The Effect of Different Phosphorus Levels in Nutrient Solution on The Growth And Appearance Values of Petunia Plant (Petunia Hybrida Vilm)

Bülent Topcuoğlu A. Cihat Kütük

***Abstract*—** In this study, the effects of phosphorus applied at different levels to the nutrient solution of Petunia plant grown in hydroponic pot culture on plant growth and appearance values were investigated. Fresh weight, number of shoots and flowers, shoot length and flowering time, N, P and K levels of Petunia plants increased with increasing levels of phosphorus applied to the nutrient solution compared to the control treatment. P applications induced early flowering in Petunia plants. The highest ornamental plant quality values were determined at 1 mmol L^{-1} P application level of phosphorus applied to the nutrient solution. At this application level, the relative N:P:K ratios were found as 1:0.57:1.47. The experimental results showed that P level in nutrient solution is an important criterion for good marketing value and plant nutrition management of petunia plants.

***Index Terms*—** Petunia, Phosphorus, Hydroponic nutrition

I. INTRODUCTION

Petunia (Petunia hybrida Vilm.), belonging to the Solanaceae family, is an ornamental plant mostly preferred both decoration for summer house gardens and for container cultivation [1]. The life cycle of petunia, as an annual plant, is usually completed within 170 days in total, including about 80 days for flowering, depending on local climatic conditions, biological characteristics and test design [2]. The Petunia plant can be easily propagated asexually from cuttings, calluses or protoplasts. Nowadays, petunia cultivation is becoming widespread along motorways, in parks and residential areas [3]. Petunia offers the potential for high economic returns and is an excellent source of additional income for the flower industry [4].

The management of mineral nutrition through fertilization is an important factor determining the ornamental value and marketability of potted plants [2]. In pot culture of ornamental plants, nutrient form, application rate and time of application during the plant development stage are of great importance in plant nutrition management. While the marketing value of the product obtained with the appropriate fertilization programme increases, negative effects such as plant toxicity, product losses and environmental pollution are minimised. In ornamental plant production, it is known that parameters such as plant biomass, number and length of branches, total leaf area and number of flowers, which determine the marketing value of the plant according to species, are directly related to fertilization [5]. Petunia plants require high nutrient levels to sustain growth and development. Both leaves and flowers are ornamental organs in the petunia plant and multiple applications of N, P and K fertilisers are needed to delay senescence of the whole plant and ensure flowering at normal times [2].

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 [6]. Phosphorus has an important role in the nutrition of petunia 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 Petunia plants [7]. Especially in soilless farming applications, the P concentration in the nutrient solution should be kept at optimum level for an effective feeding programme.

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 Petunia 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. Petunia (Petunia hybrida Vilm) 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 petunia 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.

Petunia 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 [8]. Phosphorus was applied to petunia plants at 0, 0.5, 1, 1.5 and 2 µmol L^{-1}. The composition of

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Bülent TOPCUOGLU is with the Akdeniz University Sustainable Agriculture Department, 07058 Antalya TURKİYE (phone: 0090242-3106751; e-mail: btoglu@ akdeniz.edu.tr).

A. Cihat KUTUK is with the Ankara University Faculty of Agriculture Soilnand Plnat Nutrition Department, Ankara TÜRKİYE

nutrient solutions containing different P levels is given in Table 1.

TABLE 1. COMPOSITION OF NUTRIENT SOLUTION APPLIED TO PETUNIA 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 [8]	13	1.25	1.25	1	7.5	3.125	1

Mineral sals 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°). Petunia 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 petunia 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 petunia 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, nitrogen (N), phosphorus (P) and potassium (K) levels of Petunia plants increased with phosphorus applications to the soil compared to the control treatment.

Fresh weight, number of shoots and number of flowers, shoot length and flowering time, nitrogen (N), phosphorus (P) and potassium (K) levels of Petunia plants increased with phosphorus applications to the soil compared to the control treatment (Figure 1, Figure 2, Figure 3, Figure 4 and Figure 5) In petunia 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 petunia plant are negatively affected when nutrients are not applied to the substrate medium. The fact that the flowering time was the lowest in the control treatment may be associated with the phenomenon of acceleration of the normal life cycle of the petunia plant under abiotic nutrient stress. It has been reported that shoot dry weight, length and shoot P levels of Petunia plants grown with P in fertilizer solution were higher than those grown without P, while plants grown without P were smaller and had reduced marketing quality [9].

