Scientific Papers. Series B, Horticulture. Vol. LXVII, No. 2, 2023
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

PERSPECTIVE GENOTYPES FROM *CHAENOMELES* SP. LINDL. FOR FRUIT PRODUCTION

Teodora MIHOVA, Petko MINKOV, Georgi POPSKI, Boryana STEFANOVA, Silvena TODOROVA

Agricultural Academy, Research Institute of Mountain Stockbreeding and Agriculture Troyan, 281 Vasil Levski Str., Troyan, Bulgaria

Corresponding author email: teodora.mihova@gmail.com

Abstract

Japanese quince (Chaenomeles sp. Lindl.) is fruit-medicine plant that is getting attention in the last year in Bulgaria. It has valuable nutritional, dietary and medicinal qualities and deserves to be introduced into culture in Bulgaria. The experiment was conducted in the three-year period (2018-2020) in the collection of RIMSA Troyan, Bulgaria. The reproductive characteristics of the perspective for fruit production genotypes were studied with an average yield higher than 3.5 kg per plant. They were followed also by fruit weight and biochemical compounds. During the period of the study genotype SCH4 was with the highest average yield (6.88 kg), followed by SCH3 (5.09 kg). The thornless genotype SCH 6 is with the lowest yield (3.71 kg).

Key words: *Chaenomeles sp. Lindl., Japanese quince, phenology, fruits, yield, Bulgaria.*

INTRODUCTION

In recent years, there has been an increasing interest in preserving and researching the gene pool of both cultivated and wild species, including those with ornamental and medicinal value. Additionally, there has been a focus on developing products derived from these species. The study of local genotypes enables the identification of species for the purpose of safeguarding, conserving, and enhancing the biological diversity of the local flora (Mezhenskyj, 2004; Minkov, 2012; Stoyanova et al., 2014; Kikindonov et al., 2017; Kizeková et al., 2017). One of these plants is the Japanese quince (*Chaenomeles* sp.), which was distributed in Europe since the end of the IX century. *Chaenomeles* is a perennial plant in the family Rosaceae, subfamily Maloideae, which originates from East Asia. Weber (1963; 1964). had a great deal of credit for the botanical study of this plant species. He identified and described significant taxonomic diversity, including four species and four interspecies hybrids According the current changes of the climate, Japanese quince (*Chaenomeles* sp. Lindl.) is a promising crop due to its increased resistance to cold and drought. In light of environmental pollution and rising population morbidity rates, plants containing biologically active substances with adaptogenic, antimutagenic, immunomodulating, and geroprotective properties are particularly important. *Chaenomeles* sp. Lindl., species and hybrids native to China, Japan, and Tibet, are one such source of valuable substances. Among these, *Ch. japonica* and *Ch. x superba* (Frahm.) Rehd. are the most widespread, thanks to their high resistance to cold and drought. In Japan, Korea and China, it has been grown and used for centuries as a food, medicine, ornamental plant (Mezhenskyj, 2015; Sahin, 2020; Turkiewicz et al., 2020).

The fruits have different shapes, weight and are rich in chemical composition. They are used in the food and pharmaceutical industries (Mezhenskyj, 2009; Rumpunen, 2010; Nahorska et al., 2014; Kaufmane and Ruisa, 2018). Some genotypes fruits, which can weigh up to 150 g which are a valuable raw material for the food processing, pharmaceutical, and perfume industries due to their rich chemical composition. Moreover, Japanese quince can provide raw material for industry quickly and affordably, meeting contemporary ecological production standards. *Chaenomeles* sp. Lindl. is characterized by early onset of fruit-bearing, high yield (up to 2-10 kg per shrub), high ecological plasticity, resistance to pests and diseases, and low production costs (Komar-Temnaya et al., 2001; Rumpunen, 2002; Mezhenskyj et al., 2019). According to Rumpunen and Garansson's research in 2003, the fruits of *Chaenomeles* sp. have excellent qualities and are well-received by consumers in various products such as ice cream, lemonade, jam and ext.

Chaenomeles sp. has been a popular ornamental plant in Bulgaria since the late 19th and early 20th century, as documented by Mondeshka (2005) and Mihova (2016). However, it has only gained popularity as a fruit crop in recent years.

The aim of the present study was to examine the perspective genotypes *Chaenomeles* sp. Lindl. distinguished by a series of valuable economic qualities.

