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Improving plant quality and economy for a more sustainable and efficient berry production

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National Institute of Horticultural Research (InHort), Skierniewice, Poland

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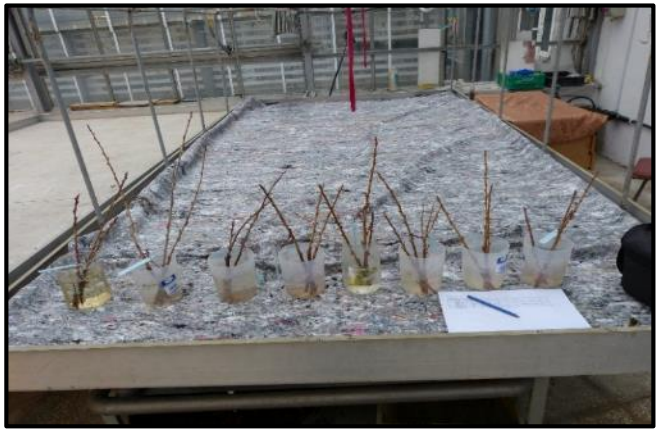
WP 1. Environmental effects on flower and dormancy initiation and breaking of dormancy in *Rubus* and *Ribes* species

- Eight blackcurrant cvs. **'Bona', 'Ben Gairn', 'Ben Lomond', 'Ben Tron', 'Gofert', 'Polares', 'Narve Viking' and 'Tihope'** were evaluated in 2022.
- The development of vegetative buds taken from the field experiment was conducted in controlled conditions,
- Shoots wrapped in foil and kept at **+ 5°C**, **0°C** and **-5°C** for 7, 14 and 21 weeks were observed.



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FIRST term - 7 weeks kept and observed on March 1st 2022

	Cultivar	01.III	04.III	07.III	09.III	11.III	14.III	16.III	18.III	21.III	23.III	TOTAL
	Temperature -5^{0}C											
1	Bona	0	0	8	4	2	8	10	0	0	0	**32**
2	Ben Gairn	0	0	0	21	11	0	0	0	0	0	**32**
3	Ben Lomond	0	0	0	8	6	6	1	4	0	0	**25**
4	Ben Tron	0	0	0	15	16	2	0	0	0	0	**33**
5	Gofert	0	0	1	21	19	2	0	1	0	0	**44**
6	Polares	0	0	0	9	5	14	2	5	0	0	**35**
7	Narve Viking	0	0	0	2	3	4	0	1	12	0	**22**
8	Tihope	0	0	1	15	6	1	0	2	0	0	**25**
	Temperature 0^{0}C											
1	Bona	0	0	15	7	7	0	2	0	0	0	**31**
2	Ben Gairn	0	0	32	8	1	0	0	0	0	0	**41**
3	Ben Lomond	0	0	20	5	6	4	0	1	0	0	**36**
4	Ben Tron	0	0	20	14	1	3	0	0	0	0	**38**
5	Gofert	0	0	16	8	4	1	0	0	0	0	**29**
6	Polares	0	0	7	11	15	3	2	1	0	0	**39**
7	Narve Viking	0	0	2	1	17	6	8	3	0	0	**37**
8	Tihope	0	0	19	3	3	2	0	0	0	0	**27**
	Temperature 5^{0}C											
1	Bona	0	0	18	4	4	0	10	0	0	0	**36**
2	Ben Gairn	0	0	20	6	2	0	0	0	0	0	**28**
3	Ben Lomond	0	0	2	8	10	5	0	0	0	0	**25**
4	Ben Tron	0	0	5	19	2	1	0	0	0	0	**27**
5	Gofert	0	0	17	6	2	2	0	0	0	0	**27**
6	Polares	0	0	2	3	36	0	0	0	0	0	**41**
7	Narve Viking	0	0	0	0	12	4	3	0	0	1	**20**
8	Tihope	0	0	17	5	11	1	0	1	0	0	**35**

