Scientific Papers. Series B, Horticulture. Vol. LXIV, No. 2, 2020
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

FERTILIZATION IMPACT ON THE GROWTH AND NUTRITIONAL STATUS OF PEACH PLANTING MATERIAL FROM REDHAVEN CULTIVAR ON GF677 ROOTSTOCK, GROWN IN CONTAINERS

Vanya AKOVA, Irina STANEVA, Stefan GANDEV

Fruit Growing Institute, Ostromila 12, Plovdiv, Bulgaria

Corresponding author email: vannnia85@abv.bg

Abstract

A pot experiment was conducted to investigate the impact of different fertilizer rates on growth characteristics and nutritional status of plants from Redhaven cultivar, grafted on GF677 (P. amygdalus x P. persica) rootstock and grown in containers. Variants of the experiment were: Variant I - Control (non-fertilizer), Variant II - $N_1P_{0.25}K_{0.5}Mg_{0.1}$, Variant III - $N_2P_{0.5}K_1Mg_{0.2}$ and Variant IV - $N_{3.2}P_{0.8}K_{1.6}Mg_{0.32}$. The results show that, at the three fertilized variants are obtained plants with a height of 164 to 177.26 cm and a stem diameter of 12.10 to 12.65 mm. The highest average values for stem diameter (12.65 mm) were found in low-fertilized plants. The control plants reached average values of 59.13 cm in height and 5.86 mm in stem diameter and in comparison to all fertilized variants the differences were statistically proven. The results obtained show that the fertilization influenced the content of N, P, K, Ca and Mg. It is concluded that fertilization with all three fertilizer rates ($N_1P_{0.25}K_{0.5}Mg_{0.1}$; $N_2P_{0.5}K_1Mg_{0.2}$; $N_{3.2}P_{0.8}K_{1.6}Mg_{0.32}$) are suitable for the container production of peach planting material for establishing fruit orchards.

Key words*: peach, container growing, fertilization, vegetative behaviour, planting material.*

INTRODUCTION

A new approach in the production of fruit planting material is the container growing. Its advantages are the easier controlling of the cultivation conditions, such as pH of the nutrient substrate, water and nutrient requirements, diseases and pests (Ruter, 1993). Container grown plants have a greater fine root mass compared to field-grown plants (Gilman & Beeson, 1996), show much less stress when planted in the orchard, due to their undamaged root system (Harris, J. R. and E. F. Gilman, 1993), resulting in lower rate of dying after being planted in the field (Mathers et al., 2007). Fertilization is one of the most important practices for the quality of container grown plants, because they are grown in a limited nutritional volume which prevents their growth (Landis, 1989). The production of a qualitative fruit planting material is of great importance as it determines the future behaviour of fruit trees in the orchards. According to Oliet et al. (2004) fertilization can increase the growth of plants, improve their nutrient supply and increase the resistance to water stress, low temperatures and diseases. Often fertilizers used in plant nurseries with container cultivation exceed the required rates for optimal growth (Maust & Williamson, 1991). Improving the efficiency of fertilizer application is one of the ways of reducing production costs and obtaining fruit planting material suitable for establishing fruit orchards.

The aim of the study was to assess the impact of fertilization on the growth and nutritional status of peach planting material from Redhaven cultivar on GF677, produced in containers.

MATERIALS AND METHODS

The study was conducted in the period 2017-2018 at the Fruit Growing Institute in Plovdiv, Bulgaria. Peach plants from Redhaven cultivar, grafted on GF677 (*P. amygdalus* x *P. persica*) rootstock under conditions of container growing experiment were studied.

The GF677 rootstock was produced in 2017 at the Production laboratory for in vitro propagation in the Fruit Growing Institute - Plovdiv. The micropropagated plants were grown in plastic containers of 7.5 litters capacity. A mixture of peat and perlite in a 2:1 ratio was used for the substrate. The plants were grown outdoors in a shaded field and fertilized with ammonium nitrate (NH_4NO_3). In August the rootstocks were grafted with

Redhaven cultivar. The fertilization experiment was set in 2018 in four variants with twenty five replications, each plant considered a separate replicate.
Variants of the experiment:
I. Control (non-fertilizer);
II. $N_1P_{0.25}K_{0.5}Mg_{0.1}$/container;
III. $N_2P_{0.5}K_1Mg_{0.2}$/container;
IV. $N_{3.2}P_{0.8}K_{1.6}$ $Mg_{0.32}$/container

