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RESPONSE OF THE SLOW-GROWING MISTLETOE FIG (*FICUS DELTOIDEA* JACK.) PLANT TO FERTILIZATION TREATMENTS AND GROWTH ACTIVATOR
1. THE LIQUID COMMERCIAL PRODUCT OF NITROPHENOLATES

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ABSTRACT: Two pot experiments were conducted under plastic house (temperature, R.H. and light intensity inside the plastic house during the course of study were ranged between: 24.5-38.7°C, 46.6-81.5% and 500-600 lux, respectively) at the nursery of Hort. Res. Int., ARC, Giza, Egypt during 2012 and 2013 seasons to study the effect of a liquid commercial product which contains 1g/l sodium 5-nitroguaiacolate + 2g/l sodium ortho-nitrophenolate + 3g/l sodium para-nitrophenolate when added individually or in combination, monthly for 5 repeats during the growing season, either as a foliar spray or as a soil drench at the rates of 0.25, 0.50 and 1.00 cm^3/l on growth performance and chemical composition of the slow-growing *Ficus deltoidea* Jack. foliage pot-plant.

The results of the experiments showed that all vegetative and root growth parameters were improved in response to the various treatments used in this work with the different significance levels relative to an untreated control in both seasons. Spraying the foliage with the low and medium levels gave, to some extent better results than the high level, while that was true for soil drench method when nitrophenolates were drenched at the low rate. Increasing level of nitrophenolates to 1.0 cm^3/l did not cause any additional improvement in growth, whereas combining between the two application methods clearly enhanced growth. So, the supremacy was for the combination of foliar spray and soil drench at 1.0 cm^3/l for each, as this combination gave the highest means in most cases of the two seasons. A similar trend was also attained concerning the leaf content of chlorophylls a and b, carotenoids , N, P, K, Fe, Zn and Mn, as these constituents were higher in the leaves of treated plants by the two methods of application at the high level for both (1.0 cm^3/l) than in the leaves of plants treated with other treatments.

Hence, it is recommended to apply the liquid commercial product of nitrophenolates to mistletoe fig plant, monthly for 5 times during the growing season, as a foliar spray and soil drench at the rate of 1.0 cm3/l for each to attain better growth performance and chemical composition.

Key word: Fertilization, nitrophenolates, ornamental plants, *Ficus deltoidea* Jack.

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INTRODUCTION

Among slowly grow ornamental plant may be mistletoe fig (*Ficus deltoidea* Jack.) that belongs to Fam. Moraceae. It is a largely glabrous shrub or small tree up to 7m height, characterized with its deltoid leaves (Huxley *et al*., 1992). When grow as a foliage pot-plant, its roots are restricted inside the small size of pot, and so it can not take its requirements of water and nutrients augmenting its slow growth rate and not reaching the suitable size for marketing except after a long period.

For decades plant growth activators have been used to improve the growth and yield of various crops. Among which, the commercial products called: chaperone, Asahi SL, Atonik, Lena tonik, ….etc., that contain some active ingredients, termed nitrophenolates, which are found naturally in plants and stimulate growth by altering the activity of specific antioxidant enzymes, such as superoxide dismutase (SOD), catalase (CAT) and peroxidase (POX) (Djanaguiraman *et al*., 2004). Several reports in the literature proved the role of these compound in enhancing growth and yield. In this regard, Gornik and Grzesik (2002) found that applying of Asahi SL, 3 times during flowering of China aster (*Callistephus chinensis*) at 0.2 or 0.4% brought about an increase in No. flowers/plant, seed yield, germination and metabolic activity without modifying vegetative growth. Using the chemical earlier, before flowering, had detrimental effect on flower yield and quality, although it stimulated vegetative growth. Xiao-yue (2008) indicated that spraying 7 repeats of 1.4% sodium ortho-nitrophenolate + sodium para-nitrophenolate + sodium5-nitroguaiacolate could significantly increase diameter, weight of simple fruit, yield of simple tree and fruit quality of *Camellia oleifera* compared with the control. Zhanga *et al*. (2010) postulated that sodium-nitrophenolate increased plant height, basal stem diameter, aboveground biomass, seed yield and harvest index of alfalfa plant (*Medicago sativa* L.).