SECOND term - 14 weeks kept and observed on April 20th 2022

	Cultivar	21.IV	23.IV	25.IV	27.IV	29.IV	02.V	04. V	06.V	09.V	11.V	TOTAL
	Temperature -5^{0}C											
1	Bona	3	5	19	1	0	0	0	0	0	0	**28**
2	Ben Gairn	0	1	8	22	7	1	0	0	0	0	**39**
3	Ben Lomond	0	0	0	12	20	2	0	2	0	0	**36**
4	Ben Tron	3	2	10	11	6	0	1	0	0	0	**33**
5	Gofert	0	4	8	13	2	3	0	0	0	0	**30**
6	Polares	0	0	0	18	16	3	0	1	1	0	**39**
7	NarveViking	1	0	0	2	12	1	2	0	2	0	**20**
8	Tihope	0	0	1	25	2	2	0	0	0	0	**30**
	Temperature 0^{0}C											
1	Bona	2	20	19	0	0	0	0	0	0	0	**41**
2	Ben Gairn	1	13	27	4	0	0	0	0	0	0	**45**
3	Ben Lomond	0	36	10	0	0	1	0	0	0	0	**47**
4	Ben Tron	1	15	20	0	0	0	0	0	0	0	**36**
5	Gofert	0	10	13	0	4	2	0	0	0	0	**29**
6	Polares	2	7	23	1	2	4	0	0	0	0	**39**
7	Narve Viking	0	2	20	3	4	6	2	0	0	0	**37**
8	Tihope	0	18	19	2	2	2	0	1	0	0	**44**
	Temperature 5^{0}C											
1	Bona	0	10	8	0	0	0	0	0	0	0	**18**
2	Ben Gairn	0	12	30	5	4	0	0	0	0	0	**51**
3	Ben Lomond	0	3	10	20	3	0	0	0	0	0	**36**
4	Ben Tron	0	11	17	0	5	0	0	0	0	0	**33**
5	Gofert	0	20	14	0	0	0	0	0	0	0	**34**
6	Polares	0	12	26	2	1	2	0	1	0	0	**44**
7	Narve Viking	0	6	11	19	1	1	1	1	1	0	**41**
8	Tihope	0	15	30	2	1	0	0	0	1	0	**49**

THIRD term - 21 weeks kept and observed on June 08th 2022

	Cultivar	08.VI	09.VI	10.VI	13.VI	15.VI	17.VI	20.VI	23.VI	27.VI	TOTAL	Undeveloped shoots
Temperature -5^{0}C												
1	Bona	0	0	0	18	6	0	0	0	0	**24**	5
2	Ben Gairn	0	0	0	28	0	0	6	0	0	**34**	12
3	Ben Lomond	0	0	0	6	4	1	0	0	0	**11**	23
4	Ben Tron	0	0	0	17	6	0	1	0	0	**24**	3
5	Gofert	0	0	0	23	0	0	0	0	0	**23**	10
6	Polares	0	0	0	25	7	0	0	0	0	**32**	9
7	Narve Viking	0	0	0	12	8	1	2	0	0	**23**	5
8	Tihope	0	0	0	1	2	4	5	1	1	**14**	9
Temperature 0^{0}C												
1	Bona	0	6	15	0	0	0	0	0	0	**21**	3
2	Ben Gairn	0	3	37	4	0	0	0	0	0	**44**	2
3	Ben Lomond	0	5	27	5	1	1	0	0	0	**39**	12
4	Ben Tron	0	10	25	0	1	0	0	0	0	**36**	0
5	Gofert	0	12	28	0	0	0	0	0	0	**40**	3
6	Polares	0	5	26	2	2	0	0	0	0	**35**	1
7	Narve Viking	0	3	7	20	3	1	0	0	0	**34**	0
8	Tihope	0	5	26	0	3	0	0	0	0	**34**	0
Temperature 5^{0}C												
1	Bona	0	0	15	9	3	2	0	0	0	**29**	3
2	Ben Gairn	0	0	12	34	1	0	0	0	0	**47**	0
3	Ben Lomond	0	0	0	11	1	2	1	0	0	**15**	20
4	Ben Tron	0	0	6	26	0	0	0	0	0	**32**	9
5	Gofert	0	0	20	10	0	0	0	0	0	**30**	5
6	Polares	0	0	1	30	0	0	0	0	0	**31**	1
7	Narve Viking	0	0	0	34	0	3	0	1	2	**40**	0
8	Tihope	0	0	16	21	0	1	0	0	0	**38**	0

