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Influence of Substrate and Fertilization on Growth and Development of *Iris adriatica*

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Abstract

Iris adriatica is indigenous to Mediterranean part of Croatia. It is an attractive plant and has opportunities for introduction into horticulture and the ornamental plant market. Research was conducted in the experimental garden of the Faculty of Agriculture, University of Zagreb, to assess the possibility of growing this species as a pot plant. Research included 360 potted plants placed as randomized block design experiment. The goal of this research was to determine influence of chosen substrates and fertilizers, as well as to explore growth and development dynamic of the species cultivated outdoors from June till August 2010. The following characteristics were measured: plants height, number of leaves, and number of rosettes. Biometric analysis showed that the development of *Iris adriatica* was significantly influenced only by substrate, while fertilization and interaction of substrate and fertilization showed no significant impact on examined plants characteristics ($p \leq 0.05$).

Keywords: Croatian flora, endemic plant species, introduction, ornamental horticulture, pot plant

Introduction

Croatian endemic species Iris adriatica Trinajstić ex Mitić is a rhizomatic perennial plant from the family of *Iridaceae* (Fig. 1). Distribution of the species is endemic to Mediterranean region of Croatia. It is decorative due to its small habit (height up to 10 cm) and very attractive yellow and purple flowers which appear in June and July. It is mostly propagated by rhizome division but seed propagation is also possible, although much more difficult, Kereša *et al*. (2009) recommended micropropagation for commercial production as an ornamental plant.

Iris adriatica is included in Croatian *Red Book* of plant species (Nikolić and Topić, 2005; Šugar, 1994) where it is listed as endangered and almost endangered species with limited habitat and small population, some places completely vanished or decreased in number. Main causes of decreased population are urbanization and natural succession. The species is protected in Croatia, according to the *Ordinance on Designating Wild Taxa Protected and Strictly Protected* (NN 7/06) and has not yet been introduced into horticultural production so it would be a novel on ornamental plant market (Halevy, 1999).

Introduction into horticultural production means, except of broadening ornamental plants offer, also *ex-situ* protection of plant species which are otherwise destroyed at their natural habitat by excessive collecting, often due to its attractive appearances (Hajoš *et al*., 2003).

The goal of this research was to assess the possibility of growing this species as a pot plant by examining influence of chosen substrates and fertilizers on growth and development of the species outdoors over a period of six weeks.

Materials and methods

Experiment was conducted with 360 vegetatively propagated plants of species *Iris adriatica* in the experimental garden of Department of Ornamental Plants, Landscape Architecture and Garden Art at the Faculty of Agriculture, University of Zagreb, Croatia, from June 24th to August 25th 2010. To ensure uniform growth conditions plants were propagated by rhizome division and planted into plastic pots (14 cm radius and 1.1 L volume). In the experiment two types of substrates were used (Tab. 1).

In experiment a specialized liquid fertilizer (factor F) for house and balcony plants was used. This fertilizer is intended to be used on flowering species because in addition to main macrofertilizers in composition 6-7-8 (6% nitrogen as amide, nitrate and ammoniac, 7% phosphorus solvable in water P_2O_5, and 8% potassium solvable in water K_2O). The fertilizer also contains the most important microfertilizers which are necessary to achieve quality of flowers and induce vegetative growth. The fertilizer also contains microelements Fe, Cu, Zn and B. Tab. 2 shows monthly values of air temperature, duration of sunlight,

Fig. 1. *Iris adriatica* Trinajstić ex Mitić, photographed by Morić, 2010

precipitation, number of sunny, foggy and rainy days in Zagreb for the period in which experiment was conducted (source: Croatian Meteorological and Hydrological Service).

This two factorial experiment (factor S-substrate, F factor-fertilization) is set according to the randomized block design with five blocks. Both factors had two levels and there were four combinations: S_1F_0-Substrate 1, no fertilizer; S_1F_1-Substrate 1, 1% solution of fertilizer; S_2F_0-Substrate 2, no fertilizer; S_2F_1-Substrate 2, 1% solution of fertilizer.

Tab. 1. Structure of substrates (factor S) used in the experiment

Structure		Substrate 1 (level S_1)	Substrate 2 (level S_2)
Composition (%):	white peat	40	40
	mixed peat	56	56
	clay	4	4
Organic matter (%)		80	58.5
pH (H_2O)		6.5-7	6.5-7
Macrofertilizer concentrate (mg L^{-1}):	N	135	200
	NH_4-N	90	120
	NO_3-N	45	80
	P_2O_5	137	150
	K_2O	200	289
	Mg	60	90.1
Moisture (%)		65-75	65-75
Dry matter (DM), 105°C (%)		30-40	40-50
Total heavy metals (mg kg^{-1} DM):	Mn	177.2	188.1
	Zn	18	26.3
	Cu	25.48	19.1
	Pb	12.66	11.56
	Cd	0.88	0.7
	Cr	1.1	0.9
	Ni	6.71	4.3
	As	1.1	1.1
	Hg	in traces	in traces
	Mo	0.101	0.065
	Co	2.1	1.1

In the experiment the following characteristics were measured:-plants height (measured from root neck to the highest part of the plant),-maximum number of leaves per plant,-number of rosettes counted on four dates: July 14th, July 28th, August 11th and August 25th. Solution of fertilizer (10 ml L^{-1} H_2O) was applied on three dates: July 15th, July 29th, August 12th i.e. every 14 days with 0.25 dL of solution per pot.

