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EVALUATION OF BLACKCURRANT GENETIC RESOURCES FOR SUSTAINABLE PRODUCTION

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A B S T R A C T

From 1999 to 2002, eighty blackcurrant genotypes were tested at the Dobele State Horticultural Plant Breeding Research Station in Latvia. The genotypes were evaluated in terms of morphology, yield potential (or yield components), fruit quality, disease and pest resistance, and winter and spring frost hardiness. Multicriteria analysis as described by Martinov (1987) was used to assign an overall value to each genotype. The highest ranking cultivars were five genotypes from Latvia: II b 14 (Keep39 / 'Pamyat' Vavilovu'), I a 58 (Keep39 / 'Vinogradnaya'), No. 89 ('Black of Naples' / 'Katyusha'), III a 68 (Keep39 / 'Zagadka'), and 'Mara' ('Black of Naples' / 'Katyusha'); and seven introduced genotypes: 'Black Dawn', 'Vakariai', 'Triton', 'Ben Alder', 'Intercontinental', 'Vernisazh', and 'Zagadka'. They can be recommended for use in breeding programs as donors of good overall value for sustainable production

Key words: *Ribes*, multicriteria analysis, yield components, quality, resistance

INTRODUCTION

A wide range of blackcurrant species and cultivars from Western Europe, including Scandinavia, and the former Soviet Union has been collected at the Dobele State Horticultural Plant Breeding Experimental Station (Dobele HPBES). Also, at the National Botanical Gardens, thirty years of breeding has produced a wide range of inter-specific blackcurrant hybrids, which are an invaluable resource for further breeding programs. However, these genotypes have not yet been comprehensively and systematically characterized and evaluated, which limits their practical and scientific value. The aim of this trial was to evaluate the genetic

resources of blackcurrants from our region. The results will help growers select the best cultivars for sustainable production, and help breeders improve their breeding programs.

MATERIAL AND METHODS

The trial was carried out at the Dobele HPBES, Latvia, from 1999 to 2002. A total of eighty blackcurrant genotypes were tested according to the following nineteen parameters:

1. Morphology:
    - Bush height (cm) between the soil surface and the top of the highest branch.
    - Number of basal shoots on a scale from 1 to 9, where 1 equals no basal shoots, and 9 equals abundant basal shoots.
    - Growth habit on a scale from 1 to 9, where 1 equals very compact, and 9 equals very prostrate.
2. Yield components (or yield potential):
    - Producctivity on a scale from 1 to 9, where 1 equals no yield, and 9 equals abundant yield.
    - Average berry weight (grams), as the average of 100 berries per plot.
    - Number of flowers per cluster, as the average of ten clusters per bush.
3. Yeld quality:
    - Separation of berries from the stalk on a scale 1, 5 and 9, where 1 equals very bad, and 9 equals very good.
    - Specific *Ribes nigrun* var. *europaeum* flavor on a scale 1 and 9, where 1 equals no specific flavor, and 9 equals the highly desirable flavor characteristic of *Ribes nigrum* var. *europaeum*.
    - Astringency in classes 1 and 9, where 1 equals no astringency, and 9 equals high astringency.
4. Chemical composition of berries:
    - Anthocyanin content (mg 100 g^{-1}) by spectrophotometry.
    - Ascorbic acid content (mg 100 g^{-1}) by the iodine method.
    - Soluble solids content (%) by refractometry.
5. Disease and pest resistance:
    - Leaf, shoots, and bud damage due to mildew, septoria leafspot, leafspot, blister rust, and gall mite, each on a scale from 1 to 9. Plants with no damage were awarded 1 point. Plants with less than 5% damage were awarded 2 points. Plants with 6-25% damage were awarded 3 points. Plants with 26-50% damage were awarded 5 points. Plants with 51-75% damage were awarded 7 points. Plants with more than 76% damage were awarded 9 points.

6. Winter and spring frost hardiness:
   - Winter and spring frost damage to shoots, leaves, buds, flowers, and ovaries on a scale from 1 and 9, where 1 equals no damage, and 9 equals very heavy damage.

Each bush was individually evaluated in terms of morphology, yield components, disease and pest resistance, and winter and spring frost resistance. Representative samples were taken to evaluate yield quality and chemical composition of berries. The collection contains two to fifteen bushes of each genotype, depending on their availability and hardiness.

Descriptive statistics and cluster analysis were used to evaluate the genotypes in terms of individual parameters.

Multicriteria analysis by Martinov (1987) was used to assign an overall value to each of the genotypes. This allows overall comparison of different genotypes in terms of multiple parameters using different measurement systems. Each parameter group and each individual parameter is assigned a particular contribution coefficient, or "weight". The best genotype is the one that scores as close to optimum as possible for as many of the parameters as possible.

The optimum value for bush height is 130 cm. The optimum value for the quantity of basal shoots is 3 points. The optimum values for growth habit, astringency, disease and pest resistance, and winter and spring frost hardiness were presumably the lowest values observed in a given year. The optimum values for yield components, separation of berries from the stalk, flavor, and chemical composition of berries were presumably the highest values observed in a given year.