WP 1. Environmental effects on flower and dormancy initiation and breaking of dormancy in *Rubus* and *Ribes* species

- After **7 weeks** taking the shoots out of the cold store, the first developed buds were observed after 6 days, and the largest number of buds developed after 7-11 days, regardless of temperature.
- After **14 weeks**, developed buds of some cultivars were observed at temperatures of **-5°C** and **0°C**, buds developed depending on the temperature at which they were stored, the fastest at **0°C** and **5°C** (3-5 days) and slower at temperature **-5°C** (5-7 days).
- After **21 days**, the first buds started to develop between 2 (**0°C**) and 6 days (**-5°C**) depending on the storage temperature, most of the buds developed in 3-6 days.

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WP 1. Environmental effects on flower and dormancy initiation and breaking of dormancy in *Rubus* and *Ribes* species

CONTROL - observation in the field conditions at the Pomological Orchard in Skierniewice, 2022

	CULTIVAR	03.III	07.III	10.III	14.III	16.III	18.III	21.III	23.III
1	Bona	0	7	11	4	0	0	0	0
2	Ben Gairn	0	0	0	0	4	1	17	0
3	Ben Lomond	0	0	0	0	2	1	2	10
4	Ben Tron	0	3	4	1	4	0	3	1
5	Gofert	0	2	6	2	5	1	0	0
6	Polares	0	0	0	0	1	0	0	3
7	Narve Viking	0	0	0	0	0	0	0	0
8	Tihope	0	0	0	0	3	0	7	11

	CULTIVAR	25.III	28.III	01.IV	05.IV	09.IV	11.IV	14.IV	TOTAL
1	Bona	0	0	0	0	0	0	0	22
2	Ben Gairn	0	0	0	0	0	0	0	22
3	Ben Lomond	1	3	0	0	0	0	0	19
4	Ben Tron	1	5	0	0	0	0	0	22
5	Gofert	0	0	0	0	0	0	0	16
6	Polares	19	3	0	0	0	0	0	26
7	Narve Viking	0	0	0	1	2	9	5	17
8	Tihope	2	1	0	0	0	0	0	24

The buds of the cvs. **‘Bona’, ‘Ben Tron’** and **‘Gofert’** began to develop on March 7th, the cvs **‘Ben Gairn’, ‘Ben Lomond’, ‘Polares’**,**‘Tihope’** – on March 16th and the cv. **‘Narve Viking’** on April 5th, as the latest.

