Determination of Optimum Phosphorus Level on The Growth and Appearance Values of Impatiens Plant (Impatiens Walleriana) Grown in Hydroponic Medium

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***Abstract*—**In this study, the effects of different levels of phosphorus applied to the nutrient solution of Impatiens plants grown in pot culture on plant growth and appearance values were investigated. Impatiens plants were grown in hydroponic medium by modifying the standard nutrient solution used for ornamental plants. Fresh weight, number of shoots and flowers, shoot length and flowering time, N, P and K levels of Impatiens plants increased with increasing phosphorus levels applied to the nutrient solution compared to the control treatment. P treatments prolonged the flowering time in Impatiens plants. The highest ornamental plant quality values were found in the 1-1.5 mmol L-1 P treatment range of phosphorus applied to the nutrient solution.

***Keywords*—** Impatiens, Phosphorus, Hydroponic Nutrition.

I. Introduction

Impatiens plant is a genus of plants in the Balsaminaceae family, known especially for its colorful flowers and decorative leaves. Common in tropical and temperate regions, these plants are often used in home and garden decorations. Impatiens are frequently used for garden borders, pot arrangements and as indoor plants. Impatiens cultivars, especially Impatiens walleriana, are in high demand due to its widespread use in garden landscaping and as an indoor plant. The variety of colors and long flowering periods make this plant commercially attractive and it is grown and traded in greenhouses in different parts of the world.

Plant nutrition management, including fertilization practices, is an important factor determining the ornamental value and marketability of potted plants [1]. In the nutrition of ornamental plants, nutrient form and application rate time according to the phenological developmental periods of the plant are of great importance. While the quality and marketing value of the product obtained with the appropriate fertilization program increases, negative effects such as plant toxicity, crop losses and environmental pollution are minimized. In ornamental plant production, it is known that parameters such as plant biomass, number and length of branches, total leaf area, number of leaves and number of flowers, which determine the marketing value of the plant according to plant species, are directly related to fertilization [2]. The Impatiens plant requires high nutrient levels to grow and build its total biomass. Leaves, branches and flowers are ornamental organs in the Impatiens

plant and essential plant nutrient applications are needed to delay senescence of the whole plant and ensure flowering.

Soil organic matter and mineral phosphorus fractions, phosphorus fertilizer applications or phosphates released in the soil by the interaction of certain groups of organisms are the main sources used to meet the P requirement of plant growth. Phosphorus is an essential nutrient for plant growth and agricultural productivity [3]. Phosphorus has an important role in the nutrition of Impatiens plant and it is one of the most important plant nutrients affecting the marketing value of the plant. In P deficiency, low biomass and P deficiency occur in ornamental plants [4]. Especially in soilless farming applications, the P concentration in the nutrient solution should be kept at optimum level for an effective plant nutrition program.

In this study, the effects of phosphorus applied to the nutrient solution at different levels on growth and product parameters and mineral matter contents of Impatiens plants grown hydroponically in pot culture were investigated

II. Material and Method

The experiment was carried out in a glass greenhouse with controlled temperature, humidity and lighting. Impatiens (*Impatiens Walleriana*) seeds were sieved through a 0.1 mm sieve and germinated in perlite + peat mixed 1:1 by volume at appropriate humidity and temperature. Germinated Impatiens plants were transferred to pots at the 6-leaf stage of development. A 1:1 by volume mixture of washed peat and perlite sieved through a 2 mm sieve was used as growing medium in pots.

Impatiens plants were grown by fertigation with nutrient solution containing different concentrations of P, which was created by modifying the nutrient solution recommended for ornamental plants [5]. Phosphorus was applied to Impatiens

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plants at 0, 0.5, 1, 1.5 and 2 µmol L^{-1}. The composition of nutrient solutions containing different P levels is given in Table 1.

TABLE 1. Composition of nutrient solution applied to impatiens plants (mmol L^{-1})

Applications	NO_3^-	$H_2PO_4^-$	SO_4^-	NH_4^+	K^+	Ca^{++}	Mg^{++}
Control	13	0	2.25	1	7.5	3.75	1
P_1	13	0.5	2.25	1	7.5	3.75	1
P_2	13	1	2	1	7.5	3.75	1
P_3	13	1.5	1.75	1	7.5	3.75	1
P_4	13	2	1.5	1	7.5	3.75	1
Reference [5]	13	1.25	1.25	1	7.5	3.125	1

Mineral nutrient salts including KH_2PO_4, $MgSO_4.7\ H_2O$, $Ca(NO_3)_2.5H_2O$, NH_4NO_3, $(NH_4)_2SO_4$, KNO_3, K_2SO_4 and Na_2SO_4 were used in the composition of the nutrient solution. Fe (Fe-EDDHA), Mn ($MnSO_4.H_2O$), Zn ($ZnSO_4.H_2O$), B ($Na_2B_4O_7.10\ H_2O$), Cu ($CuSO_4.5H_2O$), Mo ($Na_2MoO_4.2H_2O$) micronutrients were applied to all treatments at 10, 10, 5, 30, 0.5, 0.5 µmol L^{-1} levels, respectively.