MATERIALS AND METHODS

The study was conducted during 2015-2019 at the RIMSA Troyan collection plantation of *Chaenomeles* sp. to explore the available genetic resources. The study focused on six genotypes from seedlings that were obtained through open pollination and had valuable ornamental, medicinal, and nutritional qualities. The soil preparation for new plantations involved the trench method with local stocking organic fertilization, and the used planting scheme was 2.5 m/1m. The shrubs were grown without irrigation; with natural grassed inter rows that were mowed several times depending on the rainfall during the vegetation period (Table 1). The study examined

The following indicators were studied:

Phenological calendar (according to BBCH scale):

- onset of vegetation;
- onset of flowering;
- full flowering;
- end of flowering;
- picking ripeness of fruit;
- harvest.

Reproductive indicators:

- average fruit weight (g);
- yield per shrub (kg).

In terms of rainfall, the area of Troyan is within the average rainfall for the country, which varies around 410 l/m² for the period from March to August.

The data analyses were conducted by Lidanski (1998) and programs by Microsoft Excel.

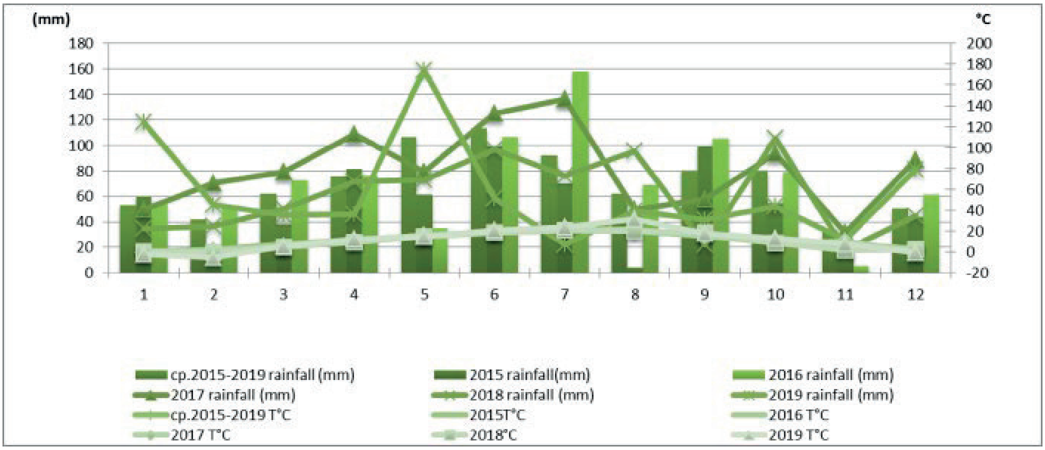


Figure 1. Climatic factors: temperature (°C), precipitation (mm), air humidity (g/m³).

RESULTS AND DISCUSSIONS

Throughout the study period, it was observed that all selected genotypes of *Chaenomeles* sp. initiated their vegetation simultaneously. The vegetation of the six genotypes, began between March 5th to 10th, to the unusually warm weather during the first few months of 2015, which had an average temperature of 7.5°C in March (Table 1). The earliest bud bursting occurred on in genotype SCH5 in 2015, and on February 28th in 2017, while the latest was observed on April 1st in genotype SCH1 in 2012.

Table 1.Phenology of selected genotypes of *Chaenomeles* sp (acording to BBCH scale)

Genotypes	Year	BBCH (01)	BBCH (61)	BBCH (65)	BBCH (69)	BBCH (87)
SCH1	2015	10 .03	15 .04	26 .04	11 .05	15 .10
	2016	18 .03	22 .04	25 .04	15 .05	07 .10
	2017	13 .03	26 .04	29 .04	14 .05	07 .10
	2018	28 .03	19 .04	27 .04	10 .05	03 .10
	2019	01 .04	21 .04	27 .04	03 .05	29 .09
SCH2	2015	10 .03	16 .04	24 .04	12 .05	15 .10
	2016	20 .03	22 .04	25 .04	12 .05	07 .10
	2017	12 .03	23 .04	28..04	15 .05	07 .10
	2018	28 .03	19 .04	27 .04	10 .05	03 .10
	2019	03 .04	26 .04	29 .04	5 .05	22 .09
SCH3	2015	05 .03	07 .04	20 .04	10 .05	05 .10
	2016	08 .03	14 .04	20 .04	16 .05	07 .10
	2017	08 .03	10 .04	19 .04	17 .05	07 .10
	2018	03 .03	12 .04	18 .04	5 .05	01 .10
	2019	27 .03	19 .04	27 .04	10 .05	27 .09
S4	2015	09 .03	15 .04	22 .04	10 .05	17 .10
	2016	18 .03	20 .04	24 .04	11 .05	26 .10
	2017	09 .03	26 .04	29 .04	13 .05	26 .10
	2018	26 .03	14 .04	25 .04	10 .05	29 .10
	2019	27 .03	18 .04	25 .04	03 .05	01 .10
SCH5	2015	16 .02	06 .04	16 .04	10 .05	15 .10
	2016	05 .03	10 .04	22 .04	11 .05	20 .10
	2017	28 .02	03 .04	18 .04	11 .05	20 .10
	2018	15 .03	10 .04	19 .04	06 .05	29 .09
	2019	20 .03	11 .04	24 .04	03 .05	01 .10
SCH6	2015	10 .03	13 .04	24 .04	10 .05	29 .10
	2016	13 .03	20 .04	23 .04	12 .05	10 .10
	2017	11 .03	13 .04	19 .04	13 .05	10 .10
	2018	27 .03	22 .04	28 .04	10 .05	03 .10
	2019	29 .03	16 .04	25 .04	02 .05	24 .09