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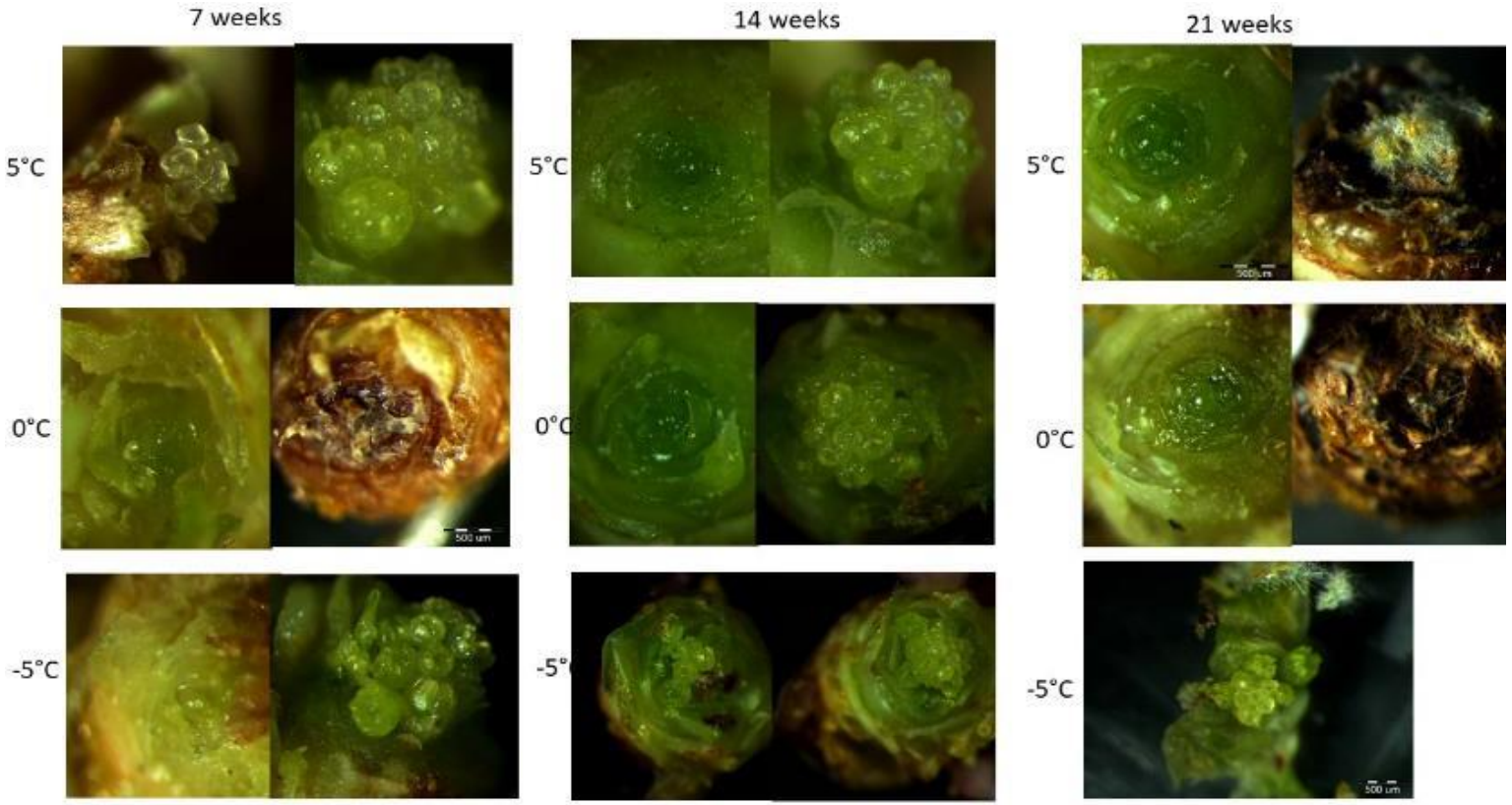
WP 1. Environmental effects on flower and dormancy initiation and breaking of dormancy in *Rubus* and *Ribes* species

Task 1.3. Dormancy breaking of established cultivars and advanced selections of *Rubus* and *Ribes* (NIBIO and INHORT)

Results – blackcurrant.



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Task 3.4. Improving production technology to extend the harvest period and supply the market with fresh berries

- In the spring of 2021, the field experiment with **black**- and **red currant** cvs. was established at the InHort.
- One-year-old shrubs of 3 dessert cultivars of **blackcurrant** (‘**Bona**’, ‘**Gofert**’ and ‘**Tihope**’) and 2 cultivars of **redcurrants** (‘**Rovada’**, ‘**Jonkheer van Tets**’) were planted in three cultivation systems: **1. bush form**, **2. trellising system**, **3. trellising system with polyethylene rain cover protection**.

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Task 3.4. Improving production technology to extend the harvest period and supply the market with fresh berries

Lp.	Cultivar	Harvesting time	Fruit yield (kg per plot)				Weight of 100 fruit (g)			
			Control	Trellising system	Trellising system with roof protection	Average	Control	Trellising system	Trellising system with roof protection	Average
1	**Bona**	11.VI	**0,58**	**0,65**	**0,72**	**0,65**	**100,0**	**99,0**	**105,0**	**101,3**
2	**Gofert**	15.VI	**0,73**	**0,68**	**1,25**	**0,89**	**120,0**	**125,0**	**132,0**	**125,7**
3	**Tihope**	19.VI	**7,16**	**4,03**	**3,40**	**4,86**	**135,5**	**148,8**	**142,2**	**142,2**
4	**Jonkheer**	22.VI	**1,17**	**0,33**	**0,41**	**0,64**	**74,0**	**80,0**	**82,2**	**78,7**
5	**Rovada**	22.VI	**0,54**	**0,99**	**0,76**	**0,77**	**84,4**	**74,5**	**75,6**	**78,2**

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Task 3.4. Improving production technology to extend the harvest period and supply the market with fresh berries

