Fruit Growing Research, Vol. XXXVII, 2021 DOI 10.33045/fgr.v37.2021.10
https://publications.icdp.ro/index.php

INFLUENȚA PORTALTOILOR DE VIGOARE REDUSĂ ASUPRA PROCESELOR DE CREȘTERE ȘI FRUCTIFICARE LA SOIUL DE CIREȘ 'REGINA'

INFLUENCE OF LOW VIGOUR ROOTSTOCKS ON GROWTH AND FRUITING PROCESS OF 'REGINA' CULTIVAR

Călinescu Mirela, Mazilu Ivona*, Chițu Emil, Butac Mădălina, Chivu Mihai, Plăiașu Florin, Antonescu Monica
Research Institute for Fruit Growing Pitesti, Romania
*Corresponding author: Mazilu Ivona; e-mail: imazilu@icdp.ro

Abstract

The aim of this paper was to study the influence of low vigor rootstocks on the 'Regina' cherry cultivar. The study was conducted at Research Institute for Fruit Growing Pitesti, Arges county, Romania between 2019 and 2021. A bifactorial experiment was set up, with A factor-the rootstock ('Gisela 3', 'Gisela 5', 'Gisela 12' and 'Weigi 2') and B factor-the study year (2019, 2020 and 2021). Fruiting and vegetative growth data (fruit production, the trunck cross-section area-TCSA, the annual increase of TCSA, the productivity index and the ratio between the fruit production and the annual increase of TCSA), as well as fruit quality data (fruit mass, firmness, pH, total soluble content, chromatic coordinates of epicarp color and chlorophyll fluorescence) were collected. 'Gisela 5' rootstock recorded the highest value of TCSA annual increase (11.46 kg/cm^2) and had also the highest cromatic coordinates values: colour brightness (25.68), red pigment (15.61) and yellow content (4.12).The highest vigor of the cultivar 'Regina' was observed in 'Weigi 2' rootstock variant (with an TCSA value of 44.71 cm^2), given that 'Weigi 2' TCSA annual increase was similar to 'Gisela 5'. 'Gisela 3' rootstock stood out for its fruit highest pH (3.97), fruit yield (13.51 t/ha), lowest vigor (TCSA=24.19 cm^2), smallest annual TCSA increase (6.11 cm^2), highest productivity index 0.219 kg/cm^2) and highest fruit production to annual TCSA increase ratio (1.79 kg/cm^2). Taking into account climatic accidents that marked the spring of 2021, on the average of the study years, the cultivar 'Regina' grafted on the rootstock 'Gisela 12' was distinguished by fruit weight (10.02 g), firmness (66.53 units HPE Bareiss) and TSS (16.03°Brix) on the background of the lowest fruit yield. A negative very signifficant correlation between fruit yield and fruit quality traits (weight, firmness and total soluble solids) was found.

Cuvinte cheie: calitatea fructelor, producție, indice de productivitate, TCSA.
Key words: fruit quality, fruit yield, productivity index, TCSA.

Introduction

Cherry cultivation is a horticultural branch of great interest, due to the special organoleptic fruit qualities, beneficial to human health compounds content, but also through its early fruiting (May-June), compared to other species. The current trend of species cultivation in a super-intensive system has been supported by the efforts of breeders, materialized not only in obtaining valuable varieties, but also rootstocks that enhance the features of the varieties (fruit quality is a characteristic of the cultivar, for example). Moreover, the new generations of rootstocks allow to reduce the planting distances (increasing the planting density) and the high of the trees (cultivars). Each of these rootstocks, suitable for modern cultivation technologies, can provide additional features to the cultivar: precocity, early maturity, productivity, low vegetative growth, resistance to diseases and pests, adaptability to pedological conditions and constantly changing climatic factors. On the other hand, grafting on low rootstocks has claimed some problems such as fruit overproduction (Anderson et al., 1999) and, as a result of the imbalance between fruiting and leaf area, small fruits. In addition, the very low height of the trees (which bring the crown closer to the ground) and the early exposure expose the trees to an additional risk, especially in areas where climate accidents such as late spring frosts occur (Anderson et al., 1999). Last but not least, the maintenance technology of trees grafted on low vigor rootstocks involves interventions such as more drastic pruning, a special regime of fertilization and, irrigation and even thinning of fruit. Among the rootstocks suitable for super-intensive cultivation are those from the 'Gisela' group and 'Weigi'. The efficiency of a cherry crop depends, without a doubt, on the quality of the fruits, but in order to obtain a valuable production it is necessary to study the behavior of the cultivar / rootstock combinations in the pedoclimatic conditions of the areas of interest. Therefore, the purpose of this study is to evaluate fruit quality, productivity and vegetative growth in the 'Regina' cultivar grafted on low vigor rootstocks 'Gisela 3', 'Gisela 5', 'Gisela 12' and 'Weigi 2' in the conditions of Arges county (South) Romania.