Statistical analysis

Analysis of variance (ANOVA) of two factorial experiment (Gomez and Gomez, 1984) was performed according to randomized block experimental design with five blocks using the commercial software SAS Ver. 9.1*. Values are presented as a means of five replications.

Results and discussion

Plants grown in Substrate 1 were significantly shorter (in average 2 cm) than plants grown in Substrate 2, which may be related to the level of nutrients in substrate. Plants grown in supstrate containing a higher level of nutrients (especially nitrogen) had a stronger vegetative growth, and a smaller number of rosettes (Tab. 3). In contrast to the plant height, the number of rosettes per plant was higher in plants grown in Substrate 1 (Tab. 5). There was no statistically significant influence of substrate on number of leaves per plant, except in measurement on July 28th, although a higher number of leaves were measured on plants grown in Substrate 2 (Tab. 4). All the results indicate that plants grown on Substrate 1 had a more compact growth which is highly desirable in growing this species as a flowering pot plant.

Balanced fertilization is very important for growth and development of flowering pot plants whereby it is relevant that certain amount of nutrition supply is available to the plant in different stages of growth.

Only basic guidelines for amounts of necessary nutrition solutions are available for most ornamental plants, except for some important species which are grown in large scale (Finck, 1982; Hershey and Paul, 1981; King *et al.*,

Tab. 2. Meteorological values for Zagreb in June, July and August 2010

Zagreb (2010)		Jun	Jul	Aug
Air temperature (°C)	mean	19.1	20.8	20
	aps. max.	37.6	40.4	39.8
	aps. min.	2.5	5.4	3.7
Sunlight (in hours)		243.7	281	256
Precipitation (mm)		96	81.6	89.3
Number of days	sunny	3	7	8
	foggy	1	0	1
	rainy	13	11	10
	warm	15	22	20
	hot	3	7	6

Tab. 3. Substrate and fertilization influence on plant height of *Iris adriatica*. Partially outline of the ANOVA for plant height characteristic; mean values for main effects levels and their combinations are listed on the right side

Source of variation	Degree of freedom	Date	Computed F	Pr > F	Plant height (cm)				
Treatment combinations	3	Jul. 14th	$2.33^{n.s.}$	0.1259					
		Jul. 28th	6.85^{**}	0.0061					
		Aug. 11th	8.81^{**}	0.0023					
		Aug. 25th	3.49^{*}	0.0500					
Substrate (S)	(1)				S_1		S_2		
		Jul. 14th	$4.94^{n.s}$	0.0462	9.9		11.1		
		Jul. 28th	20.37^{**}	0.0007	9.5		12.0		**
		Aug. 11th	25.69^{**}	0.0003	10.2		12.8		**
		Aug. 25th	10.15^{**}	0.0078	10.8		12.9		**
Fertilization (F)	(1)				F_1		F_0		
		Jul. 14th	$1.85^{n.s}$	0.1985	10.2		10.9		
		Jul. 28th	$0.19^{n.s.}$	0.6689	10.6		10.9		
		Aug. 11th	$0.00^{n.s}$	0.9448	11.5		11.5		
		Aug. 25th	$0.26^{n.s.}$	0.6175	11.7		12.0		
Interaction (SxF)	(1)				S_1F_1	S_1F_0	S_2F_1	S_2F_0	
		Jul. 14th	$0.20^{n.s}$	0.6625	9.7	10.2	10.6	11.6	
		Jul. 28th	$0.00^{n.s}$	0.9916	9.4	9.6	11.9	12.1	
		Aug. 11th	$0.73^{n.s}$	0.4109	10.4	10.0	12.6	13.0	
		Aug. 25th	$0.01^{n.s.}$	0.9386	10.7	11.0	12.7	13.1	

n.s.-not significant; **-significant at $p \leq 0.01$; *-significant at $p \leq 0.05$; S_1=Substrate 1; S_2=Substrate 2; F_1=fertilized; F_0=not fertilized; Int. S×F=interaction substrate×fertilization

1995; Macz *et al*., 2001). Regarding the fact that growing of species of genus *Iris* (Armitage, 1995; Ganslmeier and Henseler, 1985; Nau, 1996) requires substrate rich in nutrition solutions, two commercial substrates different in organic matter percentage and nutritions concentration were used in this experiment. According to research conducted by Vršek *et al.* (2004) natural habitat of species *I. adriatica* is rich in humus (9.83 to 11.38%), contains low levels of plant available phosphorus (1.75 to 2.18 mg P kg^{-1}) while potassium and nitrogen are highly available to the plant (190.92-315.44 mg K kg^{-1} and 45.16-67.74 mg N kg^{-1}).

