a	4.50b	1.00b	10.43a
Citreen at 3ml/L (C3)	22.14b	6.00ab	22.83a	4.60b	1.28ab	10.72a
Citreen at 5ml/L (C5)	20.84cd	5.31bc	17.23b	4.68ba	1.16ba	9.05b
C1+A	20.78cd	5.76b	19.15b	4.50b	0.98b	8.35bc
C3+A	24.11ab	5.64b	20.80a	4.81ab	1.26ab	7.39c
C5+A	25.04a	7.74a	21.33a	5.19a	1.37a	10.85a
	Second season: 2011					
Control	19.26d	3.88d	12.50c	4.39c	0.90c	5.65d
Humic acid 5ml/L (A)	22.51bc	4.35c	19.18b	5.48a	0.95bc	9.38b
Citreen at 1ml/L (C1)	22.73bc	5.40bc	21.00a	4.89b	1.03b	9.97ab
Citreen at 3ml/L (C3)	23.65b	6.43b	21.96a	4.93b	1.33a	9.50b
Citreen at 5ml/L (C5)	21.63c	5.68bc	18.41b	5.03ab	1.25ab	9.21b
C1+A	21.50c	6.21b	20.44ab	4.81b	1.05b	8.93c
C3+A	25.80ab	6.02b	22.26a	5.13ab	1.30a	9.10bc
C5+A	26.79a	8.24a	23.00a	5.57a	1.40a	11.17a

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.

The present results confirm with the findings of Evans and Li (2003) on Chatharanthus roseus , Pelargonium hortorum , Tagetes patula and Viola tricolor , El-Sayed and El-Shal (2008) on Schefflera , Ahmed *et al.* (2011) on Roselle and Mohamadipoor *et al.* (2013) on Spathiphyllum .

2- Chemical composition :

Data in Table (3) exhibit that combining between citreen at 1 ml/l and humic acid at 5 ml/l gave the highest content of chlorophylls a and b (mg/g f.w.), while citreen alone at 5 ml/l gave the highest content of carotenoids (0.694 mg/g f.w.), which followed by the combination of 5 ml/l citreen + 5ml/l humic acid (0.663 mg/g f.w.) . The best content of anthocyanin was obtained as a result of spray with either citreen + humic acid at 5 ml/l for each, which gave 0.331 (mg/g f.w.) or citreen alone at 1 ml/l that gave 0.315 (mg/g f.w.) . Humic acid alone at 5 ml/l also gave satisfactory results . This may be due to the role of humic acid in providing the plants with various nutrients necessary for synthesis of active constituents in plant organs . A correlation between chlorophyll content and the supplied iron level was noticed in green plants (Jakobseen and Dertili,1956),while Zn is essential for chlorophyll synthesis (Mohr and Schopter,1995) .

The percent of total carbohydrates was greatly increased in response to spraying with humic acid alone or with citreen at any

level (Table, 4) .Content of Fe and Zn (ppm) was higher when citreen applied at 5 ml/l level and also by the different interactions employed in this investigation. However, the highest values of Mn (ppm) were resulted from the individual application of humic acid at 5ml/l or joining between humic acid and citreen at 5 ml/l for each . In general, the highest content of the previous constituents was found ascribed to combining between citreen (5ml/l) and humic acid (5ml/l), with few exceptions when compared to control and other individual or combined treatments. In this regard, Mohr and Schopter (1995) claimed that Zn is necessary for metabolism of carbohydrates . Manganese is also participate in the photosynthetic reactions (Marschner, 1995) .

On the same line, were those gains reported by Aronaff (2006) on marigold, Abdel- Fattah *et al.* (2009) on Dracaena and Ruscus, Khosa *et al.* (2011) on gerbera, Sohrabi *et al.* (2012) on soybean and Zhang *et al.* (2013) on ginseng .

From the foregoing , it is concluded that combining between citreen and humic acid as monthly foliar spray at 5 ml/l for each is better way , from commercial point of view to get better performance and higher quality from cordyline as pot plant .

Table (3): Effect of fertilization treatments on some pigments content in the leaves of *Cordyline terminalis* (L.) Kunth. plant during 2011 season.