SUMMARY & PRELIMINARY CONCLUSIONS

- Blackcurrant cv. **'Bona'** ripened the earliest, and **'Tihope'** at the latest date.
- The fruits of both cvs. of red currant ripened at the same time, but later than that of the **blackcurrant.**
- In 2022 the cv. '**Tihope**' produced the highest fruit yield, but the lowest yield was recorded for the cv. '**Bona**'.
- Both red currant cultivars yielded on a similar level.
- Blackcurrant cv. '**Tihope**' had the largest fruit, and cv. '**Bona**' the smallest one.
- Both red currant cvs. 'Jonkheer van Tets' and 'Rovada' produced fruits of similar weight/size, but smaller than that of tested blackcurrant cvs.

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Task 5.1. Assessment of the possibilities to improve the strawberry, red raspberry and blackcurrant fruit characteristics by choosing the optimal pollen source for pollination of flowers.

The crossing program in a full dialell design (Griffing 1956), including 5 blackcurrant cvs. **'Gofert' , 'Bona', 'Ben Tron', 'Polares'** & **'Narve Viking'** was made on plants grown in the field and high plastic tunel. **Total 25 crossing combinations**

♀ \ ♂	Bona	Ben Tron	Gofert	Polares	Narve Viking
Bona	x	x	x	x	x
Ben Tron	x	x	x	x	x
Gofert	x	x	x	x	x
Polares	x	x	x	x	x
Narve Viking	x	x	x	x	x

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No	Crossing combinations ♀ x ♂	Date of pollination	POLLINATION IN THE FIELD Number of flowers	Number of fruits	%	Date of polli.	POLLI. IN THE TUNEL Number of flowers	Number of fruits	%	Average flowers pollin.
1	**Bona** x Bona	27.IV	250	127	50,8	02.IV	144	120	83,3	**67,1**
2	x Ben Tron	27.IV	60	27	45	03.IV	69	0	0	**22,5**
3	x Gofert	27.IV	130	28	21,5	03.IV	48	23	47,9	**34,7**
4	x Polares	27.IV	147	89	60,5	03.IV	48	0	0	**30,3**
5	x Narve Viking	27.IV	75	28	37,3	03.IV	42	2	4,8	**21,0**
6	**Ben Tron** x Bona	29.IV	104	32	30,8	05.IV	143	22	15,4	**23,1**
7	x Ben Tron	29.IV	400	66	16,5	07.IV	432	235	54,4	**35,4**
8	x Gofert	29.IV	148	67	45,3	07.IV	84	1	1,2	**23,2**
9	x Polares	29.IV	185	79	42,7	07.IV	110	20	18,2	**30,4**
10	x Narve Viking	28.IV	112	59	52,7	07.IV	126	24	19	**35,9**
11	**Gofert** x Bona	28.IV	173	27	15,6	06.IV	183	7	3,8	**9,7**
12	x Ben Tron	27.IV	115	25	21,7	06.IV	127	4	3,1	**12,4**
13	x Gofert	28.IV	273	128	46,9	06.IV	320	75	23,4	**35,2**
14	x Polares	28.IV	128	30	23,4	06.IV	147	112	76,2	**49,8**
15	x Narve Viking	29.IV	75	56	74,7	06.IV	203	0	0	**37,3**
16	**Polares** x Bona	29.IV	93	19	20,4	07.IV	62	14	22,6	**21,5**
17	x Ben Tron	29.IV	133	48	36,1	08.IV	36	7	19,4	**27,8**
18	x Gofert	29.IV	139	75	54	08.IV	115	19	16,5	**35,2**
19	x Polares	29.IV	320	252	78,8	08.IV	140	103	73,6	**76,2**
20	x Narve Viking	29.IV	91	55	60,4	08.IV	39	12	30,8	**45,6**
21	**Narve Viking** x Bona	06.V	121	21	17,4					**17,4**
22	x Ben Tron	09.V	102	27	26,5					**26,5**
23	x Gofert	06.V	71	29	40,8	no flowers				**40,8**
24	x Polares	09.V	97	8	8,2					**8,2**
25	x Narve Viking	05.V	250	201	80,4					**80,4**
Total			**3792**	**1603**	**42,3**		**2618**	**800**	**30,6**	**36,4**

Task 5.1. Assessment of the possibilities to improve the strawberry, red raspberry and currant fruit characteristics by choosing the optimal pollen source for pollination of flowers.