The onset of vegetation varied within wider limits in 2016 and 2017. Genotype SCH5 showed the earliest onset of vegetation, ranging from 28th February (2017) to 5th March (2016), while genotype SCH2 showed the latest onset, on 20th March in 2016. In the last two years of the experiment, all genotypes except SCH5 entered into vegetation at the same time, towards the end of March and on 1st April (Table 1).

Genotype SCH5 was found to be an early flowering genotype as it began to bloom first in all five years of the experiment, with flowering starting by 11th April. Genotype SCH3 followed, with flowering beginning in the second ten days of April, except in 2015 (Figure 2).

The results of the study show that the onset of vegetation and flowering, as well as the yield of fruits, vary among different genotypes of *Chaenomeles* sp. The earliest bud bursting and flowering was observed in genotype SCH5, which also had the highest yield of fruits in 2016. Genotype SCH4 also showed high yield in 2016, which could be due to the high precipitation in September of that year.

Flowering started in the second half of April in all years of the experiment in genotypes SCH1, SCH2, SCH4 and SCH6 with few exceptions.

The period of full flowering from the initial began three days after the opening of the first blooms in genotype SCH1 (in 2010); SCH2 (in 2009 and 2012); SCH4 (in 2010) and SCH6 (in 2010) to thirty days in genotype SCH3 in 2008 and SCH5 in 2012. Only in genotype SCH5 in 2009 the full flowering started 16 days after the onset of flowering.

Fruits from genotypes SCH1, SCH2 and SCH3 reached picking ripeness in the first ten days of October in 2008, 2009, 2010 and 2011. They ripened at the end of September only in 2012 because in July and August that year the average month temperature reached the record-breaking values of 24.2ºC and 32.3ºC, respectively. In the rest three genotypes - SCH4, SCH5 and SCH6 fruits were harvested 3-4 weeks later.

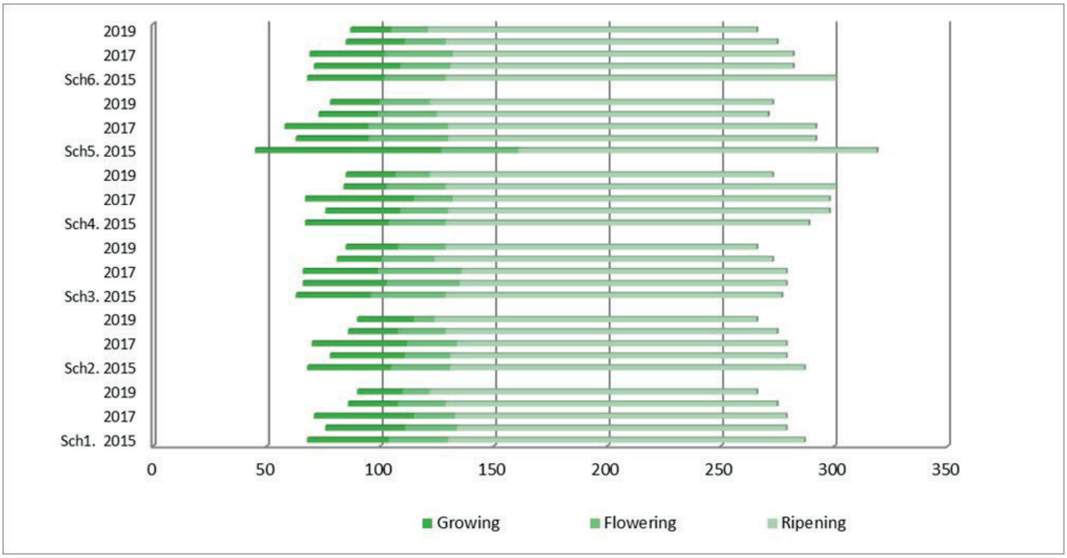


Figure 2. Phenogram of selected genotypes of *Chaenomeles* sp.