2. Material and methods

The study was conducted between 2019-2021, at Research Institute for Fruit Growing Pitești-Maracineni Arges (44.8953 degrees north latitude, 24.8609 degrees east longitude and an altitude of about 290 m above sea level), within the cherry demonstrative plot. According to the Köppen-Geiger classification, the Pitesti area is characterized by a humid continental climate. According climatological data own by RIFG Pitesti, the multiannual air average temperature (1969-2020) was 10.0ºC, and the sum of precipitation was 678 mm. The total monthly deficit of medium-annual rainfall (ETo-PM minus rainfall) reaches 153 mm, with a maximum monthly value in summer of 48 mm (August) and a rainfall surplus in winter of 121 mm. The soil on which the experiment is located is characterized by a low natural fertility and an acid reaction (pH = 5.25 in the first 20 cm). Agrochemical fertility indicators analyzed in soil (before fertilization) show a very low supply of macroelements (total nitrogen content below 0.1%, total phosphorus in the form of P_2O_5 below 70 ppm, potassium = 130 ppm). Humified organic matter also has very low content values (organic carbon=1.27%, humus=2.18%).

To evaluate the influence of rootstocks on the growth and fruiting process and on the quality of fruits and the Regina cultivar, a bifactorial experiment was set up, where as the first experimental factor (A), was the rootstock, with four levels, a1 = 'Gisela 3', a2 = 'Gisela 5', a3 = 'Gisela 12' (all three *P. cerasus* L. 'Schattenmorelle' x *P. canescens* L) and a4 = 'Weigi 2' (cross between a selection of Giessen and Weiroot), the second factor (B) being the year of study, with three levels, b1 = 2019, b2 = 2020, b3 = 2021. 'Regina' is a self-sterile cultivar, but valuable for its firm fruits, with appreciated flavour and resistant to rain-induced cracking. 'Gisela 3' is the rootstock of the lowest vigor in the 'Gisela' series, specially adapted for cultivation in protected areas, but which requires careful management of the culture. 'Gisela 5' is considered rather a semidwarf rootstock recommended for different crown shapes and different planting densities. 'Gisela 12' is more vigorous than 'Gisela 5' and prints on precooked varieties, without risk of overproduction, has a good resistance to cold, being, at the same time, suitable for areas with high temperatures. 'Weigi 2' rootstock gives the cultivar vigor similar to 'Gisela 5' or lower, depending on soil fertility.

The cultivation system is super intensive, with planting distances chosen according to the rootstock: 1 x 4 m, for the 'Gisela 3' rootstock and 1.5 x 4 m for the other three rootstocks, and the shape of the crown is slender. The cultivation technology applied in the experimental plot consisted in planting the trees on the plank and maintaining the grass between the rows, with the mowed grass kept as green manure. Plot nutrition was ensured by the fertigation system, and the fertilizer doses were established based on the "SMART FERTILIZER" program. The water supply was achieved through the drip irrigation system, depending on the soil moisture (measured by humidity sensors located in the soil, at depths of 20 and 40 cm) and the potential evapotranspiration.

Threes vegetative growth was monitored by measurements of the cross-sectional area of the trunk (TCSA), and the annual growth increase of TCSA was calculated (the difference between the TCSA determined at the start and at the end of the vegetation season). Fruit yield was determined by weighing the fruits harvested from a number of 2 trees, in 3 repetitions each. The productivity index was calculated by the ratio of fruit production per tree to TCSA. Also, the assessment of the production / vegetative growth balance was made by calculating the ratio between fruit production per tree and the annual increase of TCSA. To study the quality of the fruit, samples of 30 fruits were collected in 3 repetitions from each of the combinations of the ‘Regina’ cultivar with the four rootstocks. The following fruit quality indicators were determined: fruit mass (by individual weighing of the fruit in the sample using the "KERN" balance), firmness of the fruit pulp (by the non-destructible technique, using the "QUALITEST HPE-II-FFF" penetrometer) , the pH and the total soluble content of the fruit juice (using the "Mini-Lab" laboratory pH meter and the "KERN" portable electronic refractometer), the chromatic coordinates of the fruit epicarp color were measured using the CR400 colorimeter. at Konica Minolta, and the chlorophyll content of the fruit was assessed by determining the fluorescence of chlorophyll in the epicarp, using the FluorPen FP100 apparatus.