- **In blackcurrant** crossing combinations, the pollination efficiency (% of obtained fruit in relation to pollinated flowers) ranged from **8.2** to **80.4** %.
- The **lowest** pollination efficiency was found in the following crossings: Narve Viking x Polares (**8.2%**), Gofert x Bona (**9.7%**), Gofert x Ben Tron (**12.4%**) and Narve Viking x Bona (**17.4%**).
- The **highest** pollination efficiency was found in in self-pollination of the cultivars Narve Viking (**80.4 %**), Polares (**76.2%**) and Bona (**67.1%**)

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Task 5.2. Assessment of pollen viability of studied berry cultivars.

Two methods of pollen assessment were investigated:

- ❑ assessing the staining of pollen grains with 2% acetoorcein to determine the viability of pollen grains
- ❑ assessing the ability of pollen to germinate and produce a pollen tube in vitro.

Germination of blackcurrant pollen grains

Blackcurrant pollen grains showed a high germination capacity in the control (17%-36%). The use of a more nutrient-rich medium allowed an increase in germination capacity from 60% (**'Polares'**) to 83% (**'Ben Tron'** and **'Gofert'**).

Cultivar	Control medium			Modified medium: Sharafi (2011)	
	Acetoorcein (%)	Germinated grains (%)	Length of the pollen tube (µm)	Germinated grains (%)	Length of the pollen tube (µm)
Gofert	100	29	300	82	2000
Bona	99	31	300	78	1500
Ben Tron	89	36	400	83	1300
Polares	85	21	400	60	1500
Tihope	98	17	350	78	2200

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Task 5.3. Evaluation of selected fruit characteristics of strawberry, red raspberry and blackcurrant

No	Crossing combinations	Number of fruits			Weight of 1 fruit (g)		
		Field	Tunnel	Total	Field	Tunnel	Average
1	Bona x Bona	127	120	247	1,67	1,12	1,4
2	x Ben Tron	27	0	27	1,26		1,3
3	x Gofert	28	23	51	0,86	0,96	0,9
4	x Polares	89	0	89	1,51		1,5
5	x Narve Viking	28	2	30	0,86	0,90	0,9
6	Ben Tron x Bona	32	22	54	0,81	1,05	0,9
7	x Ben Tron	66	235	301	0,45	0,58	0,5
8	x Gofert	67	1	68	1,13	0,50	0,8
9	x Polares	79	20	99	0,78	1,00	0,9
10	x Narve Viking	59	24	83	0,44	0,67	0,6
11	Gofert x Bona	27	7	34	0,59	2,86	1,7
12	x Ben Tron	25	4	29	0,56	1,00	0,8
13	x Gofert	128	75	203	0,67	1,71	1,2
14	x Polares	30	112	142	0,60	0,63	0,6
15	x Narve Viking	56	0	56	0,61		0,6
16	Polares x Bona	19	14	33	0,74	0,86	0,8
17	x Ben Tron	48	7	55	0,71	0,57	0,6
18	x Gofert	75	19	94	0,53		0,5
19	x Polares	252	103	355	0,94	0,74	0,8
20	x Narve Viking	55	12	67	0,69	0,50	0,6
21	Narve Viking x Bona	21		21	1,14		1,1
22	x Ben Tron	27		27	1,19		1,2
23	x Gofert	29		29	0,83		0,8
24	x Polares	8		8	1,00		1,0
25	x Narve Viking	201		201	0,72		0,7
Total		1603	800	Average	0,9	0,9	0,9

Task 5.3. Evaluation of selected fruit characteristics of strawberry, red raspberry and blackcurrant

- The largest **blackcurrant** fruits from the crosses: Gofert x Bona, Bona x Polares, Bona x Bona, Bona x Ben Tron.
- The smallest fruit from self-pollination of **'Ben Tron'**, **'Narve Viking'** and from crosses of **Ben Tron x Narve Viking**, **Gofert x Polares**, **Gofert x Narve Viking**, **Polares x Gofert**, **Polares x Narve Viking**.

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