Applied breeding of Japanese quince (*Chaenomeles japonica)* at the National Institute of Horticultural Research, Skierniewice, Poland

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1. Introduction:

***Chaenomeles sp*.** plants are known as ornamental shrubs in various regions of the world such as Europe, Asia, Canada and the USA. More than 200 cultivars have been grown for this purpose in the home gardens or Botanical Gardens worldwide, due to their attractive and decorative appearance.

Japanese quince (*Chaenomeles japonica* Thunb./Lindl. ex Spach*)* as a fruit crop is well known only in Baltic countries, Belarus, Scandinavian countries, Ukraine and Poland (Rumpunen, 2002; Kaufmane, and Ruisa 2020; Kaufmane et al., 2022).

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1. Introduction:

Quinces, including **Japanese quince** (*Ch. japonica)* belong to the **Rosaceae** family and the apple subfamily (**Pomoideae**).

Flowers:



Red, pink, orange; flowering - second half of April, beginning of May.

Fruits:



Yellow or with blush, diameter 2-5 cm, weight 20-40 g, aromatic, rich in ascorbic acids (vitamin C), phenolic compounds, and pectin, fiber.
Sour in taste, not suitable for fresh consumption.

1. Introduction:

Set of 5 products

Fruits are suitable for processing of:

- jam
- addition to sweeter fruits
- instead of lemon for tea
- drying and candying

Outstanding raw material for making:

Quince fruit **SYRUP**

Liqueurs

1. Introduction:

- In Europe, the first breeding program of **Japanese quince** (*Ch. Japonica)* as a fruit crop was initiated in **1950's**, and the first commercial plantations were established in the **1970's in Latvia** (Ruisa, 1996; Ruisa, and Rubauskis, 2005)
- New applied breeding of ***Chaenomeles*** was started in the **1990's**
- **1998-2002** joint breeding program within the EU Project: "***New European Fruit Crop for Produce of Juice, Flavour and Fiber***" - **EUCHA** (Rumpunen et al., 2000, 2003). Seedlings from Finland, Latvia, Lithuania and Sweden were previously collected and used in crosses as part of this project.
- Three cultivars were released: **'Darius**', **'Rasa**' and **'Rondo**' (Kaufmane, and Ruisa, 2020).
- **In Latvia -** the newest **Japanese quince** cultivar **'Janis**' was released from the breeding work (Kaufmane, 2023, pers. commun.).

'Darius'

'Rasa'

'Rondo'

Photo E. Kaufmane (LatHort)

1. Introduction:

- **In Finland –** the breeding program was initiated in **1979** with the primary objective to select high yielding and winter hardy cultivars of *Ch. japonica* (Tigerstedt 1996, Rumpunen, 2002).
- **In Ukraine -** genetic and breeding studies on interspecific (*Ch. japonica*, *Ch. speciosa* and *Ch. cathayensis*) and intergeneric (*Pyrus sp.*) hybridization were conducted in the **1990's**. (Mezhenskij 1989, 1996).
- **In Poland** the new applied breeding program of the **Japanese quince** (*Ch. japonica*) has been conducted at the Department of Horticultural Crop Breeding (ZHRO) of the National Institute of Horticultural Research (InHort), in Skierniewice, Poland, since **2022**.

The main goals are to obtain new native high-yielding cultivars of this promising species with thornless shoots and possessing high quality and health-promoting compands in the fruit.

2. Material and Methods

- The only one public breeding program of the **Japanese quince** (*Ch. japonica)* has been conducted at the InHort in Skierniewice, Poland and financed by the Ministry of Agriculture and Rural Development.
- **The first breeding method** was the phenotypic evaluation and selections of F_1 seedlings from the open-pollinated genotypes obtained mainly from Latvia and Ukraine.
- From seeds received from these countries **over 5,000** seedlings were produced in glasshouse conditions and planted in the breeding fields for the further assessment and selection of valuable genotypes in the 3-4 subsequent years.
  - plant morphology (growth and habit of bushes), fruit yield and the weight (size) of fruits, and the field resistance of main fungal diseases and pests.
  - **over 50 breeding clones** (PIG- …) were selected and planted in the clone collection for further evaluation.

Selection field

Clone collection

2. Material and Methods

- **The second method** is traditional crossing (hybridization) used in our breeding program followed by the evaluation of F_1 seedlings and selection of best individuals.
- The selection of parental forms for crossing programs are according to:
  1) phenotypic evaluation of genotypes in the breeding core collection;
  2) description of cultivars in the literature;
  3) genetic polymorphism (DNA fingerprinting analysis) of genotypes;
  4) knowledge of genetic determination and inheritance of main traits.
- Annually, **30-40** crossing combinations are made and from seeds about **2,500-3,000** F_1 seedlings are produced in the glasshouse conditions.