Marschner (1995) states that many perennials have growth adapted to soils with low levels of nutrition solu-

Tab. 4. Substrate and fertilization influence on number of leaves per plant of *Iris adriatica*. Partially outline of the ANOVA for number of leaves characteristic; mean values for main effects levels and their combinations are listed on the right side

Source of variation	Degree of freedom	Date	Computed F	Pr > F	Number of leaves per plant				
Treatment combinations	3	Jul. 14th	$2.78^{n.s}$	0.0869					
		Jul. 28th	8.20^{**}	0.0031					
		Aug. 11th	$2.69^{n.s.}$	0.0936					
		Aug. 25th	$1.49^{n.s}$	0.0936					
Substrate (S)	(1)				S_1		S_2		
		Jul. 14th	$6.58^{n.s.}$	0.0248	4.0		4.3		
		Jul. 28th	24.26^{**}	0.0004	4.1		4.9		**
		Aug. 11th	$7.53^{n.s.}$	0.0178	4.8		5.4		
		Aug. 25th	$4.13^{n.s.}$	0.0649	5.2		5.6		
Fertilization (F)	(1)				F_1		F_0		
		Jul. 14th	$1.50^{n.s}$	0.2434	4.1		4.2		
		Jul. 28th	$0.31^{n.s.}$	0.5886	4.6		4.5		
		Aug. 11th	$0.53^{n.s}$	0.4821	5.2		5.0		
		Aug. 25th	$0.01^{n.s.}$	0.9314	5.4		5.4		
Interaction (SxF)	(1)				S_1F_1	S_1F_0	S_2F_1	S_2F_0	
		Jul. 14th	$0.25^{n.s}$	0.6274	3.9	4.1	4.3	4.4	
		Jul. 28th	$0.02^{n.s}$	0.8918	4.2	4.1	5.0	4.9	
		Aug. 11th	$0.00^{n.s}$	0.9637	4.9	4.7	5.5	5.3	
		Aug. 25th	$0.32^{n.s.}$	0.5815	5.2	5.1	5.5	5.7	

Note: n.s.-not significant; **-significant at $p \leq 0.01$; *-significant at $p \leq 0.05$; S_1=Substrate 1; S_2=Substrate 2; F_1= fertilized; F_0=not fertilized; Int. S×F=interaction substrate×fertilization

Tab. 5. Substrate and fertilization influence on number of rosettes per plant of *Iris adriatica*. Partially outline of the ANOVA for number of rosettes; mean values for main effects levels and their combinations are listed on the right side

Source of variation	Degree of freedom	Date	Computed F	Pr > F	Number of rosettes per plant				
Treatment combinations	3	Jul. 14th	14.85^{**}	0.0002					
		Jul. 28th	10.69^{**}	0.0010					
		Aug. 11th	12.52^{**}	0.0005					
		Aug. 25th	6.84^{**}	0.0061					
Substrate (S)	(1)				S_1		S_2		
		Jul. 14th	43.55^{**}	<0.0001	1.96		1.31		**
		Jul. 28th	31.14^{**}	0.0001	1.88		1.37		**
		Aug. 11th	35.05^{**}	<0.0001	1.96		1.49		**
		Aug. 25th	18.23^{**}	0.0011	2.05		1.55		**
Fertilization (F)	(1)				F_1		F_0		
		Jul. 14th	$0.00^{n.s.}$	1.0000	1.64		1.64		
		Jul. 28th	$0.29^{n.s.}$	0.6000	1.65		1.37		
		Aug. 11th	$1.45^{n.s.}$	0.2517	1.77		1.67		
		Aug. 25th	$0.01^{n.s.}$	0.9331	1.80		1.79		
Interaction (SxF)	(1)				S_1F_1	S_1F_0	S_2F_1	S_2F_0	
		Jul. 14th	$1.01^{n.s.}$	0.3351	1.91	2.01	1.36	1.26	
		Jul. 28th	$0.64^{n.s.}$	0.4409	1.87	1.90	1.43	1.30	
		Aug. 11th	$1.06^{n.s.}$	0.3240	1.96	1.95	1.57	1.40	
		Aug. 25th	$2.28^{n.s.}$	0.1572	1.96	2.13	1.64	1.45	

Note: n.s.-not significant; **-significant at $p \leq 0.01$; *-significant at $p \leq 0.05$; S_1=Substrate 1; S_2=Substrate 2; F_1=fertilized; F_0=not fertilized; Int. S×F=interaction substrate×fertilization

tions, and that they continue to grow without showing any visual symptoms of deficiency.

Finck (1982) indicates that efforts to achieve optimal levels of nutrition solutions in soil during plant growth often result in exceeding of optimal levels and in danger of over fertilization.

Biometrical analysis clearly shows that the only factor with significant influence on growth of plant species *Iris adriatica* was substrate, while fertilization and interaction of substrate and fertilization did not show any significant influence in measured plants characteristics (with $P \leq 0.05$). In this particular case this means that fertilization can be left out which decreases the costs of plants production. This research confirms it is possible to grow plant species *Iris adriatica* as a flowering pot plant.

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