Fertilization with increasing nutrient rates was applied on the surface four times. The fertilization was carried out with a combined Kristalon compound fertilizer by YARA - N(20%)-P_2O_5(5%)-K_2O(10%)-MgO(2%), applied every 20 days, the first introduce being made at the beginning of May.
The soil moisture in the containers was maintained to a field capacity, with the number of waterings complied with the specific temperature conditions and the amount of precipitated rainfall.
The following parameters were recorded: plant height (cm), stem diameter (mm), leaf area (cm^2), root system volume (cm^3) and content of photosynthetic pigments. The leaf area was measured by scanning the leaves and analysing the resulting images with specialized software (Gao et al., 2011). The volume of the root system was measured by the Burdett method (1979). The content of chlorophyll (a, b, a+b) and carotenoids was determined spectrophotometrically in 95% ethyl alcohol extract (Skazkin et al., 1958).
In order to determine the nutritional status of the plants, a chemical analysis of the leaves was carried out. Samples of 15 fully developed leaves from each replication of the variants were taken. Total concentrations of nitrogen, phosphorus, potassium, calcium, and magnesium were determined by standard methodologies (Tomov et al.,1999; Campbell & Plank, 1998; Karageorgiev, 1977; Stoilov, 1968).
The results obtained are subjected to mathematical analysis using the method developed by David B. Duncan (Duncan, 1955; Harter, 1960). Software used in the study are "R-3.1.3" in combination with "RStudio-0.98" and installed package "agricolae 1.2-2" (Mendiburu, 2015).

RESULTS AND DISCUSSIONS

The results show that the YARA Kristalon mineral fertilization has a significant impact on the growth characteristics of peach plants (Table 1). The fertilized variants (var. II, var. III and var. IV) had higher values in all measured parameters compared to the control (var. I), the differences being statistically proven.
The obtained results show that there are no significant differences between the fertilized variants (var II, var. III and var. IV)) on the growth of stem diameter and plant height.

Table 1. Impact of the fertilization on the growth characteristics of peach planting material, at the end of vegetation

Variant	Plant height (cm)	Stem diameter (mm)	Leaf area (cm^2)	Volume of root system (cm^3)
I (Control)	59.13 b	5.86 b	32.36 c	78.33 c
II	170.40 a	12.65 a	51.86 b	320.00 a
III	177.27 a	12.31 a	56.74 b	213.33 b
IV	164.00 a	12.10 a	65.58 a	206.67 b

The nourished plants (var. II, var. III and var. IV) had a height from 164 to 170.40 cm, and those of the control variant had lower average height values (59.13 cm) (Table 1).
The average stem diameter of the control plants was 5.86 mm. The fertilized plants (var. II, var. III and var. IV) had higher average values for stem diameter - from 12.10 to 12.65 mm. The differences are statistically proven.
Significant differences were observed in the leaf area of all fertilized variants compared to the control. The plants of fertilized variants (var. II, var. III and var. IV) had leaf area from 50.06 to 65.58 cm^2, and those of the control variant were characterized by lower average values (32.36 cm^2) (Table 1).
The data shows that fertilization affects both the aboveground part of the plants and the root system. The average value of the volume of the root system of the control plants was 78.33 cm^3 The low-fertilized plants (var. II) have a higher root system volume - 320.00 cm^3, which is approximately 4 times higher than the non-fertilized plants (var. I). Medium and high fertilizer rates (var. III and var. IV) have been found to stimulate the growth of the root, but compared to the low fertilizer rate (var. II) the

effect of the fertilization on the root system volume is lower. A number of authors point to a positive correlation between the volume of the root system and the subsequent crop development under field conditions, planting material with larger root system having higher survival rates. (Rose et al., 1991a, 1991b, 1992, 1997; Jacobs et al., 2005).s

Figure 1. Peach planting material at the beginning and at the end of vegetation

Chlorophyll is the basic catalyst of photosynthesis, as the green pigments exists in all plant tissues that do photosynthesis (Masinovsky et al., 1992). Although the content of photosynthetic pigments is not the only criterion for photosynthesis of plants, their content can be considered as a indicator of the photosynthetic competence of the plants. The results obtained for the photosynthetic pigments in the leaves (mg/g fresh weight) are presented in Table 2.