A two-way ANOVA test (IBM SPSS 20) was performed to find if there were significant differences between rootstocks and a multiple comparison method, such as a Duncan test was used to identify which means are different (the confidence interval was set at 95%). The graphical presentation of the influence of the experimental factors on the quality indicators and on the fruit production was made with the Microsoft Office Excel program.

3. Results and discussions

Fruiting and growth process data are presented in descriptive terms in Table 1. As can be seen, fruit yield averaged 8.82 t/ha, ranging from a minimum value of 0.5 t/ha (rootstock 'Gisela 12') and a maximum of 25.55 t/ha ('Gisela 3'). Between the third and fifth year after planting, the area of the cross section of the trunk of the 'Regina' cultivar grafted on the four rootstocks studied recorded an average

value of 34.51 cm^2, and the average annual growth increase (determined in autumn of 2020 and 2021) was 9.29 cm^2. Under these conditions, the mean productivity index registered 0.15 kg/cm^2 and the average annual production / growth rate of 0.89 kg/cm^2 was calculated (Table 2).

Fruit yield ranged signifficantly from 3.74 t/ha, for 'Regina/Gisela 12', to 13.51 t/ha, for 'Regina/Gisela 3'. As expected, fruit yield increased from 2019 to 2021, for 'Gisela 5' (with 11.1 t/ha) and 'Weigi 2' (with 10.23 t/ha), except 'Gisela 3' and 'Gisela 12'. 'Gisela 3' and 'Gisela 12' fruit yield increased in the second experimental year, but reduced in 2021 by 30.44 and 51.89%, respectively.

Study of temperature dynamics in spring of 2021 revealed three frost waves, with the last one (with a peack of -3.3°C) în April, between 8 and 10, that fount cherry trees in BBCH 55 and could explain therefore flower buds damage (Fig. 2). A similar temperature drop to -3.9°C occured in 2020, în Aprilie 1st (when flower buds reached in BBCH 57). Unlike 2021, în 2020 frost episode affected 'Regina/Gisela' 12, but 'Gisela 3'. During 2019-2021 'Regina/Gisela 3' was the most productive, with a cumulative yield of 40.54 t/ha, followed by 'Weigi 2' and 'Gisela 5', with 25.93 t/ha and 25.54 t/ha, respectively.

TCSA **(**the cross-sectional area of the trunk) varied significantly between rootstocks, from 17.58 cm2 ('Gisela 3', 2019) to 56.39 cm2 ('Weigi 2', 2021). Thus, as can be seen in Table 2, on the average, cherry trees with the highest TCSA were those grafted on 'Weigi 2' rootstock, with 44.70 cm^2, compared to 'Gisela 3', the least vigorous, with a TCSA value of 24.79 cm^2. Our results agreed with Anderson et al., (1999) conclusion: lower vigor rootstock expose the cultivar to spring frost damage and 'Gisela 3' showed it. Still, 'Regina/Gisela 3' overcome frost injures throught its highest productivity.

Significant differences were also observed between rootstocks, in terms of annual TCSA increase (Table 2), which resulted in higher growth of 'Gisela 5' rootstock grafted trees, averaging 11.46 cm^2, althought without significant differences compared to 'Weigi 2' (10.77 cm^2) and 'Gisela 12' (9.45 cm^2). All rootstocks truncks section grew similar until 2021, when when the differences became noticeable. The lowest annual growth increase was recorded for the combination 'Regina/Gisela 3', in 2021 (3.89 cm^2), while the most intense one was registered for 'Regina/Gisela 5, in 2021 (16.16 cm^2). Althought 'Weigi 2' proved to be the most vigorous rootstock, its annual TCSA increase was similar to 'Gisela 5'.

Productivity index (PI) varied significantly under rootstock influence, from 0,109 kg/cm^2 ('Weigi 2') to 0.219 ('Gisela 3'). Data presented in Table 2 indicate that the PI reached its highest value for 'Gisela 3' rootstock grafted trees in 2020 (0.330 kg/cm^2).

Fruit production to annual increase of TCSA ratio varied also significantly under rootstock influence (Table 2), ranging between 0.448 kg/cm^2 ('Gisela 12') and 1.793 ('Gisela 3'). Its increasing trend registered for 'Regina/Gisela 3' proved that cherry tree utilized its assimilates mainly to support fruit production, while 'Gisela 12' supported its vegetative growth instead yield.