The pH value of the nutrient solutions used in the experiment was adjusted to 6-6.5 and EC value to 2.5 $dS.cm^{-1}$ (25 C°). Impatiens plants were fertigated at the rate of 50-200 ml/day with nutrient solutions prepared according to the procedures given above, based on their water consumption and practically leaching of the solution from the pots. In order to prevent excessive salt accumulation in the pots, 500 ml of pure water was applied to all pots 1 day a week and then immediately its own solution was applied to drain the accumulated salts. Greenhouse temperature, humidity and illumination were kept at an appropriate level during the rooting and growth stages of the plants.

All plants were cut from the surface of the pots 4 months after they were transferred to the pots and their fresh weight, shoot numbers and shoot lengths were determined and prepared for analysis after standard washing, drying and grinding procedures for plant nutrient analyses.

The flowering time of Impatiens plants was determined based on the time from the time the seedlings were transferred to the pots until flowering, the flowering time was determined based on the time from the time the flowers formed on the Impatiens plants were labelled immediately after bud opening by using adhesive paper tapes with the date of flowering written on it in 1x1 cm dimensions until the flower shrivelled, and the total number of flowers was determined based on the number of labels used in each pot. All these procedures were carried out by keeping separate notes for each pot and making regular daily phenological observations.

Total nitrogen was determined by Kjeldahl method in dried and ground plant samples and P and K elements were determined by ICP-MS in plant samples wet ashed with HNO_3+$HClO_4$ acid mixture in accordance with the analytical procedure.

The analysis of variance of the findings obtained in the greenhouse experiment carried out according to the random blocks experimental design with 5 replicates was analysed using SPSS software (16.0) with the least significant difference (LSD) test ($P < 0.05$).

III. Results and Discussion

Fresh weight, number of shoots and number of flowers, shoot length and flowering time, total flowering days, nitrogen (N), phosphorus (P) and potassium (K) contents of Impatiens plants increased by increasing P concentration in the nutrient solution compared to the control treatment (Figure 1, Figure 2, Figure 3, Figure 4, Figure 5 and Figure 6).

