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RESPONSE OF *EUONYMUS JAPONICUS* THUNB CV. "AUREUS" PLANT TO SOME FERTILIZATION TREATMENTS, GIBBERELLIC ACID AND THEIR INTERACTIONS

Azza M. Abdel-Moniem[(1)], Amal S. El-Fouly[(1)] and S. M. Shahin[(2)]

(1) Ornamental plants and Landscape Gardening Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt.

(2) Botanic Gars. Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt.

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ABSTRACT: *A set of pot experiments was conducted under plastic house at the nursery of Hort. Res. Inst., Giza, Egypt during 2012 and 2013 seasons to study the effect of two commercial liquid fertilizers (Inka that contains 6% CaO + 1% Zn and Klover Cal-Bor that contains 9% CaO + 1% B + 5% N) at the rates of 0, 2 and 3ml/l for each, gibberellic acid (GA_3) at 0, 100, 200, 300 and 400 ppm and their interactions on growth and chemical composition of spindle tree (Euonymus japonicus Thunb cv. Aureus) plants grown in 15cm-diameter plastic pots filled with about 1.5kg of sand and clay mixture (1:1, v/v) when applied as foliar spray, five times with one month interval. Control plants were sprayed with tap water.*

The results showed that all vegetative and root growth parameters were markedly improved as a result of applying either of fertilization or GA_3 treatments at various rates, with the prevalence of the individual application of either Inka liquid fertilizer at 2ml/l or GA_3 at 300ppm, as these two individual treatments gave higher means with significant differences when compared to control means in most cases of both seasons. Spraying with either Klover at 2ml/l or GA_3 at 200ppm improved some growth traits, but less than the two individual above mentioned treatments. Combining between fertilization and GA_3 induced an additional improvement in most vegetative and root growth parameters with the dominance of 2ml/l Inka + 300ppm GA_3 combined treatment which recorded the utmost high values, not only over control, but also over other individual and combined treatments. Furthermore, combining between either GA_3 at 300ppm and Klover at 2ml/l or GA_3 at 400pm and Inka at 2ml/l increased the means of some growth traits, whereas raising rate of the two types of fertilizers used to either 3ml/l or GA_3 to 400ppm did not induce any more rising in the rate of growth, whether it was applied alone or in combination. Results of the active constituents in the leaves exhibited a great variation in their response to the different treatments employed in this study. However, the excellence was also for the treatment of 2ml/l Inka + 300ppm GA_3 combination that registered the highest records of most chemical constituents compared to other combinations.

Accordingly, it can be advised to spray the foliage of spindle tree plant with Inka liquid fertilizer at 2ml/l + GA_3 at 300ppm combination for the best growth performance of such foliage-pot-plant from the commercial point of view.

Key words : *Euonymus, Fertilization, Gibberellic acid .*

INTRODUCTION

The commercial value of some pot plants depends mainly on the beauty of their leaves, among of these may be spindle tree, *Euonymus japonicus* Thunb cv. Aureus (Fam. Celasteraceae). It is an evergreen shrub or small tree, native to South Japan; leaves with large-golden-yellow blotch in center make it as one of the most beautiful foliage-pot-plants; due to its compact growth and dense leaves, it may be used for limitation (Bailey, 1976).

Until now, fertilization is still as the best way to improve growth and quality of various plants, especially for pot plants that their roots are restricted inside the pot through all their life period. This was affirmed by Fenn and Taylor (1991) who stated that ornamental foliage plants show significant growth increases by increasing Ca : NH_4 ratio, as Ca stimulated ammonium (NH_4)

absorption by plants. Khenizy *et al* (2009) noticed that spikes of *Moluccella laevis* pulsed in a solutions containing 30mM/l of chelated Ca^{+2} increased water uptake, flower weight and its vase life, while decreased weight loss during storage period, curvature, degradation of chlorophylls a and b as well as cartoenoids content. This indicates that Ca^{+2} may play a vital role in gravitropism-related processes of cut flower stalks, so inhibited the gravitropic bending of moluccella cut flower stalks. On *Gerbera jamesonii*, Khosa *et al.* (2011) elicited that fertilizer solution containing 1, 1.5 and 2g of N, K and P, as well as 5000, 4000 and 5000ppm of Zn, B, Fe and Mn, respectively significantly increased plant height, number of shoots and leaves / plant, shoots length, leaf area, stock length, shrtened days to 1st flower emergence and flower diameter and quality. Content of N, P, K, Zn, B, Fe and Mn in the leaves and roots were also increased. Similar observations were also revealed by Ying-Chang *et al.* (2009) on blueberry, Xuefei *et al.* (2010) on *Prunus persica* and Narimani *et al.* (2010) on wheat.

