Determination of Optimum Nitrogen and Potassium Rates on The Growth and Appearance Values of Petunia (*Petunia Hybrida Vilm*) Grown in Pot Culture

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***Abstract*— In this study, the effects of nitrogen and potassium applied to Petunia plants grown in pot culture at different rates in nutrient solution on plant growth and appearance values were investigated. Plant fresh weight value, number of shoots, shoot length values, flowering time increased with increasing K rates at constant N level, while it increased with increasing N rates at constant potassium level. The N and K contents of the plant were consistent with the N and K concentration of the nutrient solution. It was determined that N/K ratios had a significant effect on N and K nutrition of petunia plants and the most effective N/K ratio in terms of plant growth and quality values was generally 0.75/1. According to these ratios, the optimum N and K feeding concentration of the nutrient solution was determined as 10.5 mmol $^{L-1}$ for N and 14 mmol $^{L-1}$ for K.**

***Keywords*— Petunia, Nitrogen, Potassium, Pot Culture**

I. Introduction

Petunia plant (Petunia hybrida Vilm.) is an annual plant belonging to the Solanaceae family in the plant kingdom and its life cycle is usually completed within 170 days depending on local climatic conditions, genotypic characteristics and environmental conditions [1]. Petunia plant is an important ornamental plant that is produced on an industrial scale and preferred in open landscape areas in urban environments [2]. Today, petunia cultivation is widely used in urban landscapes, along highways and in private gardens [3], offering the potential for high economic returns for landscape producers and the flower industry [4].

Plant nutrition management in potted plants is an important factor determining the quality value and marketability of ornamental plants [1]. In pot culture of ornamental plants, nutrient form, application rate and application time are of great importance during the plant development stage. With the appropriate fertilization program, the quantity and quality of the product obtained and thus its marketing value increases, while negative effects such as plant toxicity, product losses and environmental pollution are minimized. In ornamental plant production, 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 the species, are directly affected by plant nutrition. In general, the Petunia plant is known to require high nutrient levels for its development [5].

Nitrogen and potassium nutrients are among the essential nutrients absolutely necessary for plant nutrition. It is known that nitrogen nutrient affects especially vegetative development in plants and potassium nutrient affects the desired quality value of the plant. The presence of these two essential nutrients in appropriate ratios in soilless medium is important for plant nutrition and quality.

In this study, the effects of nitrogen and potassium applied to Petunia plants grown in pot culture at different ratios in nutrient solution on growth and crop parameters and nutrient contents were investigated.

II. Material And Methods

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 substrate mixture of heather soil sieved through a 2 mm sieve and washed peat and perlite in a 1:1:1 ratio by volume was used as growing medium in pots. The physical and chemical analytical characteristics of the potting soil were within the range of acceptable values for ornamental plants (Table 1).

TABLE I: THE ANALYTICAL CHARACTERISTICS OF THE POTTING SOIL

Parameters	
Bulk density (g cm^{3-1})	Loam
Particle density (g cm^{3-1})	1,67
Total Porosity (%)	82
Organic Matter, %	1,25
Air Capacity (%)	22
pH- H_2O (1:5 w/v)	7.21
EC, dS m^{-1} 25°C	0,87
NO3-N (mg kg^{-1})	44
P (water soluble, mg kg^{-1})	23
K (water soluble, mg kg^{-1})	46

Petunia plants were transferred to pots and grown by fertigation with a nutrient solution containing different N and K ratios, which was created by modifying the nutrient solution [6] for ornamental plants.

Table 1 shows the N and K ratios applied to Petunia plants and Table 2 shows the contents of nutrient solutions containing different N/K ratios.

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TABLE I: NITROGEN AND POTASSIUM CONTENT IN NUTRIENT SOLUTIONS OF PETUNIA PLANTS

Tretaments	N/K Rates	N/K mmol 1^{-1}
1	1/0.25	14/3.5
2	1/0.50	14/7.0
3	1/0.75	14/10.5
4	1/1	14/14
5	0.75/1	10.5/14
6	0.50/1	7.0/14
7	0.25/1	3.5/14

TABLE II: CONTENT OF NUTRIENT SOLUTIONS CONTAINING DİFFERENT N/K RATİOS İN THE EXPERİMENT (mmol 1^{-1})

Tretaments	NO_3^-	$H_2PO_4^-$	SO_4^-	NH_4^+	K^+	Ca^{++}	Mg^{++}	Na^+
1	13	1.25	5.37	1	3.5	4	1	10.5
2	13	1.25	5.37	1	7,0	4	1	7
3	13	1.25	5.37	1	10.5	4	1	3.5
4	13	1.25	5.37	1	14	4	1	-
5	9.69	1.25	7.03	0.81	14	4	1	0.19
6	6.40	1.25	8.64	0.54	14	4	1	0.46
7	3.25	1.25	10.25	0.25	14	4	1	0.75
Reference [6]	13	1.25	1.25	1	7.5	3.125	1	-

The pH value of the nutrient solutions used in the experiment was adjusted to 6-6.5 and the EC value to 2.5 ms.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 practical leaching of the solution from the pots during the growth period. 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.

Four months after all plants were transferred to the pots, they were cut from the surface of 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 analysis.

The flowering time of Petunia plants was determined based on the time from the transfer of the seedlings to the pots until flowering. The flowering time was determined by labeling the flowers formed on the Petunia plants immediately after bud opening by using adhesive paper tapes with the date of flowering written on it in 1x1 cm dimensions and the time until the flower shriveled. 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 (23.0).

III. RESULTS

N and K treatments applied at different rates to the nutrient solution had statistically significant effects on fresh weight (biomass), number of shoots, shoot length, flowering time, total number of flowers, N and P contents of Petunia plants (Table 3).