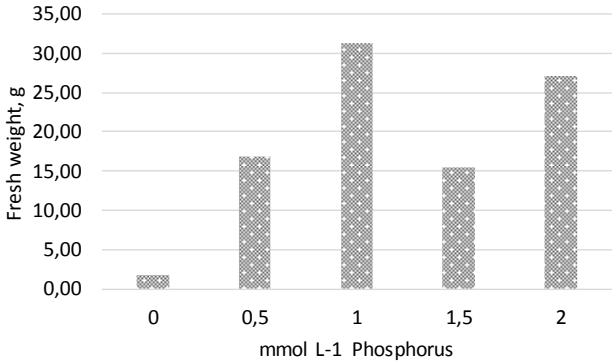

Figure 1. Fresh weight of Petunia in P applications

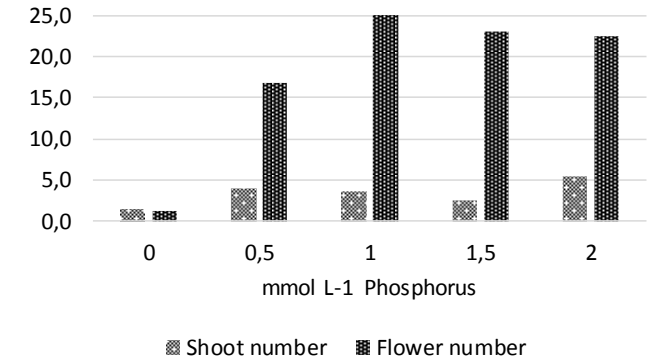

Figure 2. Shoot and flower number of Petunia in P applications

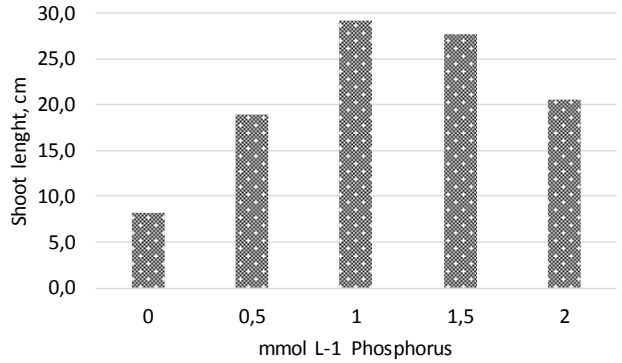

Figure 3. Shoot lenght of Petunia in P applications

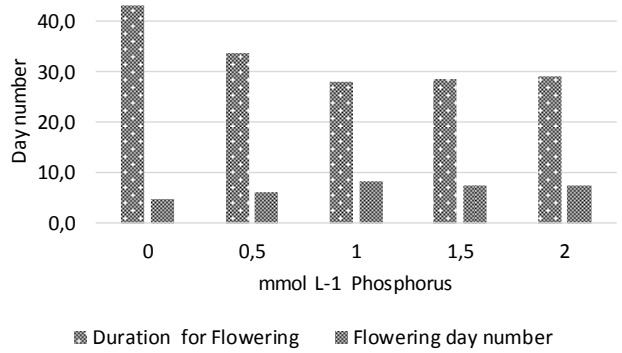

Figure 4. Duration days for flowering and fowering days of Petunia in P applications

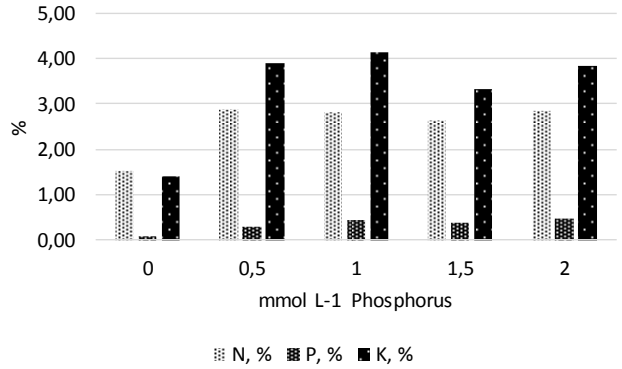

Figure 5. N, P and K content of Petunia in P applications

Fresh weight, number of shoots and flowers, shoot length, duration to flowering of petunia plant were highest at 1 mmol L^{-1} P level in the treatments in which phosphorus was applied at increasing levels of nutrient solution compared to the control treatment. (Table 2). It was determined that lower values were obtained at 0, 0.5, 1.5 and 2 mmol L^{-1} P application levels compared to 1 mmol L^{-1} P level. Accordingly, it is understood that 1 mmol L^{-1} P application level is an ideal concentration in terms of plant growth and flowering criteria in hydroponic feeding of Petunia plant.