Regarding the effect of gibberellic acid (GA_3) on growth and composition of plants, El-Salami and Makary (1997) noticed that treatment of *Cupressus sempervirens* seedlings with GA_3 at 200ppm concentration increased plant height, No. branches and fresh and dry weights of aerial parts and roots. Likely, Abdel-Wahid (1999) pointed out that GA_3 at the rate of 500ppm increased plant height, branch number and leaf area of *Ficus benjamina* plant. Auda *et al.* (2002) postulated that soaking tuberose bulbs before planting in 200ppm of GA_3 solution resulted the best vegetative growth and flowering. On the same line, were those results of Saadawy *et al* (2003) on *Rosa hybrida* cv. Mercedes, Agina *et al.* (2005) on *Bougainvillea glabra*, *Cordyline terminalis*, *Ficus microcarpa* Hawaii and *Jasminum sambac*, Ahmed *et al.* (2005) and El-Sayed *et al.* (2007) on *Peperomia obtusifolia*, as well as Ibrahim *et al.* (2010) who declared that foliar application of GA_3 at 100, 150 and 200ppm improved plant height, number of branches and leaves / plant, root length, leaf area and fresh and dry weights of stems, leaves and roots of croton plants. Chlorophylls a and b, carotenoids, total soluble sugars, total indoles, total phenols and N, P and K were also increased.

Combining between fertilizer and bioregulator additionally improved growth and quality of plants. This was true and demonstrated by Gomaa (2003) on *Dahlia pinnata*, El-Quesni *et al.* (2010) on *Syngonium podophyllum* and Hassan *et al* (2010) who found that foliar spray of "Hollywood" plum trees with aminofert (20% amino acids + 12% organic acids + 3.6% chelated micro-elements) at 0.25% + GA_3 at 20ppm was more effective on growth and chemical composition than individual treatments.

This work was set out in order to investigate the effect of some commercial liquid fertilizers, alone or combining with gibberellic acid on growth performance and chemical composition of spindle tree as a pot plant.

MATERIALS AND METHODS

Two independent pot experiments were established 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 ^{0}C, 46.6-81.5% and 500-600 lux, respectively) at the nursery of Hort Res. Inst., ARC, Giza, Egypt during the two consecutive seasons of 2012 and 2013 to examine the effect of both chemical fertilization and gibberellic acid, each alone or in combination on growth and quality of *Euonymus japonicus* (L.) A. Dietr. cv. Aureus plants.

Therefore, six-months-old transplants of the studied plant at about 15cm height, carries about 28 leaves were planted on April, 1st for the two seasons in 15-cm-diameter pots (one transplant/ pot) filled with about 1.5kg of an equal mixture of sand and clay (1:1, v/v). The physical and chemical analyses of the used sand and clay were determined and illustrated in Table (a).

Table (a): Physical and chemical analysis of the used soils in the two 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

One month later (on May, 1st), the plants received the following treatments as a foliar spray, 5 times with one month interval till the solution was run-off:

1- Control(without fertilization or GA_3 application) .
2- Two commercial liquid fertilizers, Inka,which contains 6% CaO + 1% Zn and Klover Cal-Bor that contains 9% CaO + 1% B + 5% N, manufactured by CAM Ferti Co. Spain at the rates of 0, 2 and 3ml/l water for each.
3- Gibberellic acid in the form of Berelex tablets, manufactured by ICI Co., England, as each tablet contains 1g of gibberellin (92% GA_3) at the rates of 0,100, 200, 300 and 400ppm.
4- The different rates of the two liquid fertilizers and gibberallic acid were factorially combined to form 25 combined treatments.

A factorial complete randomized design (Mead *et al*., 1993) was used in the two seasons, with 3 replicates as each replicate consisted of 5 plants. All plants under various treatments received the usual agricultural practices suitable for such plantation whenever needed. At the end of each season (on October, 1st), data were recorded as follows: plant height (cm), number of branches and leaves/ plants, leaf area (cm^2), the final root length (cm), number of rootlets/plant and fresh and dry weights of vegetative parts and roots (g). Besides, photosynthetic pigments (chlorophyll a, b and cartenoids) were determined as mg/g f.w. according to the method of Moran (1982) in fresh leaf samples taken from the middle part of the plants in the 2nd season only. Meanwhile, in dried samples, were measured the percentages of nitrogen using micro-kjeldahle method described by Pregle (1945), phosphorus colorimetrically as explained by Cottenie *et al.* (1982), potassium, calcium and zinc (Jackson, 1973) .