Descriptive statistical analysis of fruit quality data for the 'Regina' cultivar (Table 1) indicated that, on the entire experiment, the average fruit weight was 9.39 g, ranging from the extreme 5.41 g ('Gisela 3') and 13.29 g ('Gisela 12'), the firmness recorded an average value of 58.41 HPE Bareiss units and fluctuated from 40.40 ('Weigi 2') to 87.10 ('Gisela 12'). Fruit juice had an average pH (3.90), that ranged between 3.02 ('Gisela 3') and 4.81 ('Gisela 5'), and average total soluble solids (TSS), 15.04 ° Brix, varied from 10.50 ('Gisela 5') to 22°Brix ('Gisela 12'). Chromatic coordinates data, describing the color of the fruit epicarp, indicated average values of 25.09 for brightness (L*), 12.72 for red pigment content (a*) and 2.92 for yellow pigment content (b*), respectively. Chlorophyll fluorescence (QY), determined on the fruit skin, varied between 0.00 and 0.52, and averaged 0.21.

Fruit weight varied significantly, from a minimum value of 8.67 g ('Gisela 3') to a maximum of 10.02 g ('Gisela 12'). It could be observed that fruit bigger fruit yield correlated with smaller fruit size (r=-0.557°°°). Fruit weight increased from 2019 to 2021 for all rootstoks, except 'Gisela 5' which registered a 12.18% decrease in 2021 compared with 2019. It must be reminded that 'Gisela 5' had a large yield an also the highest TCSA anual increase în 2021. Therefore, between 2019-2021, 'Gisela 5' raised its fruit yield (from 2.83 to 13.93 t/ha) and doubled TCSA by reducing fruit size (from 10.16 to 8.92 g). Similar was registered for 'Gisela 3' between 2019-2020. On the other hand, 'Gisela 3', when reduced fruit yield from 20.96 to 14.58 t/ha (between 2020-2021) had bigger fruits (9.31 compared to 7.53 g). The smallest fruit size of 'Regina/Gisela 3 in 2020 could be explained by the fact that the fruit had not reached harvest maturity stage. The statement is supported by the fruits lowest TSS value (12.95°Brix), as well as by the QY (clorophyll fluorescence-quantum yield), which recorded, in 2020, the highest value for 'Regina /Gisela 3 (Table 3). In 2021, 'Gisela 12' grafted cherry trees fruit production decreased (possibly due to the late spring frosts effects), which would justify the highest fruit weight in this variant.

Significant differences between rootstocks were also highlighted in terms of fruit pulp firmness, which ranged from 53.63 ('Weigi 2') to 66.53 HPE Bareiss units ('Gisela 12'). On the average of the four rootstocks, fruits had the highest firmness, respectively 65.88 HPE Bareiss units in 2019, compared to the following years.

As shown in Table 3, the fruit pH of 'Regina' cultivar ranged from 3.79 ('Weigi 2') to 3.97 ('Gisela 3'). A comparison of fruit acidity over the three experimental years indicated that the pH value of the fruit of the 'Regina' cultivar increased between the first and last year from 3.78 to 3.93.

Data analysis of fruits total soluble content revealed significant differences between rootstocks, with an oscillation between 14.338 ('Gisela 3') and 16.03°Brix ('Gisela 12'), althought 'Gisela 5' registered a peack in 2020 (16.05°Brix). It could be also observed that the soluble content of 'Regina' cv. fruits recorded the highest value, 15.22°Brix, in 2021, however without significant differences compared to the first year.

Brightness of the fruit epicarp color, L* (Table 3), took values between 23.63 ('Weigi 2', 2019) and 26.89 ('Gisela 5', 2021). It recorded, on the average of the study years, the superior value of 25.68 for the 'Gisela 5' rootstock, the darkest color of the epicarp being observed for the fruits of 'Gisela 3' rootstock grafted trees, 24.32. On average of rootstocks, fruits with superior color brightness were harvested in the third year of study (25.40).

Red pigment content of the fruit epicarp color, a* (Table 3) ranged between 9.69 ('Weigi 2', 2020) and 19.47 ('Gisela 5', 2021). On average, 'Gisela 5' rootstock had a* highest value (15.61). It was also observed that a* increased from 2019 to 2021.

Yellow pigment content of the epicarp color, b* (Table 3), reached its maximum value, 5.49, for 'Gisela 5' rootstock (2021) and the minimum, 0.51 for 'Weigi 2' (2021). 'Regina'/'Gisela 5' rootstock fruits had the highest yellow pigment content (4.12). As shown in Table 2, similar to L* and a*, b* increased between 2019 and 2021.