TABLE III: SOME ORNAMENTAL PLANT QUALITY PARAMETERS OF PETUNIA PLANT AT DIFFERENT N AND K TREATMENTS

Tretaments	Fresh weight, g	Shoot number	Shoot length, cm	Duration for Flowering	Flowering day number	Flower number
1/0.25	0,88	1,00	5,80	45,20	6,00	4,80
1/0.50	33,32	5,20	26,68	25,60	5,80	38,20
1/0.75	47,80	7,20	29,16	17,00	7,00	55,60
1/1	40,83	8,80	22,88	18,00	5,80	67,80
0.75/1	56,71	8,80	30,68	20,60	7,80	58,00
0.50/1	46,76	6,00	29,06	19,20	7,60	46,60
0.25/1	24,17	2,80	19,36	21,20	10,00	25,00
St. Dev.	18,54	3,06	8,54	10,19	2,17	22,49
Anova	**	**	**	**	NS	**

**:P<0,01; NS: no significancy

Plant fresh weight, shoot number and shoot length values increased with increasing K ratios at constant N level, while they increased with increasing N ratios at constant potassium level. The highest biomass and shoot length values were obtained at 0.75/1 N/K ratio and the highest shoot number was obtained at 1/1 N/K ratio. Flowering time increased with increasing K ratios at constant N level, while there was no significant change with increasing N ratios at constant potassium level. The lowest flowering time was obtained at 1/0.75 N/K ratio. Flowering time increased with increasing K rates at constant N level, but decreased with increasing N rates at constant potassium level. The highest flowering time was obtained at 0.25/1 N/K ratio. The number of flowers of petunia plant increased with increasing K ratios at constant N level, while it increased with increasing N ratios at constant potassium level. The highest flower number was obtained at 1/1 N/K ratio.

Nitrogen nutrient had a positive effect on vegetative growth of petunia plants by increasing fresh weight, shoot length and number of shoots, while potassium nutrient supported vegetative growth with synergistic effect. Nitrogen nutrient had a significant effect on the plant's attractiveness, especially on the number of flowers. Potassium nutrient has a positive effect on plant quality value by increasing flowering time and flower number at constant N levels.

N and P contents of petunia plants did not change significantly with increasing K ratios at constant N level, but increased with increasing N ratios at constant potassium level. The effect of N/K ratios on K content was not significant. The highest N and P contents were obtained at 0,75/1 N/K ratio. The N and K contents of the plant were consistent with the N and K concentrations of the nutrient solution. According to these ratios, the optimum N and K feeding concentration of the nutrient solution was determined as 10.5 mmol L^{-1} for N and 14 5 mmol L^{-1} for K (Table 4).

TABLE IV: MINERAL CONTENTS OF PETUNIA PLANT AT DIFFERENT N AND K TREATMENTS

Tretaments	N, %	P, %	K, %
1/0.25	3,34	0,123	2,94
1/0.50	3,44	0,475	2,64
1/0.75	3,32	0,407	3,31
1/1	3,39	0,444	3,16
0.75/1	3,48	0,502	3,55
0.50/1	2,96	0,393	3,52
0.25/1	2,37	0,394	3,54
St. Deviation	0,43	0,130	0,69
Anova	**	**	NS

**:P<0,01; NS: no significancy

IV. Conclusion

The results of the study showed that an optimum N/K nutrition ratio is required to obtain high quality value in pot culture of petunia plants. Flowers and shoots are the main attractive ornamental organs in petunia plants. In addition, the duration of flowering and the length of flowering period during the vegetation period are among the most important parameters that increase the marketing value of the plant. The findings show that N/K ratios have a significant effect on N and K nutrition of petunia plants and the most effective N/K ratio in terms of plant growth and quality values is generally 0.75/1.

References

[1] Zhang, W., Li, X., Chen, F., & Lu, J. (2012). Accumulation and distribution characteristics for nitrogen, phosphorus and potassium in different cultivars of Petunia hybrida Vlim. *Scientia Horticulturae*, *141*, 83-90. https://doi.org/10.1016/j.scienta.2012.04.010

[2] Ramos, L., Bettin, A., Herrada, B. M. P., Arenas, T. L., & Becker, S. J. (2013). Effects of nitrogen form and application rates on the growth of petunia and nitrogen content in the substrate. *Communications in soil science and plant analysis*, *44*(1-4), 473-479. https://doi.org/10.1080/00103624.2013.744147

[3] Xu, G., Huo, R., Guo, Y., 2010. Growth and development performance of different Petunia hybrida varieties in Yinchuan region. J. Anhui Agric. Sci. 38 (30), 16833–16835.

[4] Fain, G.B., Gilliam, C.H., Sibley, J.L., Boyer, C.R., Witcher, A.L., 2008. Whole tree substrate and fertilizer rate in production of greenhouse-grown petunia (Petunia × hybrida Vilm.) and marigold (Tagetes patula L.). HortScience 43, 700–705. https://doi.org/10.21273/HORTSCI.43.3.700

[5] Gadagi, R.S., Krishnaraj, P.U., Kulkarni, J.H., Sa, T., 2004. The effect of combined Azospirillum inoculation and nitrogen fertilizer on plant growth promotion and yield response of the blanket flower Gaillardia pulchella. Sci. Hortic. 100, 323–332. https://doi.org/10.1016/j.scienta.2003.10.002

[6] Sonneveld, C., Voogt, W., Sonneveld, C., & Voogt, W. (2009). Nutrient solutions for soilless cultures. Plant nutrition of greenhouse crops, 257-275. https://doi.org/10.1007/978-90-481-2532-6_12

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