Table 2. Content of photosynthetic pigments in leaves (mg/g fresh weight) of peach plants with different rates of fertilization

Variant	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Chlorophyll a+b (mg/g)	Carotenoids (mg/g)
I (Control)	0.88 b	0.33 b	1.21 b	1.19 b
II	1.91 a	0.87 a	2.94 a	2.21 a
III	2.06 a	0.93 a	2.96 a	2.33 a
IV	2.09 a	1.03 a	2.98 a	2.36 a

The results obtained show that the content of chlorophyll a, b, a+b and carotenoids increases when applied increasing rates of the used fertilizer Kristalon, as the differences with the control plants are statistically proven. In all tested variants the values of chlorophyll a are higher than those obtained for chlorophyll b. The content of chlorophyll a increases from 0.88 mg/g (var. I) to 2.09 mg/g (var. IV), and that of chlorophyll b increases from 0.33 mg/g (var. I) to 1.03 mg/g (var. IV). The highest values of total chlorophyll a+b (2.98 mg/g) and carotenoids (2.36 mg/g) are obtained at the high fertilization rate (var. IV) As the fertilizer rate increases the content of photosynthetic pigments in leaves also increases, but there are no significant differences between the fertilized variants (var. II, var. III and var. IV). Considering the obtained results we can therefore conclude that the applied fertilizer is beneficial to the content of photosynthetic pigments in leaves, which is a condition for good physiological status of peach plants.

The influence of the various fertilizer rates on the content of macroelements in the leaves is presented in Table 3.

Table 3. Contents of the macroelements in the leaves

Variant	%N	%K	%P	%Ca	%Mg
I (Control)	1.88 d	3.30 b	0.47 ab	2.68 a	0.44 b
II	3.26 c	3.32 b	0.36 b	2.33 a	0.59 ab
III	3.63 b	3.63 a	0.41 ab	2.74 a	0.73 a
IV	4.13 a	3.36 b	0.51 a	2.30 a	0.56 ab

The results obtained show that the fertilization influenced the content of macroelements in the leaves of peach plants.

It was found that with the applied fertilizing rates the content of N in the leaves increases straightforward to the fertilizer rate. The content of N in the leaves was approximately twice higher in the fertilized plants than those of the control. Foliar nitrogen fluctuates from 1.88% at the control to 4.13% for variant IV. The differences are statistically proven.

The values for the K content in the leaves were in the range from 3.30% to 3.63%. Only in variant III there is a statistically proven difference with the control.

The values obtained for the Mg in all variants of fertilization were in the range 0.44% - 0.73%. The highest content of 0.73% was in variant III and the difference with the control variant being significant.

The content of P in the leaves was in the range from 0.36% (var. II) to 0.51%. (var. IV). The results regarding the content of P did not show a clear tendency.

The values for the Ca content in the leaves varied in range 2.30-2.74%. The fertilization rate did not significantly affect the calcium content in the leaves of the peach plants.

The fertilization applied has a favourable effect on the content of the macroelements in the leaves of peach trees. Fertilization leads to a better nutritional supply compared to the control.

CONCLUSIONS

Fertilization with Kristalon by YARA in fertilization rates $N_1P_{0.25}K_{0.5}Mg_{0.1}$; $N_2P_{0.5}K_1Mg_{0.2}$ and $N_{3.2}P_{0.8}K_{1.6}Mg_{0.32}$ leads to the production of peach planting material of larger sizes than the control (not-fertilized) trees.

The content of macroelements in the leaves of the grafted plants of the Redhaven cultivar on GF677 (*P. amygdalus* x *P. persica*) rootstock are effected from fertilization with the combined fertilizer Kristalon by YARA. Fertilization leads to a better nutritional supply compared to the control.

All three fertilizer rates ($N_1P_{0.25}K_{0.5}Mg_{0.1}$; $N_2P_{0.5}K_1Mg_{0.2}$ and $N_{3.2}P_{0.8}K_{1.6}Mg_{0.32}$) are effective, stimulate plant growth and are suitable for the container production of peach planting material for establishing fruit orchards. In container production of peach plants, nutrition should be a mandatory practice.

REFERENCES

Burdett, A.N. (1979). A nondestructive method for measuring the volume of intact plant parts. *Canadian Journal of Forest Research*, 9:120-122.