Crossing combinations – spring 2023

2. Material and Methods

- The classical breeding of ***C. japonica*** is supported by biotechnological methods, mainly as verification of genetic diversity of parental forms and development of molecular markers useful for early selection (MAS) of high-quality fruit traits in genotypes and to accelerate and increase the efficiency of this work.
- In cooperation with other scientists, studies are carried out on:
  - the analysis of the fruit chemical composition of selected genotypes (cultivars and breeding clones);
  - the ploidy level/genome size is assessed using flow cytometry of selected genotypes;
  - pollen viability of parental forms used in breeding programs and an assessment of the germination of pollen grains on the stigma.
  - a comprehensive evaluation of the occurrence of diseases caused by pathogenic fungi and the threat to plants and fruits caused by insects and mites are also provided.

3. Results and Discussions

Table 1. Fruit yield and weight of Japanese quince genotypes, Skierniewice, 2022-2023.

From the first breeding methods over **50** clones marked “PIG-…” were selected and evaluated for certain traits. Some results for selected **15** clones and **3** Latvian cultivars in 2022 and 2023) are presented (**Table 1**).

/1 – fruit weight of 10 random selected fruits
/2 – large fruit weight of selected the largest 10 fruits from the yield collected from plant.

No	Cultivar /clone	Fruit yield (kg/plant)			Fruit weight (g)	
		2022	2023	Average	*random*/1	large/2
1	*Darius*	*1,63*	*2,24*	*1,94*	*26,4*	*45,2*
2	*Rasa*	*2,52*	*2,20*	*2,36*	*46,8*	*84,6*
3	*Rondo*	*2,54*	*1,54*	*2,04*	*61,0*	*86,6*
4	PIG-2	2,20	1,86	2,03	39,6	60,0
5	PIG-4	4,43	3,34	3,89	47,2	71,4
6	PIG-5	4,52	3,54	4,03	58,4	82,6
7	**PIG-6**	**10,93**	**6,88**	**8,91**	**38,0**	**58,2**
8	PIG-7	4,30	3,26	3,78	52,8	66,0
9	PIG-11	4,78	3,66	4,22	41,0	65,4
10	**PIG-12**	**6,10**	**4,86**	**5,48**	**37,8**	**65,0**
11	PIG-13	4,64	1,36	3,00	28,2	50,2
12	PIG-21	2,70	3,34	3,02	38,2	64,2
13	**PIG-24**	**8,99**	**3,98**	**6,49**	**36,2**	**52,8**
14	PIG-28	1,86	0,98	1,42	40,4	65,4
15	**PIG-34**	**8,36**	**3,84**	**6,10**	**45,0**	**61,6**
16	**PIG-42**	**14,05**	**4,86**	**9,46**	**51,2**	**63,8**
17	**PIG-44**	**12,07**	**3,22**	**7,65**	**42,4**	**62,0**
18	PIG-48	3,64	1,50	2,57	44,8	81,4
Mean		***5,57***	***3,14***	***4,35***	***43,1***	***65,9***