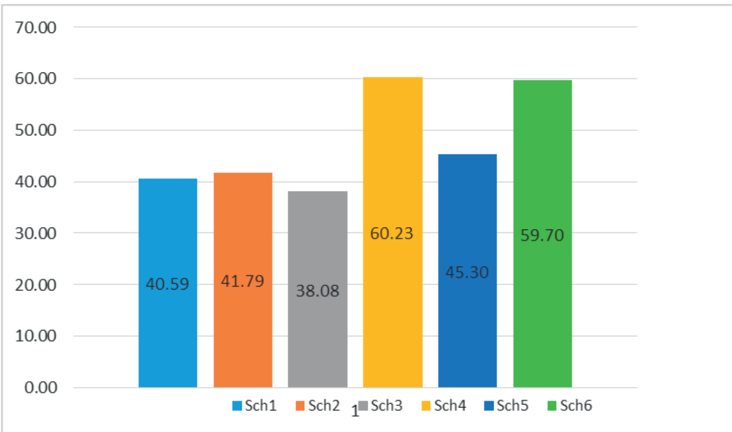
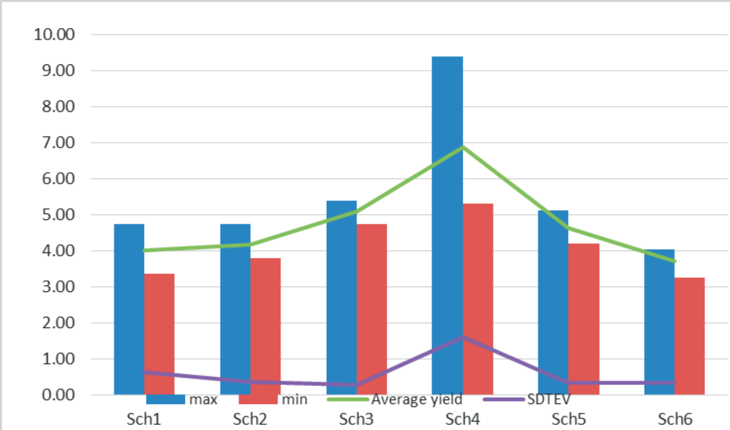


Figure 3. Weight of fruits of the studied genotypes of *Chaenomeles* sp. (g)

The study also notes the effect of climate factors, such as temperature and precipitation, on the growth and yield of *Chaenomeles* sp. For example, the warm weather in March 2015 resulted in earlier onset of vegetation and flowering, while the high temperatures in July and August 2012 resulted in earlier ripening of fruits. The study provides valuable information for breeders and growers of *Chaenomeles* sp. in selecting and managing genotypes for optimal growth and yield under different environmental conditions.



Analysis of variance (ANOVA): LSD 0.05 - 2.57 ;LSD 0.01 - 3.46; LSD 0.0 01 - 4.58

Figure 4. Yield from a shrub of the studied genotypes of *Chaenomeles* sp. (kg)

The fruits of the investigated genotypes of Japanese quince exhibit differences in their shape, color, and size. Among the genotypes studied, Sch4 and Sch6 had the highest average fruit weight, both weighing around 60 g. On the other hand, genotypes SCH3 and SCH1 had the medium fruits, weighing 38.08 g and 40.59 g, respectively (Figure 3).

CONCLUSIONS

The studied genotypes of *Chaenomeles* sp. Lindl. demonstrate notable differences in various parameters. There is considerable variation in reproductive characteristics, including fruit weight and yield per shrub. Additionally, there are significant differences in the timing of the phenologycal stages: the onset of vegetation, flowering, and fruit harvest, with a wide interval between genotypes.

Among the studied genotypes, SCH4 and SCH5 stands out as highly productive, while SCH3, and SCH6 are moderately fruitful. Notably, genotype SCH4 appears to be the most promising for cultivation in the Troyan region, based on the study results.

Based on the study results, it can be inferred that the *Chaenomeles* sp. plant can grow and produce fruit successfully in the Central Balkan Mountains region.