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

RESULTS AND DISCUSSION

Effect of fertilization treatments, gibberellic acid and their interactions on:

A. Vegetative and root growth parameters:

From data presented in Tables (1, 2 and 3), it can be concluded that all vegetative and root growth characters; expressed as plant height (cm), No. branches and leaves / plant, leaf area (cm^2), root length (cm), No. rootlets/ plant, as well as fresh and dry weights of vegetative growth and roots (g) were markedly improved with various significant levels as a result of applying either fertilization or GA_3 treatments at the different rates. However, the superiority was for either Inka fertilization treatment at 2ml/l or GA_3 at 300ppm, as these two individual treatments gave the highest means in most cases of both seasons relative to control. Spraying either Klover at 2ml/l or GA_3 at 200ppm occupied the second rank in improving the previously mentioned parameters giving means closely near to those of the corresponding Inka at 2ml/l and

Table 1

Table 2

Table (3): Effect of fertilization treatments, gibberellic acid and their interactions on vegetative parts and roots fresh and dry weights of *Euonymus japonicus* Thunb cv. Aureus plant during 2012 and 2013 seasons.

GA_3 treatments (ppm) / Fertilization treatments (ml/l)	Vegetative parts fresh weight (g)						Roots fresh weight (g)					
	GA_3 at 0.0	GA_3 at 100	GA_3 at 200	GA_3 at 300	GA_3 at 400	Mean	GA_3 at 0.0	GA_3 at 100	GA_3 at 200	GA_3 at 300	GA_3 at 400	Mean
	First season : 2012											
Control	10.29g	15.30de	16.20d	17.20c	12.25f	14.25d	2.63g	3.29fg	4.56ef	4.75ef	3.92f	3.83d
Inka at 2	19.25b	19.75b	18.60bc	24.54a	18.63bc	20.16a	11.18ab	8.70c	9.93bc	12.92a	10.50b	10.65a
Inka at 3	15.31de	16.28d	17.28c	18.76bc	17.23c	16.97b	5.76de	4.74ef	5.98de	8.10c	6.45d	6.21c
Klover at 2	14.04e	18.37cb	18.05c	19.85b	17.50c	17.56b	8.22c	6.21d	9.13cb	10.47b	9.03c	8.61b
Klover at 3	10.59g	16.10d	16.91cd	16.20d	16.35dc	15.23c	3.47f	4.33fe	5.00e	6.39d	6.00de	5.04cd
Mean	13.90c	17.16b	17.41b	19.31a	16.39b		6.25cb	5.46c	6.92b	8.53a	7.18b	
	Second season : 2013											
Control	11.23g	13.32fg	14.10f	15.81de	13.74f	13.64c	3.87g	3.99fg	4.39f	5.13ef	4.00fg	4.28c
Inka at 2	17.50c	19.08b	19.33b	21.87a	18.50bc	19.26a	7.25cd	8.78b	9.80ab	10.79a	8.66b	9.06a
Inka at 3	14.76ef	16.13d	17.00c	19.33b	17.01c	16.85b	5.50e	5.57e	7.00d	8.46bc	6.50de	6.61b
Klover at 2	16.10d	17.58c	18.13cb	20.10ab	17.42c	17.87b	6.93d	7.21cd	8.79b	9.26b	8.00c	8.04ab
Klover at 3	11.56g	14.50ef	15.00e	16.36dc	16.11d	14.71c	3.96fg	4.50f	5.33ef	6.51de	5.97e	5.26cb
Mean	14.23c	16.12bc	16.71b	18.70a	16.56b		5.50c	6.01bc	7.06ab	8.03a	6.63b	
	Vegetative parts dry weight (g)						Roots dry weight (g)					
	First season: 2012											
Control	2.23f	5.34cd	5.41c	5.29cd	4.13de	4.48c	1.28f	2.27ef	2.17fe	2.60de	2.30e	2.13d
Inka at 2	6.34cb	7.58ab	6.50bc	8.15a	6.54bc	7.02a	6.24b	5.40bc	6.88b	8.06a	4.99cb	6.32a
Inka at 3	3.56e	7.00b	5.86c	6.50bc	4.47d	5.48b	2.43e	3.11d	3.35dc	5.32cb	4.15c	3.67c
Klover at 2	2.99fe	6.10cb	6.37cb	6.67bc	5.58c	5.54b	3.78cd	4.00c	5.50bc	7.18ab	4.05c	4.90b
Klover at 3	3.17ef	5.51c	5.68c	5.73c	4.65d	4.95bc	2.26ef	2.83d	2.41e	3.34dc	3.96cd	2.96cd
Mean	3.66c	6.31a	5.97ab	6.47a	5.08b		3.20c	3.52bc	4.06b	5.30a	3.89b	
	Second season: 2013											
Control	2.44e	4.12dc	4.50c	4.89c	3.78d	3.95c	1.59f	2.30e	2.21e	2.70de	2.18ef	2.20c
Inka at 2	5.76b	7.31a	6.99ab	7.58a	6.00b	6.73a	3.87c	5.00b	5.94ab	7.10a	4.27cb	5.24a
Inka at 3	3.45d	5.58bc	5.50bc	6.63ba	5.11cb	5.26b	2.40ed	3.03cd	4.08cb	4.89b	4.00cb	3.68b
Klover at 2	3.43d	5.73b	6.86ab	6.92ab	5.77b	5.74ab	3.21cd	4.45bc	5.06b	6.62a	4.76b	4.82ab
Klover at 3	3.46d	5.00c	5.28cb	5.80b	4.25cd	4.76bc	2.30e	2.87d	2.90d	3.31c	3.00d	2.88cb
Mean	3.71d	5.55ab	5.83ab	6.37a	4.98c		2.68c	3.53b	4.04ab	4.93a	3.64b	