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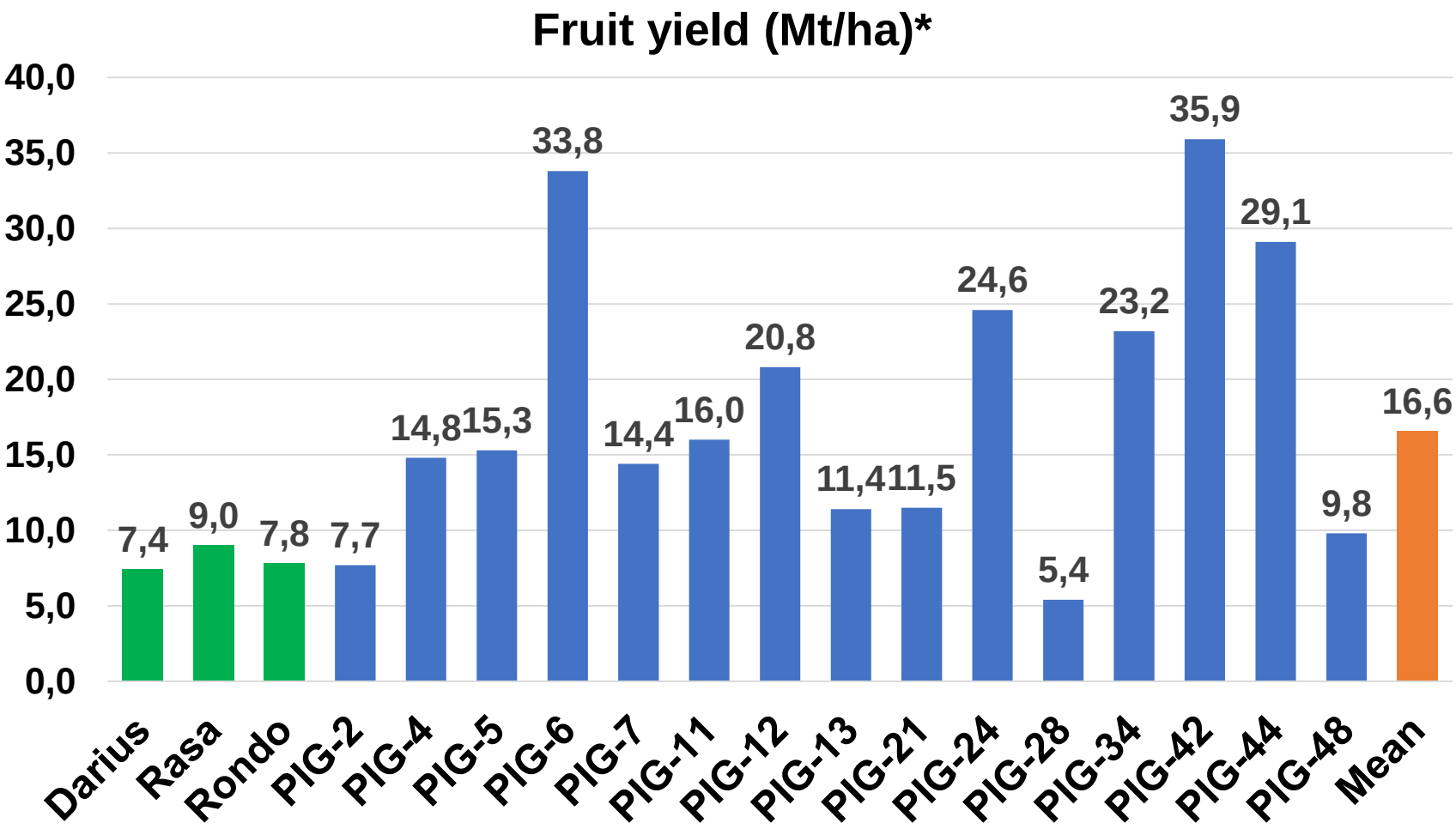
3. Results and Discussions



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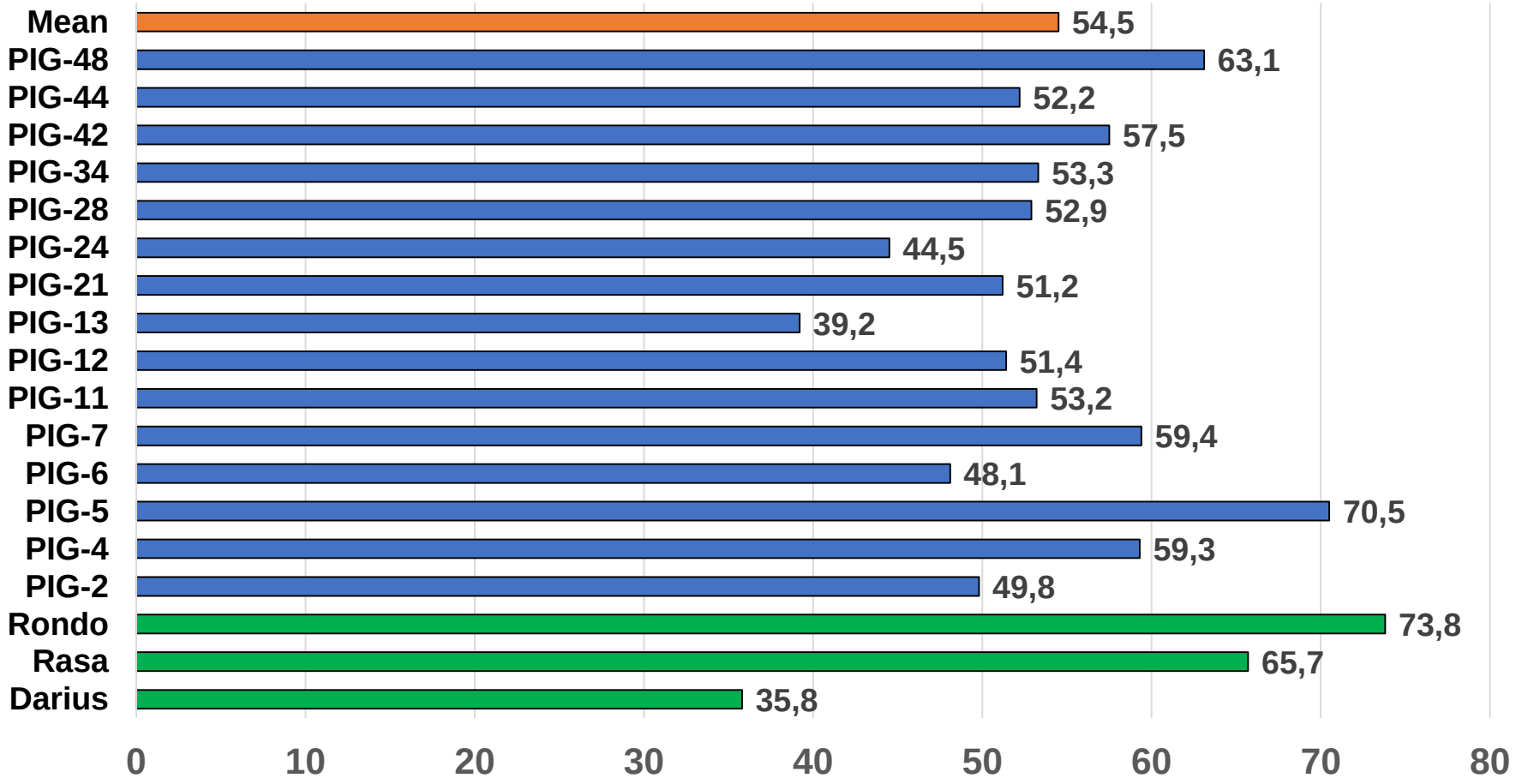
* - fruit yield (Metric tons/ha) was calculated for **3,800 plans/ha** grown on the commercial plantation.