Fertilization treatments	Photosynthetic pigments (mg/g F.w.)			Anthocyanin (mg/g F.W.)
	Chlorophyll a	Chlorophyll b	Carotenoids	
Control	3.744	1.887	0.414	0.147
Humic acid at 5ml/L (A)	5.390	2.986	0.593	0.218
Citreen at 1ml/L (C1)	4.755	2.127	0.468	0.315
Citreen at 3ml/L (C3)	4.003	2.113	0.500	0.187
Citreen at 5ml/L (C5)	5.488	2.556	0.694	0.229
C1+A	6.399	3.128	0.573	0.182
C3+A	5.663	3.078	0.601	0.169
C5+A	6.991	3.679	0.663	0.331

Table (4): Effect of fertilization treatments on total carbohydrates and mineral content in the leaves of *Cordyline terminalis* (L.) Kunth. plant during 2011 season.

Fertilization treatments	Total carbohydrates (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)
Control	7.25	69.33	5.00	12.93
Humic acid at 5ml/L (A)	13.77	80.50	17.20	19.08
Citreen at 1ml/L (C1)	7.98	81.00	20.00	17.52
Citreen at 3ml/L (C3)	8.53	84.76	20.79	16.90
Citreen at 5ml/L (C5)	9.56	91.10	23.36	14.66
C1+A	14.50	92.08	25.00	15.45
C3+A	14.07	89.30	25.16	16.27
C5+A	16.14	98.73	30.33	20.11

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تأثير الرش الورقى بحمض الهيوميك والعناصر الصغرى المخلبية على نمو وجودة نبات الحظ السعيد (*Cordyline terminalis* (L.) Kunth.)

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[2] قسم بحوث الحدائق النباتية ، معهد بحوث البساتين ، مركز البحوث الزراعية ، الجيزة– مصر .

الملخص العربى

أجريت تجربة أصص بإحدى الصوبات البلاستيكية بالمزرعة التجريبية لمعهد بحوث البساتين ، الجيزة ، مصر خلال موسمى 2010 ، 2011 وذلك لإختبار تأثير الرش الورقى كل شهر إما بالسماد التجارى السائل لحمض الهيوميك (10 ن : 10 فو : 10 بو + عناصر صغرى) بتركيز 5 مل/ لتر أو السترين (مغذى ورقى سائل ومنشط للنمو يحتوى على 2 % من كلٍ من الحديد ، الزنك والمنجنيز فى صورة مخلبية + 15 % أحماض عضوية + 3 % مادة ناشرة) بتركيزات : 1 ، 3 أو 5 مل/لتر على نمو وجودة شتلات عمر سنة لنبات الحظ السعيد (*Cordyline terminalis* (L.) Kunth.) المنزرعة فى أصص بلاستيك قطرها 20 سم ومملؤة بحوالى

2,5 كجم من مخلوط الرمل + الطين + البيتموس (بنسبة 1 : 1 : 1 حجماً) . تم أيضاً دراسة تأثير التفاعل بين الرش بكل تركيز من الستيرين و حمض الهيوميك بتركيز 5 مل/لتر .

أوضحت النتائج المتحصل عليها ان جميع معاملات التسميد المستخدمة بهذه الدراسة أحدثت زيادة واضحة فى جميع قياسات النمو الخضرى والجذرى بكلا الموسمين ، وكذلك فى محتوى الأوراق من كلوروفيللى أ ، ب، الكاروتينويدات والأنثوسيانين . أيضاً زاد محتوى الأوراق من الكربوهيدرات الكلية ، الحديد ، الزنك والمنجنيز بفروق معنوية مختلفة عند مقارنتها بالكنترول . إلا أن السيادة فى معظم القياسات السابقة كانت للمعاملة المشتركة بين الستيرين وحمض الهيوميك بتركيز 5 مل/ لتر لكلٍ منهما ، حيث أعطت هذه المعاملة أعلى المتوسطات فى معظم الحالات بكلا الموسمين . ولقد أدى الرش بالستيرين بمعدل 1 أو 3 مل/لتر ، بمفردة أو مع حمض الهيوميك بمعدل 5 مل/لتر إلى تحسين بعض الصفات ، معطياً متوسطات قريبة جداً من متوسطات المعاملة المشتركة المتفوقة سالفة الذكر . أيضاً ، أدى الرش بحمض الهيوميك بمفردة بمعدل 5 مل/لتر إلى تحسين بعض الصفات ورفع قيم متوسطاتها إلى مستوى قريب جداً للمستوى الذى حققته المعاملة المشتركة المتفوقة و دون وجود أى فروق معنوية بينهما .

من هذه النتائج ، يمكن التوصية برش أوراق شتلات نبات الحظ السعيد (الكوردلين) عمر سنة بتوليفة من الستيرين وحمض الهيوميك بمعدل 5 مل/لتر لكل منهما ، كل شهر خلال موسم النمو للحصول على أفضل مظهر للنمو وأعلى جودة .