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

GA_3 at 300ppm, respectively. This may indicate the role of both chemical fertilizers in supplying plants with more nutrients necessary for more metabolities and healthier growth, and the role of GA_3, as a growth regulator in inducing cell enlargement and promoting internal biosynthesis. In this regard, Singh *et al.* (1994) stated that GA_3 may cause cell elongation by the induction of enzymes that weaken the cell walls. Macleod and Millar (1962) explained the mechanism by which GA_3 can stimulate cell elongation by the hydrolysis of starch resulting from the production of GA_3 which activate amylase that my increase concentration of sugars, thus increasing the osmotic pressure in the cell sap which allows , water interance to the cell and tends to stretch it.

Also, combining between fertilization and GA_3 treatments greatly improved all vegetative and root growth traits, with the mastery of 2ml/l Inka + 300ppm GA_3 combined treatment, which recorded the utmost high averages over control and all other individual or combined treatments in most cases of the two seasons. Moreover, combining between either GA_3 at 300ppm and Klover at 2ml/l or GA_3 at 400ppm and Inka at 2ml/l increased the means of some traits to the rank of superior treatment with non-significant differences among them selves. This may be attributed to lumping the benefits of both fertilizer, as a source of nutrients and GA_3, as a growth regulator activating plant growth. Raising concentration of either any of the used fertilizers to 3ml/l or GA_3 to 400pm did not cause any more improvement in vegetative and root growth parameters, whether sprayed alone or in combination.

The aforementioned results are in parallel with those detected by Fenn and Taylor (1991) on some ornamental foliage plants, Abdel-Wahid (1999) on *Ficus benjamina*, Ahmed *et al.* (2005) on *Peperomia obtusifolia*, Ibrahim *et al.* (2010) on croton and Khosa *et al.* (2011) on *Gerbera jamesonii.*

B. Chemical composition:

As shown in Table (4), data of chemical constituents in the leaves exhibited a great variation in their response to the different treatments employed in such trial, as the content of chlorophyll a, b and carotenoids mg/g f.w., as well as the percentages of K, Ca and Zn were pronouncedly increased to reach the maximum by the individual application of either Inka at 2m/l that was followed by either Klover at 2ml/l or GA_3 at 300ppm, whereas N% was remarkably increased by either Klover at 3ml/l which was followed by the same fertilizer at the low level (2ml/l) or GA_3 at 300ppm level. Calcium % was not affected by GA_3 treatments, while the opposite was true regarding P%, as it was decreased in the leaves of plants treated with the different rates of the two fertilizers, but greatly increased by GA_3 application at either 200 or 300ppm concentrations.