Similar observations were also demonstrated by Sharma *et al*. (1990) on soybean, Jadhav *et al*. (1990) on pearl millet (*Pennisetum americanum*), Bynum *et al*. (2007), Gencsoylu (2009) and Singh *et al*. (2010) on cotton, Cai-lian *et al*. (2010) on soybean, and Ogorek *et al*. (2011) who pointed out that growth rate of *Fusarium spp.* was different in response to the different concentrations of Asahi SL biostimulator. The extent of the growth inhibition was directly proportional to the concentration of Asahi SL in culture medium.

The aim of the current experiment was to determine the effect of application method and level of sodium-nitrophenolate and its composition on growth and quality of mistletoe fig plant.

MATERIALS AND METHODS

Two pot experiments were consummated under plastic house at the nursery of Hort. Res. Inst., ARC, Giza, Egypt throughout 2012 and 2013 seasons to study the individual or combined effect of Na-nitrophenolate and its ingredients at various levels on growth and chemical composition of mistletoe fig as foliage pot-plant.

Therefore, uniform, six-months-old transplants of mistletoe fig (*Ficus deltoidea* Jack.) were planted on mid of March for both seasons in 20-cm-diameter plastic pots (one transplant/pot) filled with about 2.5kg of sand + clay + peatmoss mixture at equal volumes (1:1:1,v/v/v). The physical and chemical properties of the used sand and clay, as well as those of peatmoss are shown in Tables (a) and (b), respectively. During the course of this work, air temperature and R.H. inside the plastic house ranged between 22.5-37.5^{o}C and 50-75%, respectively. Irrigation and other agricultural practices necessary for such plantation were done whenever needed.

The pots were arranged in a completely randomized design (Mead *et al.*, 1993) with 3 replicates, where each replicate contained 5 pots.

Table a. Some physical and chemical properties of the used sand and clay during 2012 and 2013 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^{--}
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
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

Table b. Physical and chemical analysis of the used peatmoss in the two seasons.

Organic matter……	90-95%	**P**……..	0.23%
Ash……	5-10%	**K**……..…	1.77 %
Density (Vol. Dry) ……..	80-90 mg/l.	**Fe**……..…	421 ppm
pH value……...	3.4	**Mn**……..…	27 ppm
Water relation capacity...	60-75%	**Zn**……..…	41 ppm
Salinity…….....	0.3 g/l.		
N……...	1.09 %		

One month later (on April, 15th), the transplants received the different treatments as follows:

1. No. treatment, (control).
2. A liquid commercial product which contains 1g/l sodium 5-nitroguaiacolate ($NaC_7H_6NO_4$) + 2g/l sodium ortho-nitrophenolate ($NaC_6H_4NO_3$) + 3g/l sodium para-nitrophenolate ($NaC_6H_4NO_3$), manufactured by Lena Tarim Co., Ltd., Sokak No. 63 Ostim, Ankara, Turkey, was added monthly for 5 times during the active growing season, either as a foliar spray or as a soil drench at the rates of 0.25, 0.50 and 1.00 cm^3/l.
3. Three combined treatments were formed as follows:
   - Foliar spray + soil drench at 0.25 cm^3/l for each.
   - Foliar spray + soil drench at 0.50 cm^3/l for each.
   - Foliar spray + soil drench at 1.00 cm^3/l for each.

At the end of the experiment (on mid of October for each season), the following data were recorded: plant height (cm), number of leaves and branches/plant, root length (cm) and fresh and dry weights of leaves and roots (g). In fresh leaf samples taken from the middle part of the plants, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) were assessed according to the method of Saric *et al.* (1976), while in dry ones, the percentages of nitrogen (N), phosphorus (P) and potassium (K), as well as the content of ferrous (Fe), zinc (Zn) and manganese (Mn) (mg/100g d.w.) were measured using the methods described by A.O.A.C. (1995).