Campbell, C.R. & Plank, C.O. (1998). Preparation of plant tissue for laboratory analysis. Chapter 3 in: Kalra, Y.P. (Ed.), *Handbook of reference methods for plant analysis*. Soil and Plant Analysis Council, Inc., CRC Press, Taylor & Francis Group, 287 pp.

Duncan, D. B. (1955). Multiple Range and Multiple F Tests. *Biometrics*, 11(1): 1-42.

Gao, J. C., Guo, G. J., Guo, Y. M., Wang, X. X., & Du, Y. C. (2011). Measuring plant leaf area by scanner and ImageJ software. *China Vegetables*, 2, 73-77.

Gilman, E.F. & Beeson, R.C. (1996). Jr. Nursery production method affects root growth. *Journal of Environmental Horticulture*, 14:88-91.

Harris, J.R.& Gilman, E.F. (1993). Production method affects growth and post-transplant establishment of 'East Palatka' holly. *Journal of the American Society for Horticultural Science*, 118:194-200.

Harter, H. L. (1960). Critical Values for Duncan's New Multiple Range Test. *Biometrics*, 16(4): 671-685.

Jacobs, D.F., Salifu K.F., Seifert, J.R. (2005). Relative contribution of initial root and shoot morphology in predicting field performance of hardwood seedlings. *New Forests in press*.

Karageorgiev, D. (1977). Improved method for calcium and magnesium determination. *Soil Science and Agrochemistry*, XII(1): 31-34.

Landis, T.D. (1989). Mineral nutrients and fertilization. In: Landis, T.D., Tinus, R.W., McDonald, S.E., Barnett, J.P. (Eds.), *The Container Tree Nursery Manual*, vol. 4., Agriculture Handbook No. 674. USDA Forest Service, pp. 1-70.

Masinovsky, Z., Lozovaya, G.I., Sivash, A.A.(1992). Some aspects of the early evolution of photosynthesis. *Adv. Space Res. 12(4):199-205.*

Mathers, H.M., Lowe S.B., Scagel C., Struve D.K., Case L.T. (2007). Abiotic factors influencing root growth of woody nursery plants in containers. *HortTechnology*, 17:151-162.

Maust, B. E. & Williamson, J. G. (1991). Nitrogen rate effect on growth of containerized citrus nursery plants. *Proc. Fla. State Hort. Soc.*, *104*, 191-195.

Mendiburu, F. (2015). Statistical Procedures for Agricultural Research., URL:*http://cran.r-project.org/web/packages/agricolae.*

Oliet, J., Planelles, R., Segura, M. L., Artero, F., Jacobs, D. F. (2004). Mineral nutrition and growth of containerized Pinus halepensis seedlings under controlled-release fertilizer. *Scientia Horticulturae*, 103(1), 113-129.

Rose R., Atkinson M., Gleason J. & Haase D. (1992). Nursery morphology and preliminary comparison of 3-year field performance of 1 + 0 and 2 + 0 bareroot ponderosa pine seedlings. *Tree Planters' Notes, 43*, 153-158.

Rose R., Atkinson M., Gleason J. & Sabin T. (1991a). Root volume as a grading criterion to improve field performance of Douglas-fir seedlings. *New Forest* 5, 195-209.

Rose R., Gleason J., Atkinson M. & Sabin T. (1991b). Grading ponderosa pine seedlings for outplanting according to their root volume. *Western J. Appl. For. 6*, 11-15.

Rose R., Haase D.L., Kroiher F. & Sabin T. (1997). Root volume and growth of ponderosa pine and Douglass-

fir seedlings: a summary of eight growing seasons. *Western J. Appl. For. 12*, 69-73.

Ruter, J.M. (1993). Growth and landscape performance of three landscape plants produced in conventional and pot-in-pot production systems. *Journal of Environmental Horticulture*, 11:124-127.

Skazkin F. D., Lovchinovskaya E. I., Miller M. S. & Anakiev V. B. (1958). Manual of plant physiology, sp. „*Sovetskaya nauka*“, Moskva. (Ru).

Stoilov, G. (1968). *Evaluation of the hydrazine method for phodphorus determination in studing plant samples*. Reports of Bulgarian Agriculture Science Academy, book, 1, 115-121.

Tomov, T, G. Rachovski, S. Kostadinova, I Manolov. (1999). *Handbook of agrochemistry methods*, Academic publisher VSI – Plovdiv, Bulgaria.


EX·TERRA·AVRVM