Increasing the content of some active constituents in plant tissues by fertilizers would be reasonable, as fertilizers of any type usually provide the plants with nutrients in available forms, while GA_3 has the capability of modifying the growth pattern of treated plants by affecting the DNA and RNA levels, cell division and expansion, biosynthesis of enzymes, protein, carbohydrates and photosynthetic pigments (Leopold and Kriedmann, 1975).

The excellence, however resulted from the combination of Inka at 2ml/l and GA_3 at 300ppm, which recorded the highest values for the most constituents mentioned above. Other combinations, on the other hand caused a limited increment compared to the excellent one with few exceptions. This may explain the synergistic effect of both Inka liquid fertilizer and GA_3 to lump their beneficial effects for increasing the active constituents in tissues of the treated plants.

Table (4): Effect of fertilization treatments, gibberellic acid and their interactions on chemical composition of *Euonymus japonicus* Thunb cv. Aureus leaves during 2013 season.

GA$_3$ treatments (ppm) / Fertilization treatments (ml/l)	GA$_3$ at 0.0	GA$_3$ at 100	GA$_3$ at 200	GA$_3$ at 300	GA$_3$ at 400	Mean	GA$_3$ at 0.0	GA$_3$ at 100	GA$_3$ at 200	GA$_3$ at 300	GA$_3$ at 400	Mean
	Chlorophyll a (mg/g f.w.)						Chlorophyll b (mg/g f.w.)					
Control	0.981	.820	0.878	1.012	0.680	0.874	0.220	0.423	0.418	0.623	0.247	0.366
Inka at 2	1.890	1.028	1.372	1.901	1.751	1.589	0.574	1.193	0.672	1.102	0.837	0.876
Inka at 3	1.422	0.894	1.192	1.449	1.211	1.233	0.509	0.696	0.576	0.793	0.756	0.666
Klover at 2	1.450	1.549	1.257	1.746	1.661	1.533	0.616	0.698	0.873	0.855	0.804	0.769
Klover at 3	1.289	1.202	0.900	1.334	1.211	1.187	0.493	0.647	0.467	0.509	0.433	0.510
Mean	1.407	1.099	1.120	1.588	1.303		0.483	0.731	0.601	0.777	0.415	
	Carotenoids (mg/g f.w.)						N (%)					
Control	0.195	0.357	0.552	0.673	0.407	0.437	0.70	0.98	0.98	1.12	0.84	0.93
Inka at 2	1.005	0.887	0.712	1.662	1.413	1.136	1.56	1.70	1.42	1.70	1.70	1.62
Inka at 3	0.643	0.567	0.703	0.978	0.768	0.732	1.56	1.70	1.70	1.70	1.53	1.64
Klover at 2	0.630	0.685	0.719	1.228	0.938	0.840	1.70	1.84	1.84	1.98	1.70	1.81
Klover at 3	0.253	0.493	0.597	1.068	0.686	0.619	1.84	1.84	1.98	1.98	1.84	1.90
Mean	0.545	0.598	0.657	1.122	0.842		1.47	1.61	1.59	1.70	1.52	
	P (%)						K (%)					
Control	0.11	0.12	0.21	0.18	0.12	0.15	1.21	1.44	1.35	1.55	1.41	1.39
Inka at 2	0.03	0.09	0.14	0.13	0.06	0.09	1.41	1.65	1.75	1.95	1.75	1.70
Inka at 3	0.02	0.05	0.12	0.13	0.05	0.08	1.41	1.38	1.41	1.64	1.28	1.43
Klover at 2	0.02	0.09	0.13	0.14	0.08	0.09	1.50	1.47	1.64	1.87	1.73	1.64
Klover at 3	0.02	0.03	0.12	0.11	0.03	0.06	1.38	1.35	1.38	1.24	1.23	1.32
Mean	0.04	0.08	0.15	0.14	0.07		1.38	1.46	1.51	1.65	1.48	
	Ca (%)						Zn (%)					
Control	1.27	1.27	1.55	1.35	1.32	1.35	0.011	0.013	0.015	0.015	0.011	0.013
Inka at 2	1.47	1.35	1.75	1.75	1.58	1.58	0.015	0.015	0.019	0.020	0.016	0.017
Inka at 3	1.41	1.32	1.32	1.47	1.47	1.40	0.013	0.015	0.016	0.016	0.015	0.015
Klover at 2	1.50	1.38	1.48	1.52	1.50	1.48	0.014	0.013	0.018	0.018	0.015	0.016
Klover at 3	1.41	1.32	1.35	1.40	1.44	1.39	0.012	0.013	0.013	0.015	0.013	0.013
Mean	1.41	1.33	1.49	1.45	1.46		0.013	0.014	0.016	0.017	0.014	

Analogous results were also revealed by El-Salami and Makary (1997) on *Cupressus sempervirens*, Auda *et al*. (2002) on tuberose, Agina *et al*. (2005) on *Bougainvillea glabra*, *Cordyline terminalis*, *Ficus macrocarpa* "Hawaii" and *Jasminum sambac*, Khenizy *et al*. (2009) on *Moluccella laevis* and El-Quesni *et al* (2010) on *Syngonium podophyllum*.