Data were then tabulated and subjected to analysis of variance using SAS program (1994) and Duncan's Multiple Range Test (Duncan, 1955) was used to compare among means of the different treatments.

RESULTS AND DISCUSSION

Effect of nitrophenolate and its composition on:

1- Vegetative and root growth traits:

It is clear from data averaged in Tables (1 and 2) that means of all vegetative and root growth parameters were improved in response to the various treatments used in this study with different significant levels when compared to those of control in the two seasons.

Table 1. Effect of application method and level of plant growth regulator on some vegetative growth traits of *Ficus deltoidea* Jack. plant during 2012 and 2013 seasons.

Application method and level (cm^3/l)	Plant height (cm)		No. leaves/plant		No. branches/plant		Root length (cm)	
	2012	2013	2012	2013	2012	2013	2012	2013
Control	27.67c	27.00d	15.69f	16.27f	2.33d	2.00d	22.00e	23.10e
Foliar spray at 0.25 (A)	27.76c	27.36cd	22.33d	22.30d	3.67c	3.33cd	43.20b	43.21bc
Foliar spray at 0.50 (B)	30.70ba	30.90ba	27.31c	27.38c	4.00c	4.00c	38.33c	37.80c
Foliar spray at 1.00 (C)	28.68bc	28.00c	26.00c	27.00c	4.70b	4.76bc	30.10d	28.33de
Soil drench at 0.25 (D)	30.33b	30.56ba	23.00d	23.76d	4.00c	4.33cb	28.00de	28.35de
Soil drench at 0.50 (E)	28.67bc	28.76bc	16.90f	16.30f	4.00c	4.00c	31.00d	30.67d
Soil drench at 1.00 (F)	26.30d	26.68d	19.30e	19.71e	4.68b	4.33cb	24.26e	24.33e
A+D	30.33b	29.67b	41.70a	40.68a	7.31a	7.33a	45.80b	46.67b
B+E	31.70ab	31.50ab	39.33a	39.72a	4.67b	5.00b	37.69c	38.00c
C+F	32.31a	32.35a	33.50b	32.46b	5.73ab	5.75ab	58.30a	56.71a

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

Table 2. Effect of application method and level of plant growth regulator on fresh and dry weight of leaves and roots of *Ficus deltoidea* Jack. plant during 2012 and 2013 seasons.

Application method and level (cm^3/l)	Fresh weight (g)				Dry weight (g)			
	Leaves		Roots		Leaves		Roots	
	2012	2013	2012	2013	2012	2013	2012	2013
Control	15.10e	15.56e	5.80f	6.21ef	8.20f	8.24e	1.63c	1.69c
Foliar spray at 0.25 (A)	25.50b	25.60b	11.76d	13.70c	12.93c	13.00c	2.17b	2.20bc
Foliar spray at 0.50 (B)	22.71c	22.83c	12.15d	11.89d	15.00b	15.50b	2.60b	2.91b
Foliar spray at 1.00 (C)	18.49d	18.50d	8.36e	6.55e	9.81e	10.81d	1.45c	1.33c
Soil drench at 0.25 (D)	25.20b	25.30b	6.30f	6.89e	11.20d	10.90d	2.60b	2.67b
Soil drench at 0.50 (E)	21.60cd	21.90c	6.50f	6.60e	11.80d	11.10cd	1.42c	1.60c
Soil drench at 1.00 (F)	17.92d	18.87d	5.21f	5.20f	9.10e	9.50d	1.30c	1.30c
A+D	32.10a	32.00a	19.60b	19.50a	17.50ab	15.78b	6.41a	5.27a
B+E	29.63ab	29.90ab	16.24c	16.40b	15.11b	14.88bc	6.60a	5.94a
C+F	31.60a	31.80a	22.90a	19.97a	20.40a	19.82a	5.95a	5.33a

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

Spraying the foliage at the low and medium levels (0.25 and 0.50 cm^3/l, consecutively) gave, to some extent better results than the high level (1.00 cm^3/l) with few exceptions, while that was true for soil drenching method when Na- nitrophenolate was drenched at the low rate (0.25cm^3/l) that gave higher means in most cases of both seasons comparing with the medium and high rates. Combining between the two methods of application caused an additional improvement in growth of plants, with the superiority of foliar spray + soil drench combined treatment at 1.00 cm^3/l for each, which recorded the utmost high averages in most instances of the two seasons. This may

be reasonable because of plants absorption of greater amount of Na- nitrophenolates solution by both leaves and roots.