Chlorophyll fluorescence (QY) of the fruits epicarp (Table 3) varied significantly depending on the rootstock, with an oscillating between the minimum value, 0.122 ('Gisela 12', 2019) and the upper value of 0.266 ('Gisela 3', 2019). The highest fruits maturation degree (lowest fluorescence of epicarp chlorophyll) was recorded in the second year of the study (0.174). At a constant level of the study year, fruits with low epicarp fluorescence level were those harvested from trees grafted on the 'Gisela 12' rootstock in 2019 (0.122), 'Weigi 2' in 2020 (0.147) and 'Gisela 3' in 2021 (0.193).

According Pearson coefficients, fruit production correlated very significantly negatively (r=-0.557°°°) with fruit weight, especially for 'Gisela 5' (r=-0.763°). There was also a very significant increase in fruit production while reducing fruit firmness (r=-0.533°°°) and total soluble content (r=-0.572°°°). Therefore fruit yield increased by reducing not only fruit weight, but also reducing fruit quality. The annual increase in TCSA was very significantly positively correlated with fruit epicarp chlorophyll fluorescence, which means that in the case of rootstocks that stimulated the cherry tree vegetative growth, fruit ripening was delayed. High-weight fruits were significantly firmer (r=0.370*) and showed significantly higher TSS (r=0.744***). Last but not least, the increase in L* was achieved simultaneously with the distinctly significant increase in the value of a* (r=0.565**) and a significant increase in the value of b* (r=0.477*).

Results of the present study indicated lower fruit weight compared to those reported by Zlati et al. (2019), which determined a fruit mass of 11.0 g for the 'Regina' cultivar grafted on the rootstock Gisela 5. Balmer et al. (2020) studied the 'Regina' cultivar grafted on 'Gisela 3', 5, 12 and 'Weigi 2' and observed that the percentage of fruit larger than 28 mm increased in the order of 'Weigi 2', 'Gisela 12', 'Gisela 5' and 'Gisela 3'.

In other studies on fruit mass or fruit production of the 'Regina' cultivar grafted on rootstocks similar to those in our study, the results reported were different. Thus, Zlati et al. (2019) reported higher cumulative yields (4 years) for the cultivar 'Regina' grafted on the rootstock 'Gisela 5' (planting distances not mentioned) compared to other 8 varieties. Balmer et al. (2020) reported, similar to Zlati et al. (2019), cumulative yields (for a period of 4 years) higher than 'Gisela 5' compared to 'Gisela 3', 'Gisela 12' and 'Wiegi 2' (for planting distances of 4.5 x 2.2 or 3.0 m). Similar results to the present study were previously obtained by Robinson and Hoying (2009) and Robinson et al. (2017). In addition, Robinson et al. (2017) obtained data on lower tree vigor, lower fruit mass and higher TSS content in the 'Regina/Gisela 5' combination compared to 'Regina/Gisela 12', but no differences in efficiency were observed of fruit production. Similar to the results of this study, higher fruit yields at 'Gisela 3' rootstock compared to 'Gisela 5' were also reported by Stehr (2005).

Different results were reported by Bujdosó in a comparative study conducted in the period 2006-2014: higher cumulative yields and higher fruit in the 'Regina' cultivar grafted on 'Weigi 2', compared to Gisela 5, for planting distances of 4-4,5 m x 2.5 m. As shown in Stehr's 2014 study, fruit production of the 'Regina' cultivar grafted on rootstocks 'Gisela 3' and 'Gisela 5' varies depending on planting distances: for example, in the third year of experiment, 'Regina/Gisela 3' planted at 1.5 m produced more than 'Regina/Gisela 5' planted at 2.0 m, but less than 'Regina/Gisela 5' planted at 2.5 m.

4. Conclusions

In pedoclimatic conditions in Maracineni-Arges area (Romania), for trees in the 3rd, 4th and 5th years after planting (2019-2021), with planting distances of 4x1 m ('Gisela 3') and 4x1.5 m (for the other 3 rootstocks), the rootstock 'Gisela 5' recorded the highest TCSA annual increase (11.46 kg / cm^2). The most vigorous trees were those grafted on the 'Weigi 2' rootstock (44.71 cm^2 TCSA), with a large annual increase in TCSA, althought no significantly different compared to 'Gisela 5'. 'Gisela 3' was noticed by its