From the previous results, we concluded that spraying the foliage of spindle tree with Inka liquid fertilizer at 2ml/l+ GA_3 at 300ppm combination treatment is considered one of the best ways for improving growth and quality of such foliage-pot-plant from the commercial point of view.

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إستجابة نبات الأيونيمس (*Euonymus japonicus* Thunb cv. Aureus) لبعض معاملات التسميد و حمض الجبريلليك والتفاعلات بينهما

عزة محمد عبد المنعم(١)، أمل صلاح الفولي(١)، سيد محمد شاهين(٢)

(١) قسم بحوث الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر.

(٢) قسم بحوث الحدائق النباتية، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر.

الملخص العربي

أجريت مجموعة من تجارب الأصص بإحدى الصوبات البلاستيكية بمشتل معهد بحوث البساتين، الجيزة، مصر خلال موسمي ٢٠١٢، ٢٠١٣ لدراسة تأثير نوعين من الأسمدة التجارية السائلة (إنكا والذي يحتوي على ٦% كالسيوم + ١% زنك وكلوفر كالبور والذي يحتوي على ٩% كالسيوم + ١% بورون + ٥% أزوت) بتركيزات: صفر، ٢، ٣مم/ لتر ماء (لكل سماد على حدة) ، حمض الجبريلليك (GA_3) بتركيزات: صفر، ١٠٠، ٢٠٠، ٣٠٠، ٤٠٠ جزء في المليون وكذلك التفاعلات بينهما على النمو والتركيب الكيماوي لنبات الأيونيمس

(*Euonymus japouicus* Thunb) صنف (Aureus) النامي في أصص بلاستيك قطرها ١٥سم مملوءة بحوالي ١.٥كجم من مخلوط الرمل والطين (بنسبة ١:١ حجماً)، عند إضافتها رشاً على الأوراق، خمس مرات وبفاصل شهر بين كل مرتين. وقد تم رش نباتات المقارنة بماء الصنبور العادي.

أوضحت النتائج المتحصل عليها أن جميع قياسات النمو الخضري والجذري قد تحسنت بشكل ملحوظ نتيجة للرش بأيٍ من معاملات التسميد أو حمض الجبرلليك بالمستويات المختلفة ، مع تفوق الإضافة الفردية لسماد الإنكا بتركيز ٢مم/ لتر أو حمض الجبريلليك بتركيز ٣٠٠ جزء في المليون، حيث أعطت هاتين المعاملتين الفرديتين متوسطات أعلى وبفروق معنوية عند مقارنتها بمتوسطات الكنترول في معظم الحالات بكلا الموسمين.

كما لوحظ أن الرش بسماد الكلوفر كالبور بمعدل ٢مم/ لتر أو بحمض الجبريلليك بتركيز ٢٠٠ جزء في المليون قد حسَّن بعض صفات النمو، لكن بدرجة أقل من المعاملتين الفرديتين السابق ذكرهما. ولقد أحدث الجمع بين معاملات التسميد المختلفة والرش بحمض الجبريلليك تحسناً إضافياً في معظم قياسات النمو الخضري والجذري، مع تفوق المعاملة المشتركة بين سماد الإنكا (٢مم/ لتر) + حمض الجبريلليك (٣٠٠ جزء في المليون) والتي سجلت أعلى المتوسطات على الإطلاق، ليس فقط عند مقارنتها بالكنترول ولكن أيضاً عند مقارنتها بجميع المعاملات الفردية والمشتركة الأخرى. إضافة إلى ذلك، فقد أدى الجمع بين GA_3 بتركيز ٣٠٠ جزء في المليون وسماد الكلوفر كالبور بمعدل ٢مم/ لتر وبين GA_3 بتركيز ٤٠٠ جزء في المليون وسماد الإنكا بمعدل ٢مم/ لتر إلى زيادة في متوسطات بعض قياسات النمو، بينما لم تُحدث زيادة معدل التسميد إلى ٣ مم/ لتر أو تركيز GA_3 إلى ٤٠٠ جزء في المليون أية زيادة إضافية في معدل النمو، سواء عند إضافتها بشكل فردي أو في توليفات. أظهرت نتائج المحتوى الكيماوي لبعض المكونات الكيماوية في أوراق النباتات المعاملة تبايناً واضحاً في إستجابتها للمعاملات المختلفة المطبقة بهذه الدراسة، إلا أن الأفضلية في محتوى هذه المكونات كانت أيضاً للمعاملة المشتركة بين سماد الإنكا بمعدل ٢مم/ لتر وحمض الجبريلليك بتركيز ٣٠٠ جزء في المليون والتي أعطت أعلى القيم مقارنة بالتوليفات الأخرى، مع بعض الإستثناءات البسيطة بكلا الموسمين.