Furthermore, the active ingredients of nitrophenolates stimulated plant growth by altering the activitiy of specific antioxidant enzymes, such as superoxide dismutase, catalase and peroxidase (Djanaguiraman *et al.*, 2004). These antioxidant enzymes are involved in the scavenging of reactive oxygen species (ROS), such as hydrogen peroxide (H_2O_2), hydroxyl (OH^-) and singlet oxygen (O^-_2) (Shanker *et al.*,2004). The ROS are able to attack polysaccharides, proteins and nucleic acids (Matysik *et al.*, 2002). Oxidative stress can occur when more ROS are produced than are metabolized (Dhindsa *et al*., 1981), so the ability to ameliorate or lessen the impact of ROS on the physiology and subsequent growth and yield of the crop species by nitrophenolates is a desirable target. Besides, Djanaguiraman *et al.* (2004) noted the nitrophenolates under many trade names were registered for pesticide use in cotton (*Gossypium hirsutum*), rice (*Oryza sativa*) and soybean (*Glycine max*) and as a protein transport enhancer in cotton.

The previous findings are in well accordance with those of Gornik and Grzesik (2002) on China aster, Xiao-yue (2008) on *Camellia oleifera*, Jadhav *et al*. (1990) on Pearl millet, Singh *et al.* (2010) on cotton and Zhanga *et al.* (2010) on alfalfa.

2- Chemical composition:

As shown in Table (3), it can be summarized that leaf content of chlorophyll a, b and carotenoids (mg/g f.w.), the percentages of N, P and K, as well as Fe, Zn and Mn (mg/100g d.w.) were increased as a result of spraying the foliage or drenching the soil with Na-nitrophenolates at the different levels, with the dominance of combining between spray and drench methods treatment at the high concentration for each, followed by foliar spray treatment at 0.50 cm^3/l that gave higher content of chlorophyll a, b and K%, as well as closely near content of carotenoids, Fe and Mn relative to the dominant combined treatment mentioned above. Foliar spray at 0.25 cm^3/l and soil drench at either 0.25 or 0.50 cm^3/l treatments gave higher content of some constituents near to those of the superior combination.

Table 3. Effect of application method and level of plant growth regulator on some active constituents in the leaves of *Ficus deltoidea* Jack. plant during 2012 and 2013 seasons.

Application method and level (cm^3/l)	Pigment content (mg/g f.w.)			N (%)	P (%)	K (%)	Fe (mg/100g d.w.)	Zn (mg/100g d.w.)	Mn (mg/100g d.w.)
	Ch. a	Ch. b	Carot.						
Control	0.93	0.81	0.67	1.12	0.22	1.34	2.20	0.05	11.05
Foliar spray at 0.25 (A)	1.62	0.93	0.82	1.70	0.24	1.70	2.46	0.07	13.13
Foliar spray at 0.50 (B)	3.74	1.64	1.41	1.70	0.25	1.81	2.79	0.09	19.20
Foliar spray at 1.00 (C)	1.24	1.02	1.00	1.98	0.28	1.55	2.24	0.06	14.24
Soil drench at 0.25 (D)	2.89	1.97	0.83	1.84	0.38	1.49	2.28	0.07	12.11
Soil drench at 0.50 (E)	1.68	1.05	0.98	1.70	0.28	1.72	2.83	0.09	13.06
Soil drench at 1.00 (F)	1.31	1.00	0.98	1.56	0.23	1.58	2.54	0.07	11.10
A+D	2.32	2.17	1.65	1.70	0.29	1.58	2.70	0.09	14.00
B+E	1.53	1.45	1.39	1.84	0.36	1.64	2.81	0.09	14.07
C+F	2.48	2.05	1.69	1.90	0.39	1.72	3.19	0.17	19.33

This may indicate the role of nitrophenolates in increasing assimilating capacity, cell juice activity and absorbing more water and minerals. Djanaguiraman *et al.* (2004) mentioned that nitrophenolates act as a protein transport enhancer in cotton.