highest fruit yield (13.51 t/ha), lowest trees vigor (TCSA = 24.19 cm^2), lowest annual TCSA growth (6.11 cm^2), highest productivity index (0.219 kg/cm^2) and a ratio between fruit production and the annual increase of TCSA also superior (1.79 kg/cm^2). 'Regina' cultivar grafted on 'Gisela 12' rootstock was distinguished by its fruit quality: weight (10.02 g), firmness (66.53 HPE Bareiss units) and TSS (16.03°Brix). Fruits harvested from the trees grafted on the rootstock 'Gisela 5' had the highest values of epicarp color brightness (25.68), content of red (15.61) and yellow (4.12) pigment. Therefore, the present study indicated that the rootstock that ensured optimal fruit quality was 'Gisela 12', and the rootstock that ensured a high fruit production in conditions of low vegetative growth was 'Gisela 3'. The year 2021 was marked by 3 episodes of late spring frosts, which may have affected flower buds of the 'Regina' cultivar, grafted on the rootstock 'Gisela 12' and 'Gisela 3', thus explaining the reduction in fruit yield, as well as the higher fruit weight in this experimental variant. In addition, the fact that 'Gisela 12' suffered repeated bud injuries caused by late spring frosts should be considered a warning regarding the adaptability of this rootstock to the climatic conditions in the Maracineni Arges area. Also, even in these circumstances, 'Gisela 3' should be noted by its high fruit yield that overcome frost damage. Therefore, in order to draw the correct conclusions regarding the influence of 'Weigi 2' rootstock and those of the 'Gisela' group on ‘Regina’ cherry cultivar growth and fruiting processes, appears necessary to continue the studies.

Acknowledgment

This work was supported by the Romanian Ministry of Agriculture and Rural Development, project ADER 7.3.12/2019.

References

1. Andersen R. L., Robinson T., & Lang G.A., 1999. Managing the Gisela cherry rootstocks. New York Fruit Quarterly, 7(4): 19-22.
2. Balmer M., 2020. Improving profitability: assessment of new rootstocks and planting systems.
3. Zlati C., Istrate M., Pașcu R., Bernardir R., 2019. Sweet cherry cultivars evaluation in Romania. Scientific papers Journal, Horticulture Series, vol. 62 (2): 69-74.
4. Bujdosó G. Il programma di miglioramento genetico su ciliegio al NARIC-Istituto di Ricerca su piante da frutto ed ornamentali.
5. Franken-Bembenek S., 2002. Gisela 3 (209/1)-a new cherry rootstock clone of the Giessen series. In I International Symposium on Rootstocks for Deciduous Fruit Tree Species 658: 141-143.
6. Balmer M. and Blanke M., 2001. Developments in high density cherries in Germany. In IV International Cherry Symposium 667: 273-278.
7. Stehr R., 2001. Experiences with dwarfing sweet cherry rootstocks in Northern Germany. In IV International Cherry Symposium 667: 173-178.
8. Robinson T.L. and Hoying S.A., 2009. Training system and rootstock affect yield, fruit size, fruit quality and crop value of sweet cherry. In VI International Cherry Symposium 1020: 453-462.
9. Robinson T.L., Hoying S.A., Dominguez L., 2013. Interaction of training system and rootstock on yield, fruit size, fruit quality and crop value of three sweet cherry cultivars. In VII International Cherry Symposium 1161: 231-238.

 DOI 10.33045/fgr.v37.2021.10

Tables and Figures

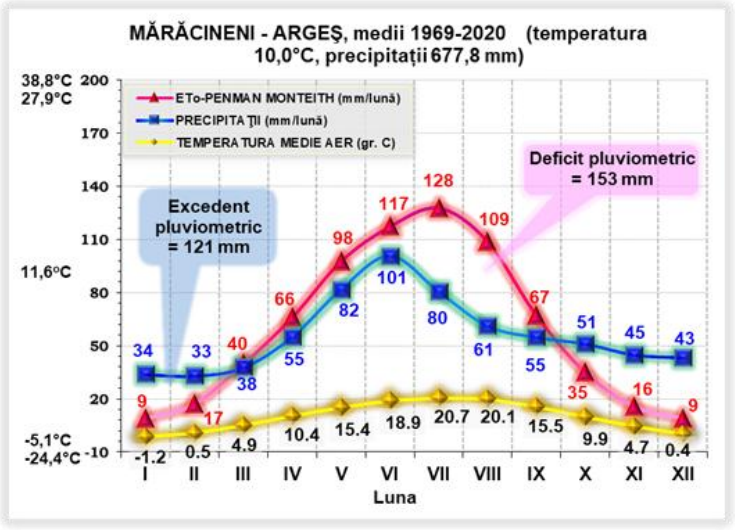

Fig. 1. Monthly values, multiannual averages, temperature, precipitation and potential evapotranspiration Penman-Monteith evolution at Maracineni, Arges (climate diagram)

