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≤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 (Haley, 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 O , and 8% potassium solvable in water K O ). 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,
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 substrate 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. 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$_2$O$_5$                 | 137                       | 150                       |
| K$_2$O                     | 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                       |

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

| Zagreb (2010) | Jun | Jul | Aug |
|---------------|-----|-----|-----|
| Air temperature ($^\circC$) | 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 |
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 nutrition 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).

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*** | 0.1259 |                    |
|                      |                   | Jul. 28th  | 6.85**   | 0.0061 |                    |
|                      |                   | Aug. 11th  | 8.81**   | 0.0023 |                    |
|                      |                   | Aug. 25th  | 3.49*    | 0.0500 |                    |
| Substrate (S)        | (1)               | Jul. 14th  | 4.94**   | 0.0462 | S₁ 9.9 11.1       |
|                      |                   | Jul. 28th  | 20.37**  | 0.0007 | S₂ 9.5 12.0       |
|                      |                   | Aug. 11th  | 25.69*   | 0.0003 | S₁ 10.2 12.8     |
|                      |                   | Aug. 25th  | 10.15**  | 0.0078 | S₂ 10.8 12.9     |
| Fertilization (F)    | (1)               | Jul. 14th  | 1.85      | 0.1985 | F₁ 10.2 10.9  |
|                      |                   | Jul. 28th  | 0.19      | 0.6689 | F₀ 10.6 10.9  |
|                      |                   | Aug. 11th  | 0.00      | 0.9448 | F₁ 11.5 11.5  |
|                      |                   | Aug. 25th  | 0.26      | 0.6175 | F₀ 11.7 12.0  |
| Interaction (SxF)    | (1)               | Jul. 14th  | 0.20      | 0.6625 | S₁F₁ 9.7 10.2 10.6 11.6 |
|                      |                   | Jul. 28th  | 0.00      | 0.9916 | S₂F₀ 9.4 9.6 11.9 12.1 |
|                      |                   | Aug. 11th  | 0.73      | 0.4109 | S₁F₀ 10.4 10.0 12.6 13.0  |
|                      |                   | Aug. 25th  | 0.01      | 0.9386 | S₂F₁ 10.7 11.0 12.7 13.1 |

Note: n.s.-not significant; *-significant at p≤0.05; **-significant at p≤0.01; S₁=Substrate 1; S₂=Substrate 2; F₁=fertilized; F₀=not fertilized; Int. SxF=interaction substrate×fertilization.

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*** | 0.0869 |                         |
|                      |                   | Jul. 28th  | 8.20**   | 0.0031 |                         |
|                      |                   | Aug. 11th  | 2.69***  | 0.0936 |                         |
|                      |                   | Aug. 25th  | 1.49***  | 0.0936 |                         |
| Substrate (S)        | (1)               | Jul. 14th  | 6.58**   | 0.0248 | S₁ 4.0 4.3       |
|                      |                   | Jul. 28th  | 24.26**  | 0.0004 | S₂ 9.4 9.6 11.9 12.1 |
|                      |                   | Aug. 11th  | 7.53**   | 0.0178 | S₁ 4.8 5.4       |
|                      |                   | Aug. 25th  | 4.13**   | 0.0649 | S₂ 5.2 5.6       |
| Fertilization (F)    | (1)               | Jul. 14th  | 1.50**   | 0.2434 | F₁ 4.1 4.2       |
|                      |                   | Jul. 28th  | 0.31**   | 0.5886 | F₀ 4.6 4.5       |
|                      |                   | Aug. 11th  | 0.53**   | 0.4821 | F₁ 5.2 5.0       |
|                      |                   | Aug. 25th  | 0.01**   | 0.9314 | F₀ 5.4 5.4       |
| Interaction (SxF)    | (1)               | Jul. 14th  | 0.25**   | 0.6274 | S₁F₁ 3.9 4.1 4.3 4.4 |
|                      |                   | Jul. 28th  | 0.02**   | 0.8918 | S₂F₀ 4.2 4.1 5.0 4.9 |
|                      |                   | Aug. 11th  | 0.00**   | 0.9637 | S₁F₀ 4.9 4.7 5.5 5.3 |
|                      |                   | Aug. 25th  | 0.32**   | 0.5815 | S₂F₁ 5.2 5.1 5.5 5.7 |

Note: n.s.-not significant; *-significant at p≤0.05; **-significant at p≤0.01; S₁=Substrate 1; S₂=Substrate 2; F₁=fertilized; F₀=not fertilized; Int. SxF=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.

References

Armitage AM (1995). Speciality Cut Flowers, 1st Ed. Timber Press, Portland, Oregon.

Finck A (1982). Fertilizers and Fertilization, Verlag Chemie, Weinheim.

Ganslmeier H, K Henseler (1985). Schnittstauden, Verlag Eugen Ulmer, Stuttgart.

Gomez KA, Gomez AA (1984). Statistical Procedures for Agricultural Research, 2nd Ed. John Wiley and Sons, Inc., New York.

Hajdić D, Vršek I, Karlović K, Židovec V, Morkić S (2003). Commercial cultivation of indigenous plant species, a measure of ex-situ conservation (in Croatian). Šemenarstvo 20:37-45.

Haley AH (1999). Ornamentals: Where diversity is king—the Israeli experience. Perspectives on new crops and new uses.

Hershey DR, Paul JI (1981). Critical foliar levels of potassium in pot chrysanthemum. Hort Sci 16(2):220-222.

Kereša S, Mihovilović A, Ćurković-Perica M, Mitić B, Barić M, Vršek I, Marchetti S (2009). In vitro regeneration of the Croatian endemic species Iris adriatica Trinajstić ex Mitić. Acta Biologica Cracoviensia Series Botanica 51(2):7-12.

King JJ, Peterson LA, Stimart DP (1995). Ammonium and nitrate uptake through development in Dendranthema grandiflorum. Hort Sci 30(3):499-503.

Macz O, PaparoZZi ET, Stroup W (2001). Effect of nitrogen and sulfur applications on pot chrysanthemum production and postharvest performance. I. leaf nitrogen and sulfur concentrations, Journal of Plant Nutrition 24(1):111-129.

Marschner H (1995). Mineral Nutrition of Higher Plants, 2nd Ed. Academic Press, London.

Nau J (1996). Ball Perennial Manual, 1st Ed. Ball Publishing, Batavia, Illinois.

Nikolić T, Topić J (2005). Red Book of Vascular Flora of Croatia, Categories EX, RE, CR, EN and VU, Ministry of culture, State Institute for Nature Protection, Zagreb.

SAS Institute Inc. (2004). SAS/STAT Software, Version 9.1., User’s Guide, SAS Institute, Cary, NC.

Šugar I (1994). Red Book of Plant Species of Croatia, Ministry of Environmental Protection, Physical Planning and Construction, Institute for Nature Protection, Zagreb.

Vršek I, Mitić B, Bujan M, Ćoga L, Milović M, Richter M (2004). Iris adriatica Trinajstić ex Mitić, potential plant suitable for cultivation in pots, 173-174 p. In: Mitić B, Soštarić R (Eds.). Book of abstracts. Prvi hrvatski botanički simpozij s međunarodnim sudjelovanjem. Hrvatsko botaničko društvo, Zagreb.