Analogous observations were also obtained by Sharma *et al.* (1990) on soybean, Bynum *et al.* (2007) and Gencsoylu (2009) on cotton and Cai-lian *et al.*(2010) on soybean.

According to the previous results, it can be advised to apply nitrophenolate commercial product to mistletoe fig plant, monthly for 5 repeats as a foliar spray and soil drench at the rate of 1.00 cm^3/l for each method to get better growth performance.

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استجابة نبات الفيكس دلتا بطئ النمو للمعاملة بالتسميد ومنشط النمو
١- المنتج التجاري السائل للنيتروفينولات

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أجريت تجربتا أصص بإحدى الصوبات البلاستيكية بمشتل معهد بحوث البساتين، مركز البحوث الزراعية ، الجيزة، مصر خلال موسمي ٢٠١٢ ، ٢٠١٣ وذلك لدراسة تأثير المنتج التجاري السائل المحتوى على : ١جم/لتر من صوديوم ٥- نيتروشينكولات + ٢جم/لتر من صوديوم أورثو-نيتروفينولات + ٣ جم/لتر من صوديوم بارا- نيتروفينولات، عند إضافته منفرداً أو في توليفة، شهرياً ولخمسة مرات خلال موسم النمو، إما رشاً على الأوراق أو إضافة للتربة بتركيزات: ٠,٢٥ ، ٠,٥٠ ، ١,٠ سم^{٣}/لتر على النمو والتركيب الكيميائي لنبات الفيكس دلتا بطئ النمو.

ولقد أوضحت النتائج المتحصل عليها أن جميع قياسات النمو الخضري قد تحسنت استجابة للمعاملات المختلفة المستخدمة بهذه الدراسة بمستويات معنوية مختلفة عند مقارنتها بالكنترول في كلا الموسمين. أعطت معاملتا رش الأوراق بالمستويات المنخفضة والمتوسطة من المركب التجاري السابق نتائج أفضل نسبياً من معاملة الرش بالمستوى المرتفع، بينما تحقق ذلك بالنسبة لطريقة الإضافة الأرضية عندما أضيفت النيتروفينولات بالمستوى المنخفض.

أوضحت النتائج أيضاً أن زيادة تركيز النيتروفينولات حتى ١ سم^{٣} /لتر لم تحدث تحسناً إضافياً في النمو الخضري والجذري بصرف النظر عن طريقة الإضافة، بينما عززت الإضافة بالرش على الأوراق مع الإضافة الأرضية معدل النمو بشكل واضح. لذلك، كانت الأفضلية في كلا الموسمين للمعاملة المشتركة بين الرش الورقي و الإضافة الأرضية بمعدل ١ سم^{٣} /لتر لكل منهما والتي أعطت أعلى القيم لمتوسطات النمو في معظم القياسات. ولقد تم الحصول على إتجاه مشابه فيما يتعلق بمحتوى الأوراق من كلوروفيللى أ، ب، الكاروتينويدات، وعناصر النيتروجين، الفوسفور، البوتاسيوم، الحديد، الزنك و

المنجنيز، حيث كانت هذه المكونات أعلى في أوراق النباتات التي عوملت بالرش الورقي مع الإضافة الأرضية (بمعدل ١ سم^{٣}/لتر لكلا الطريقتين) منه في أوراق النباتات التي عوملت بالمعاملات الأخرى.

من هذه النتائج ، يمكن التوصية بإضافة المنتج التجاري السائل للنيتروفينولات إلى نبات الفيكس دلتا الورقي، بطئ النمو، شهرياً ولخمسة مرات خلال موسم النمو، رشاً على الأوراق مع الإضافة الأرضية بمعدل١ سم^{٣}/لتر لكلا الطريقتين للحصول على أفضل مظهر للنمو وللمحتوى الكيماوي للنبات.