Fig. 2. Cherry flower buds and flower affected by frost în April 2021 (Maracineni-Arges)

Tabel 1. Statistical descriptors (central tendency and dispersion) for growth an fruiting process on cherry 'Regina' (Maracineni, Arges, 2019-2021)

		Fruit yield (t/ha)	TCSA (cm^2)	Annual TCSA increase (cm^2)	Productivity index (kg/cm^2 TCSA)	Yield/annual TCSA increase ratio (kg/cm^2)	Fruit yield (g)	Pulp firmness (HPE Bareiss units)	pH	TSS (°Brix)	CIE L*	a*	b*	QY
N	Valid	63	63	63	63	63	876	847	670	670	690	690	690	690
	Missing	0	0	0	0	0	0	29	206	206	186	186	186	186
Mean		8.82	34.51	9.29	0.15	0.89	9.26	60.55	3.86	15.07	24.84	12.17	2.78	0.20
Median		6.57	29.71	8.21	0.12	0.46	9.22	58.95	3.85	14.80	24.52	11.75	2.64	0.19
Mode		3.10[a]	28.26[a]	5.84	0.06[a]	0.08[a]	9.23	55.10	3.80	14.60	24.19	9.60	1.85[a]	0.00
Std. Deviation		6.57	18.10	5.95	0.11	1.43	1.45	9.26	0.18	1.68	1.48	4.90	1.95	0.12
Variance		43.11	327.51	35.40	0.01	2.04	0.24	0.57	0.70	0.65	0.94	0.00	-0.53	0.35
Skewness		0.76	0.55	0.79	1.72	4.09	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09
Std. Error of Skewness		0.30	0.30	0.30	0.30	0.30	-0.09	-0.14	2.52	1.16	1.24	0.17	2.65	-0.51
Kurtosis		-0.64	-0.31	0.16	5.16	20.48	0.17	0.17	0.19	0.19	0.19	0.19	0.19	0.19
Std. Error of Kurtosis		0.59	0.59	0.59	0.59	0.59	7.88	48.95	1.79	11.50	10.72	26.62	14.42	0.52
Minimum		0.50	3.97	0.68	0.02	0.05	5.41	40.40	3.02	10.50	20.85	0.05	-5.30	0.00
Maximum		25.55	85.11	24.98	0.66	9.37	13.29	89.35	4.81	22.00	31.57	26.67	9.13	0.52
a. Multiple modes exist. The smallest value is shown														

*Different letter(s) in columns indicate significantly different values at P≤0.05 by Duncan test.

Table 2. Rootstock influence on yield and vegetative growth on 'Regina' cherry cultivar (Maracineni-Arges 2019-2021)

Yield and growth indicators	Rootstock	Study year						Rootstock influence		Significance		
		2019		2020		2021				Rootstock (A)	Study year (B)	A/B
Fruit yield (t/ha)	Gisela 3	5.00	a	20.96	a	14.58	a	13.51	a	***	***	***
	Gisela 5	2.83	b	8.54	b	13.93	a	8.44	b			
	Gisela 12	3.00	b	5.55	b	2.67	b	3.74	c			
	Weigi 2	3.00	b	9.70	b	13.23	a	8.64	b			
	Average	3.53		11.65		11.27		8.82				
TCSA (cm^2)	Gisela 3	17.58	a	25.55	a	29.44	a	24.19	c	**	**	n.s.
	Gisela 5	21.34	a	30.60	a	46.76	a	32.90	bc			
	Gisela 12	28.95	a	36.98	a	48.94	a	38.29	ab			
	Weigi 2	33.72	a	44.00	a	56.40	a	44.71	a			
	Average	25.02		33.87		44.62		34.51				
Annual TCSA increase (cm^2)	Gisela 3	6.48	a	7.97	a	3.89	b	6.11	b	*	n.s.	n.s.
	Gisela 5	8.95	a	9.26	a	16.16	a	11.46	a			
	Gisela 12	8.37	a	8.03	a	11.96	ab	9.45	ab			
	Weigi 2	9.64	a	10.28	a	12.39	ab	10.77	a			
	Average	8.27		8.84		10.76		9.29				
Productivity index (kg/cm^2 TCSA)	Gisela 3	0.128	a	0.330	a	0.200	a	0.219	a	**	*	*
	Gisela 5	0.096	a	0.188	b	0.192	a	0.159	ab			
	Gisela 12	0.178	a	0.114	b	0.042	b	0.111	b			
	Weigi 2	0.052	a	0.136	b	0.140	a	0.109	b			
	Average	0.114		0.199		0.146		0.153				
Yield/annual TCSA increase ratio (kg/cm^2)	Gisela 3	0.375	a	1.997	a	3.008	a	1.793	a	**	n.s.	n.s.
	Gisela 5	0.206	a	0.632	a	0.620	ab	0.486	b			
	Gisela 12	0.620	a	0.462	a	0.262	b	0.448	b			
	Weigi 2	0.192	a	1.028	a	0.778	ab	0.666	b			
	Average	0.350		1.076		1.255		0.893				