3. Results and Discussions

Average fruit weight in 2022-2023 (g)



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The largest fruits:
'Rasa', 'Rondo' and PIG-4, **PIG-5**, PIG-7, PIG-44, **PIG-48**

3. Results and Discussions

Table 2. Fruit chemical analyses of Japanese quince cultivars and breeding clones, Skierniewice, 2023.

No.	Cultivar /clone	Soluble solids (°Brix)	pH	Acidity (%)	Polyphenols total (mg/100g)	Ascorbic acid (mg/100 g)
1	***Darius***	*7,9*	*3,35*	*3,09*	*387*	*138*
2	***Rasa***	*8,8*	*3,26*	*4,02*	*408*	*104*
3	***Rondo***	*9,4*	*3,32*	*4,01*	*394*	*128*
4	**PIG 1B/1**	10,3	3,22	4,28	407	101
5	**PIG 1C/5**	11,0	3,31	4,90	377	**200**
6	**PIG 2B/3**	8,7	3,31	4,93	386	**201**
7	**PIG 4C/1**	10,7	3,23	5,02	435	**271**
8	**PIG 4C/10**	10,0	3,24	4,87	482	**234**
9	**PIG 6C/3**	13,4	3,28	4,36	559	**277**
10	**PIG 6C/9**	11,7	3,37	3,89	500	164
	Mean	***10,2***	***3,29***	***4,34***	***433,4***	***181,7***

The highest contents:
1. Soluble solids:
PIB-1C/5, PIG-6C/9, **PIG-6C/3**
2. Polyphenols total:
PIG-4C/1, **PIG-4C/10, PIG- PIG-6C/9, PIG-6C/3**
3. Ascorbic acid:
PIG-1C/5, PIG-2B/3, **PIG-4C/1, PIG-4C/10, PIG-6C/3.**

3. Results and Discussions

❖ **Since 2022**, **using traditional hybridization breeding, we have achieved:**

- **3 crossing programs** (2022/23, 2023/24, 2024/25), **total 164 crossing combinations** have been made so far.
- > **4,200 F_1 seedlings** were produced and planted in the breeding field for further evaluation and selection best individuals and clones.

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Selected genotypes differ in ripening periods, are high yielding, produce large fruits (50-70g) and are winter hardy and with thornless shoots.

4. Conclusions and Perspectives

1. The first results of the applied breeding of **Japanese quince** conducted at the InHort in Skierniewice, Poland have already been achieved as valuable genotypes, which are high yielding, produce large fruits with high quality and content of bioactive compounds (ascorbic acid - vit. C, polyphenols and extract) and thornless shoots.
2. It can be assumed that within the next **2-3 years**, a new Polish cultivar/s of **Japanese quince** will be submitted for testing before registration at the Research Centre for Cultivar Testing (COBORU) in Poland.
3. By conducting the breeding work, it will be possible to release new and better cultivars for fruit production by our growers.
4. New cultivars can be suitable for food processing and increasing interest and consumption of this new fruit crop.

Acknowledgements:

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