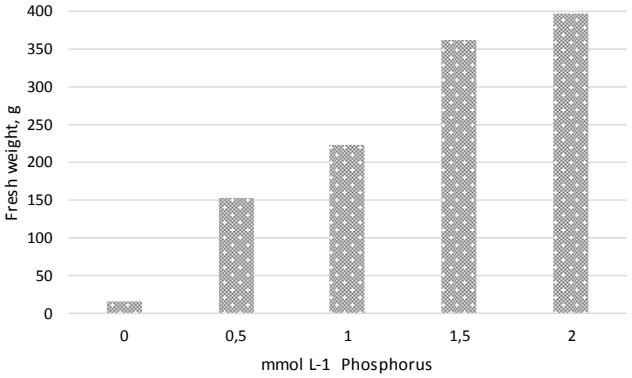

Fig. 1. Fresh weight of Impatiens in P applications

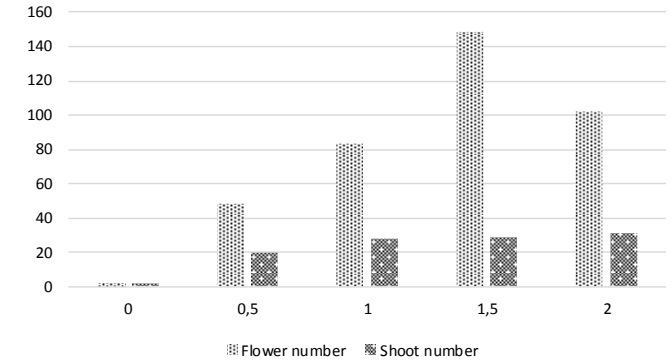

Fig. 2. Shoot and flower number of Impatiens in P applications

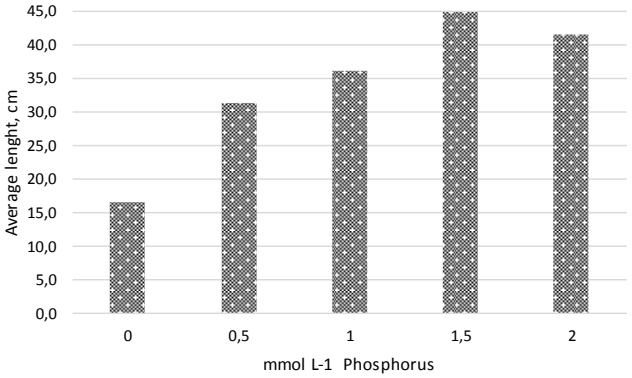

Fig. 3. Average shoot lenght of Impatiens in P applications

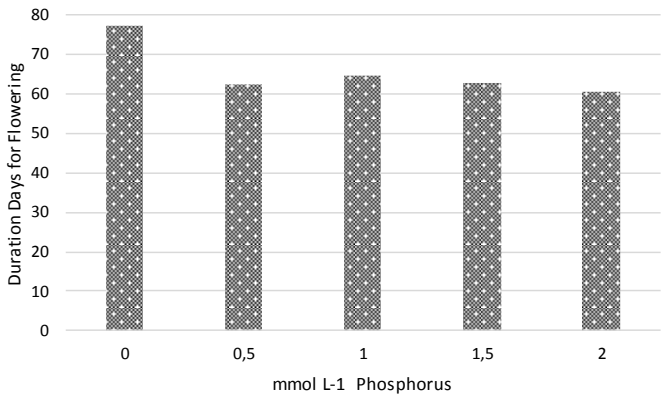

Fig. 4. Duration days for flowering of Impatiens in P applications

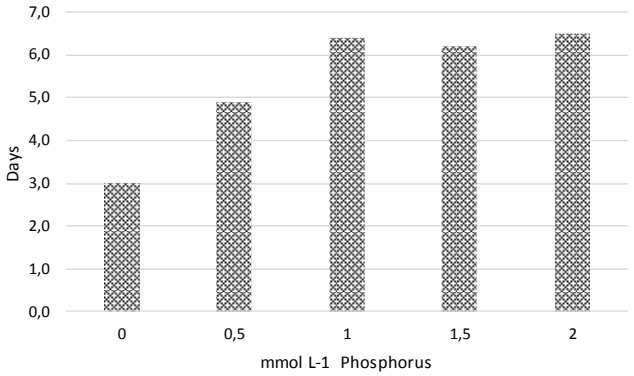

Fig. 5. Total flowering days of Impatiens in P applications

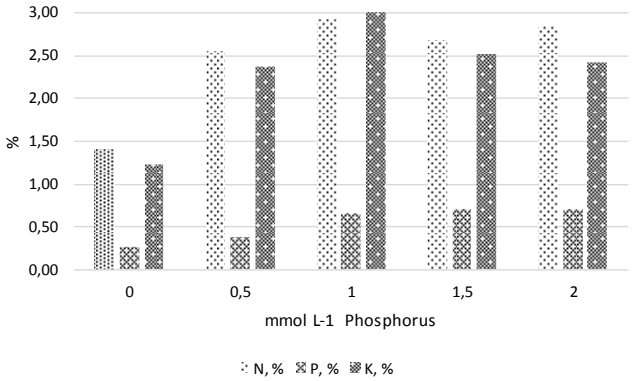

Fig. 6. N, P and K content of Impatiens in P applications

The fresh weight of Impatiens plants clearly increased with increasing applications of phosphorus compared to the control treatment, and an increase of more than 10-fold was determined in the 2 mmol L^{-1} P treatment. The number of shoots and flowers of Impatiens increased with increasing concentration of phosphorus in the nutrient solution, while the highest number of shoots was determined at 1.5 mmol L^{-1} P treatment. The average shoot length value showed a similar trend.

Number of shoots and flowers, average shoot length of Impatiens plant were highest at 1,5 mmol L^{-1} P level in the treatments in which phosphorus was applied at increasing levels of nutrient solution compared to the control treatment. (Figure 2 and Figure 3). Accordingly, it is understood that 1,5 mmol L^{-1} P application level is an ideal concentration in terms of plant growth and flowering criteria in hydroponic nutrition of Impatiens plant.

In Impatiens plant, duration to flowering time was shortened by an average of 10-15 days in the other treatments compared to the control treatment (Figure 4). Except for duration to flowering time, the other parameters analysed in the control treatment were determined at the lowest value. This clearly shows that the development and flowering parameters of Impatiens plant are adversely affected when there is not enough phosphorus nutrient in the substrate medium. In particular, the fact that the flowering time was the lowest in the control treatment may be associated with the phenomenon of senescence of Impatiens plants under abiotic nutrient stress.

The total flowering days of Impatiens plants increased with increasing concentration of P in the nutrient solution. However, the highest flowering time was determined in 1 mmL^{-1} P treatment. The P content of Impatiens plant increased with increasing P applications in the nutrient solution, while N and K contents showed a similar trend, but the highest N and K contents were determined in 1 mm L^{-1} P treatment. In a similar study on ornamental plants, it was reported that a P concentration of 1 mmol L^{-1} in the nutrient solution was ideal on flowering time, flower number and total biomass values of Petunia plant [6].

These results show the importance of P nutrition for high quality production in Impatiens cultivation. Since total biomass, shoot length, number of flowers and leaves and flowering time are important parameters determining the ornamental value of Impatiens plants, it is considered that the ideal P concentration value in the nutrient solution of Impatiens plants grown in pots is in the range of 1-1.5 mmol L^{-1}.

IV. CONCLUSIONS

An optimum plant nutrition management is necessary to obtain high quality value in ornamental plants grown in nutrient solution. In Impatiens, shoots, leaves and flowers are the main attractive ornamental organs and adequate biomass, sufficient number of flowers and length of flowering period are among the most important parameters that increase the marketing value of the plant. The experimental results showed that the phosphorus application level in the range of 1-1,5 mmol L^{-1} to the modified standard nutrient solution in hydroponic Impatiens cultivation was optimum in terms of ornamental plant quality parameters in Impatiens.

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