Table 3. Rootstock influence on fruit quality traits on 'Regina' cherry cultivar (Maracineni-Arges 2019-2021)

Quality traits	Rootstock	Study year*						Rootstock influence Rootstock		Significance		
		2019		2020		2021				2019	2020	2021
0	1	2	3	4	5	6	7	8	9	10	11	12
Fruit weight (g)	Gisela 3	8.8058	b	7.53	c	9.31	b	8.67	c	***	***	***
	Gisela 5	10.1574	a	10.37	a	8.92	c	9.71	b			
	Gisela 12	9.9597	a	8.54	b	11.03	a	10.02	a			
	Weigi 2	8.9327	b	8.21	b	9.24	b	8.87	c			
	Average	9.3051		8.66		9.63		9.26				
Pulp firmness (HPE Bareiss units)	Gisela 3	74.60	a	56.45	c	58.27	b	64.01	b	***	***	***
	Gisela 5	62.80	b	59.95	b	57.35	b	59.32	c			
	Gisela 12	74.49	a	63.04	a	66.20	a	66.53	a			
	Weigi 2	55.67	c	52.18	d	52.56	c	53.63	d			
	Average	65.88		57.90		58.60		60.55				
pH	Gisela 3	3.95	a	3.89	a	4.01	a	3.97	a	***	***	***
	Gisela 5	3.73	b	3.83	b	3.92	b	3.85	b			
	Gisela 12	3.76	b	3.70	d	3.95	b	3.86	b			
	Weigi 2	3.76	b	3.76	c	3.83	c	3.79	c			
	Average	3.78		3.79		3.93		3.86				
TSS (°Brix)	Gisela 3	14.652	c	12.947	d	14.709	b	14.338	c	***	***	***
	Gisela 5	15.646	a	16.053	a	15.017	b	15.377	b			
	Gisela 12	15.206	ab	15.317	b	16.540	a	16.029	a			
	Weigi 2	14.930	bc	13.839	c	14.603	b	14.642	c			
	Average	15.095		14.551		15.222		15.067				
L*	Gisela 3	23.977	bc	23.914	b	24.705	c	24.323	c	***	***	***
	Gisela 5	24.383	ab	24.558	a	26.869	a	25.684	a			
	Gisela 12	24.948	a	24.720	a	24.729	c	24.752	b			
	Weigi 2	23.634	c	23.741	b	25.295	b	24.562	bc			
	Average	23.634		23.741		25.295		24.562				
a*	Gisela 3	10.563	b	10.179	b	13.520	b	11.924	b	***	***	***
	Gisela 5	11.374	ab	11.935	a	19.474	a	15.611	a			
	Gisela 12	12.602	a	11.558	a	13.309	b	12.608	b			
	Weigi 2	9.957	b	9.691	b	7.030	c	8.294	c			
	Average	11.146		10.841		13.331		12.170				

0	1	2	3	4	5	6	7	8	9	10	11	12
b*	Gisela 3	2.157	bc	2.137	b	3.062	b	2.608	c	***	***	***
	Gisela 5	2.618	ab	2.808	a	5.497	a	4.121	a			
	Gisela 12	3.109	a	2.776	a	3.299	b	3.092	b			
	Weigi 2	1.994	c	1.970	b	0.516	c	1.194	d			
	Average	2.479		2.423		3.094		2.777				
QY	Gisela 3	0.266	a	0.189	a	0.193	b	0.202	ab	*	***	***
	Gisela 5	0.190	b	0.183	ab	0.212	b	0.198	ab			
	Gisela 12	0.122	b	0.179	ab	0.261	a	0.216	a			
	Weigi 2	0.134	b	0.147	b	0.216	b	0.183	b			
	Average	0.185		0.174		0.221		0.200				

*Different letter(s) in columns indicate significantly different values at P≤0.05 by Duncan test.