وعليه، فإنه طبقاً لنتائج هذه الدراسة ، يمكن النصح برش أوراق شتلات نبات الأيونيمس ، عمر ستة أشهر بسماد الإنكا السائل بمعدل ٢مم/ لتر مع حمض الجبريلليك بمعدل ٣٠٠ جزء في المليون للحصول على أفضل مظهر للنمو والجودة في هذا النبات الورقي المتميز.

Table (1): Effect of fertilization treatments, gibberellic acid and their interactions on some growth parameters of *Euonymus japonicus* Thunb cv. Aureus plant during 2012 and 2013 seasons.

GA3 treatments (ppm) / Fertilization treatments (ml/l)	Plant height (cm)						No. branches / plant						No. Leaves / plant					
	GA_3 at 0.0	GA_3 at 100	GA_3 at 200	GA_3 at 300	GA_3 at 400	Mean	GA_3 at 0.0	GA_3 at 100	GA_3 at 200	GA_3 at 300	GA_3 at 400	Mean	GA_3 at 0.0	GA_3 at 100	GA_3 at 200	GA_3 at 300	GA_3 at 400	Mean
	First season : 2012																	
Control	22.56f	25.83de	25.83de	24.67e	23.00f	24.38c	1.00f	4.00d	5.00c	5.33bc	4.33cd	3.93c	44.00f	63.65d	65.00d	88.01ba	82.67b	68.67c
Inka at 2	28.00c	29.50bc	29.67be	33.25a	32.17a	30.52a	6.33ba	7.00a	7.50a	7.00a	5.87b	6.74a	79.50bc	91.36b	105.33a	106.67a	91.00b	94.77a
Inka at 3	25.46ed	28.33c	27.50cd	28.00c	27.33cd	27.33b	2.33e	6.33ba	7.00a	6.10b	5.33bc	5.35b	51.50e	76.80c	72.67c	83.33b	75.10c	71.88b
Klover at 2	23.50ef	27.50cd	26.00de	32.33a	25.67de	27.00b	4.00d	6.00b	4.33cd	6.50ba	5.67bc	5.30b	64.00d	72.00c	72.00c	82.59b	71.67c	72.45b
Klover at 3	28.00e	25.90de	28.17c	27.31cd	25.88de	27.05b	5.10cb	6.67ab	5.33bc	5.00c	4.67c	5.36b	53.10e	68.33cd	69.33cd	74.68c	84.00b	69.89c
Mean	25.51c	27.41b	27.44b	29.11a	26.81b		3.75b	6.00a	5.83a	5.99a	5.18ab		58.42d	74.43c	76.87c	87.06a	80.89b	
	Second season : 2013																	
Control	24.37f	26.78e	27.87d	26.57e	24.69f	26.06d	1.08e	2.96d	4.03c	5.00bc	3.70cd	3.36c	47.52f	51.84ef	59.41de	65.80d	59.15de	56.75e
Inka at 2	29.40c	31.32b	32.10ab	34.65a	30.15bc	31.53a	4.67cb	5.76b	7.00a	7.50a	5.63b	6.11a	75.60cd	86.50b	94.00ab	99.56a	87.55b	88.64a
Inka at 3	26.46e	28.00d	29.16c	30.00bc	27.50de	28.23bc	2.50d	4.00c	5.88b	6.33ab	4.25cb	4.59b	55.08e	84.44bc	78.52c	86.40b	68.30d	73.95c
Klover at 2	25.38ef	29.30c	29.79cb	32.76ab	28.73cd	29.19b	4.00c	5.10bc	6.36ab	7.00a	5.00bc	5.49ab	68.00d	78.76c	83.80b	88.70b	72.18dc	78.29b
Klover at 3	25.31ef	27.50de	28.08dc	29.03c	25.33ef	27.05c	3.05cd	4.00c	4.89cb	5.76b	4.00c	4.34b	55.00e	66.50d	74.52cd	79.90c	65.10d	68.21d
Mean	26.19c	28.58b	29.40ab	30.60a	27.28b		3.06d	4.37c	5.63ab	6.30a	4.52c		60.24d	73.01c	78.05b	84.07a	70.46cd	