TABLE 2. SOME ORNAMENTAL PLANT QUALITY PARAMETERS OF PETUNIA PLANT AT DIFFERENT PHOSPHORUS APPLICATIONS

Phosphorus Applications, mmol L^{-1}	Fresh weight, g	Shoot number	Shoot length, cm	Duration for Flowering	Flowering day number	Flower number
0	1,76 a	1,4 a	8,3 a	43,2 a	4,8 a	1,2 a
0,5	16,83 b	4,0 b	19,0 b	33,8 b	6,2 ab	16,8 b
1	31,32 c	3,6 b	29,1 b	28,0 b	8,2 c	25,0 c
1,5	15,39 b	2,6 ab	27,7 b	28,6 b	7,4 b	23,0 c
2	27,17	5,4 c	20,6 b	29,2 b	7,6 b	22,6 c
Significiency	**	**	**	*	**	**

**: P<0,01; *: P<0,05

The N and P contents of Petunia plant were determined below the minimum nutrient adequacy levels (2.06 and 0.07, respectively) [10] at 0 mmol mmol L^{-1} P application level (Table 3). Accordingly, it is understood that the critical application level for P element in the nutrient solution should be kept at minimum 0.5 mmol L^{-1} P and above.

TABLE 3. SOME MINERAL CONTENTS OF PETUNIA PLANT AT DIFFERENT PHOSPHORUS TREATMENTS

Phosphorus Applications, mmol L^{-1}	N, %	P, %	K, %
0	1,52 a	0,06 a	1,40 a
0,5	2,89 b	0,29 b	3,89 b
1	2,81 b	0,46 c	4,13 c
1,5	2,63 b	0,40 c	3,33 ab
2	2,84 b	0,48 c	3,84 c
Significiency	**	**	**

**: P<0,01

Flowering time and P content of petunia plants showed differences in the treatments, the highest flowering time was obtained in the control treatment and the highest P content was obtained in 2 mmol L^{-1} P treatment. There was no significant change in N and K content of the plant with increasing P application except for the control treatment. The average relative N:P:K contents of petunia plant with respect to nitrogen nutrient were found in the ratio of 1:0.14:1.31. According to this, it is seen that K content of petunia plant is higher than N and P nutrients. At 1 mmol L^{-1} P application level, where the marketing value was the highest, these relative contents were found in the ratio of 1:0.57:1.47. These results show the importance of P nutrition in the healthy nutrition of Petunia plant and in the increase of its marketing value.

IV. CONCLUSION

An optimum plant nutrition management is necessary to obtain high quality value in hydroponic pot culture of ornamental plants. In petunia plant, flowers are the main attractive ornamental organs and the formation of a sufficient number of flowers with a sufficient biomass in the plant, as well as the duration of flowering time are among the most important parameters that increase the marketing value of the plant. The experimental results showed that the application level of 1 mmol L^{-1} phosphorus to the modified standard nutrient solution

in hydroponic Petunia cultivation was found optimum in terms of ornamental plant quality parameters in Petunia plant.

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Bülent TOPCUOĞLU has born in Turkey, 1966; obtained PhD degree in 1993 from the Ankara University, Turkey in Soil Science and Plant Nutrition department.

He is currently working as a Professor on Soil Science and Plant Nutrition, Soil Pollution and Environmental Sciences topics, at the Akdeniz University Vocational school of Tecnical Sciences, Antalya TURKEY. Author has done more than one hundred research publication to his credit.

Prof. Dr. Topcuoğlu has a scientific member of many organizations and chaired of many conferences organized by IAAST, IAE, CBMSR, IICBEE, IIENG, EARBM, EARET and PSRC held in İstanbul and Antalya, TURKEY.