Additionally, the research indicate that *Chaenomeles* sp. is relatively undemanding in terms of soil and plant protection requirements.

REFERENCES

Kaufmane, E. Ruisa, S. (2018). Breeding of new cultivars of the fruit crop Japanese quince (*Chaenomeles japonica*) in Latvia. In: XXX *International Horticultural Congress (IHC) 2018*: International Symposium on Cultivars, Rootstocks and Management Systems of 1281. p. 51-58.

Kikindonov, Tz., Enchev, S., Mehmed, A. (2017). Stability of characters, forming foliar mass productivity of elite population of the new stevia variety Stela. *Journal of Mountain Agriculture on the Balkans*, 20(1), 363-371

Kizeková, M., Martincová, J., Jančová, M., Čunderlík, J., Dugátová, Z., Mihovský, T., Bozhanská, T. (2017). Monitoring and collection of forage grasses and legumes in Slovakia. *Genofond*, 21, 20-21. ISSN 1335-5848 https://www.vurv.sk/fileadmin/VURV/subory/Casopis_GENOFOND/Genofond_2017.pdf

Komar-Temnaya L.D., A.A. Richter (2001). Perspective of *Chaenomeles* sp. breeding in Crimea. 9th *International Conference of Horticulture*. Lednice. Czech Republic. Vol. 1., pp. 101-105.

Lidanski, T. (1998). Statistical Methods in Biology and Agriculture. https://www.hortiadvice.dk/upl/website/bbch-skala/scaleBBCH.pdf

Mezhenskyj, V. (2004). Chaenomeles - Donetsk: "Stalker", 62 p..

Mezhenskyj, V. M. (2009). Evolutionary changes during the breeding of Japanese quince as a fruit crop. Avtohtonn i ta itrodukovani roslini [Autochthonous and Alien Plants], 5, 126–132 [in Ukrainian].

Mezhenskyj , V. M. (2015). On streamlining the Ukrainian names of plants. Information 5. Species names for pome fruit crops. Plant Var. Stud. Prot., 3–4, 4–11. doi: 10.21498/2518-1017.34(28-29).2015.58405 [in Ukrainian].

Mezhenskyj, V., Kostenko, N., Likar S., Dushar M. (2019). Rozrobotka novoi metodiki prowedennia ekspertizi sortiv japonskoi aivi (*Chaenomeles* Lindl.) na vidminnist, odnoridnist i stabilnist. *Plant Varieties Studying and protection*, *vol. 15*, No 4. 337-353 (in Ukrainian) https://doi.org/10.21498/2518-1017.15.4.2019.188507

Mihova, T. (2016). Characterization of genetic resources of Japanese quince (*Chaenomeles* sp. L.), *Dissertation thesis*, Troyan, Bulgaria (Bg).

Mondeshka, P. (2005). Lechebli plodovi rastenia, Zemizdat, 180 p. (Bg).

Nahorska, A., Dzwoniarska, M., & Thiem, B. (2014). Owoce pigwowca japonskiego (*Chaenomeles japonica* (Thunb.) Lindl. ex Spach.) zrodlem substancji biologicznie aktywnych. Postepy Fitoterapii, 4: 239-246.

Rumpunen, K. (2002). *Chaenomeles*: potential new fruit crop for northern Europe. Trends in new crops and new uses. ASHA Press, Alexandria, VA, USA, 385-392.

Rumpunen, K. (2010). Pros and cons of japanese quince (Chaenomeles japonica)-an underutilized pome fruit. In *XXVIII International Horticultural Congress on Science and Horticulture for People* (IHC 2010): III International Symposium on 918 (pp. 887-900).

Sahin Muge (2020). Seedling properties and fire blight resistance on openpollinated Chaenomeles japonica hybrids in Turkey. 2020. *Proceedings of II International Agricultural, Biological & Life Science Conference*, September 1-3, 2020, Edirne, Turkey, p.1254-1262.

Turkiewicz Igor Piotr , A. Wojdyło, K. Tkacz, P. Nowicka (2020). Carotenoids, chlorophylls, vitamin E and amino acid profile in fruits of nineteen Chaenomeles cultivars. *Journal of Food Composition and Analysis*, Volume 93, 2020, 103608 https://doi.org/10.1016/j.jfca.2020.103608

Weber, C. (1963). Cultivars in the genus *Chaenomeles*. *Arnoldia*, 23(3), 17-75.

Weber, C. (1964). The genus *Chaenomeles* (Rosaceae). *Journal of the Arnold Arboretum*, 45(2), 161-205.