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

Table (2): Effect of fertilization treatments, gibberellic acid and their interactions on leaf area, root length and rootlet number of *Euonymus japonicus* Thunb cv. Aureus plant during 2012 and 2013 seasons.

GA_3 treatments (ppm) / Fertilization treatments (ml/l)	Leaf area (cm)						Root length (cm)						No. rootlets / plant					
	GA_3 at 0.0	GA_3 at 100	GA_3 at 200	GA_3 at 300	GA_3 at 400	Mean	GA_3 at 0.0	GA_3 at 100	GA_3 at 200	GA_3 at 300	GA_3 at 400	Mean	GA_3 at 0.0	GA_3 at 100	GA_3 at 200	GA_3 at 300	GA_3 at 400	Mean
	First season : 2012																	
Control	1.33e	2.40ed	3.17cd	3.42c	2.36ed	2.54c	23.00de	21.75e	27.81c	28.75bc	21.50e	24.56c	3.00f	5.00e	5.61d	4.58ef	5.33de	4.71c
Inka at 2	4.50bc	4.86bc	5.00b	6.33a	5.00b	5.14a	29.10bc	30.50b	29.33bc	32.26a	28.76bc	3000a	7.00c	9.00a	6.50cd	9.00a	9.50a	8.20a
Inka at 3	3.96c	4.28cb	4.43cb	4.50bc	3.56c	4.15b	26.25c	27.16c	28.75bc	30.50b	22.50de	27.03b	3.36f	7.50bc	5.78d	6.33dc	7.50bc	6.10b
Klover at 2	4.10cb	4.50bc	5.00b	5.88a	4.90bc	4.88ab	29.00bc	31.20ab	32.25a	33.35a	27.11c	30.58a	7.40cb	8.00b	9.11a	9.00a	9.00a	8.48a
Klover at 3	3.00d	3.76c	4.09cb	5.00b	3.50c	3.87bc	24.58d	30.18b	27.95c	30.50b	24.28d	27.50b	3.28f	7.00c	5.60d	7.76bc	8.00b	6.33b
Mean	3.38c	3.96b	4.34ab	5.03a	3.87b		26.39c	28.16b	29.22ab	31.07a	24.83d		4.81b	7.30a	6.50ab	7.32a	7.87a	
	Second season : 2013																	
Control	1.42e	2.61de	3.47dc	3.71cd	2.50de	2.74c	22.16e	23.65de	26.63c	30.52b	22.90e	25.17c	3.30f	3.67f	4.13fe	5.00e	3.96f	4.01c
Inka at 2	3.48dc	5.13ba	5.50ab	6.10a	4.80bc	5.00a	26.33c	28.50bc	30.00b	33.86a	27.81cb	29.30a	5.67de	7.00c	7.70bc	9.33a	8.00b	7.54a
Inka at 3	3.00d	3.97c	4.36cb	5.36ba	3.67cd	4.07b	24.50d	25.76cd	28.00bc	30.00b	24.00d	26.45b	3.50f	4.87e	5.86d	4.70cd	7.50bc	5.83b
Klover at 2	3.50cd	4.91bc	5.00b	5.73ab	4.00c	4.63ab	25.47cd	27.00c	30.00b	31.50ab	26.33c	28.06a	5.00e	7.00c	7.00c	9.00a	7.76bc	7.14a
Klover at 3	2.76de	3.33dc	3.70cd	4.27cb	3.10dc	3.43bc	23.33ed	25.00dc	26.78c	29.65b	23.10e	25.57b	3.50f	4.33fe	5.47fe	6.91cd	6.50cd	5.34b
Mean	2.83c	3.99b	4.41ab	5.04a	3.62b		24.36d	25.98c	28.28b	31.11a	24.83cd		4.20c	5.38b	5.38b	7.53a	6.73ab	

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