Contribution coefficients for parameter groups were as follows:

- Morphology: 10%, evenly divided between bush height, quantity of basal shoots, and growth habit.
- Yield components: 20%, evenly divided between productivity, average berry weight, and number of flowers per cluster.
- Yield quality: 5%, with separation of berries from the stalk contributing 50%, and flavor and astringency contributing 25% each.
- Chemical composition: 25%, with anthocyanin content contributing 50%, and ascorbic acid content and soluble solids content contributing 25% each.
- Disease and pest resistance: 25%, evenly divided between mildew, septoria leafspot, leafspot, blister rust, and gall mite.
- Frost hardiness: 15%, with winter frost damage contributing 60%, and spring frost damage contributing 40%.

RESULTS AND DISCUSSION

Data for all parameters of the eighty blackcurrant genotypes are presented in Table 1.

T a b l e 1 . Blackcurrant genotype characterization

Genotype	Height, cm	Number of basal shoots, points	Growth habit, points	Total yield, points	Average berry weight, g	Flowers per cluster, count	Separation from stalk, points	Flavor, points	Astringency, points	Anthocyanins, mg100g^{-1}	Ascorbic acid, mg100g^{-1}	Soluble solids, %	Mildew damage, points	Septoria leafspot damage, points	Leafspot damage, points	Blister rust damage, points	Gall mite damage, points	Winter frost damage, points	Spring frost damage, points
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AA-98	125	2.7	5.1	3.8	0.78	5.4	5	9	1	256.1	131.8	15.9	1.0	2.2	4.2	1.3	1.0	2.3	55.0
Almiai	99	2.6	4.8	4.8	1.09	5.9	6	9	1	196.8	186.4	13.2	1.0	3.0	3.0	1.0	1.1	1.8	41.7
Bagira	107	4.2	6.7	5.7	0.87	6.2	4	9	1	252.3	148.4	15.3	1.0	3.0	3.2	1.0	1.2	1.7	47.2
Belorusskaya Sladkaya	114	2.3	3.3	4.6	0.69	6.2	9	9	1	177.0	266.8	14.5	1.0	2.5	3.7	1.3	1.0	2.5	46.0
Ben Alder	112	3.3	5.1	7.6	0.70	7.0	7	9	4	263.5	172.2	14.2	1.0	4.7	3.7	1.7	1.0	1.7	20.8
Ben More	95	3.3	5.0	5.5	0.73	6.8	4	9	1	244.4	226.4	12.6	1.0	3.3	2.9	1.3	1.0	1.8	58.2
Black Dawn	121	3.7	5.9	6.7	0.74	9.0	8	9	1	214.1	225.7	14.5	1.0	3.0	2.0	1.7	1.0	2.7	33.4
Intercontinental	99	2.9	5.1	5.8	0.97	5.2	7	9	1	229.9	212.7	15.4	1.0	2.9	4.1	1.3	1.1	1.9	27.8
BRi 8707-29	95	2.7	4.7	4.0	1.01	6.0	3	4	1	158.3	108.8	15.4	1.0	2.7	2.3	1.0	1.0	1.7	45.7
BRi 8707-42	103	2.7	4.8	5.9	1.29	5.3	5	6	1	164.3	150.1	15.1	1.0	4.3	3.0	1.0	1.0	2.1	31.7
Chereshneva	112	2.4	4.8	5.5	0.88	8.1	6	9	1	184.2	171.5	14.1	1.0	2.1	2.3	1.7	1.0	2.6	36.0
Chernii Kentavr	112	3.3	5.3	4.3	1.15	8.8	6	4	1	232.3	197.6	13.8	1.0	2.9	2.9	1.7	1.3	1.7	43.9
Chernii Zhemchug	120	3.2	5.8	5.6	1.02	8.7	7	9	1	195.0	135.0	13.0	1.0	2.6	2.9	2.3	1.4	1.7	48.2
Detskosel'skaya	116	4.0	5.8	5.6	0.80	5.8	3	1	1	221.9	288.6	17.3	1.0	5.3	4.0	1.3	1.0	2.0	33.3
I a 47	121	4.0	4.8	5.5	0.63	6.8	3	9	1	226.6	232.2	14.1	1.0	4.7	3.3	1.3	1.0	2.1	42.5
I a 58	118	2.3	3.3	4.5	0.57	7.5	3	9	1	307.8	238.4	17.2	1.0	2.7	3.3	1.0	1.0	2.9	51.7
II a 23	149	5.0	5.0	5.0	0.55	6.3	8	9	1	204.8	231.3	14.0	1.0	3.7	2.7	1.0	1.0	1.7	42.8
II a 40	139	4.7	4.8	6.7	0.64	8.5	5	9	1	187.2	173.2	13.9	1.0	2.3	3.0	1.0	1.0	1.5	25.8
II a 46	148	6.0	5.0	4.8	0.39	7.8	9	6	1	210.4	133.7	14.0	1.0	2.8	2.3	1.3	1.0	1.7	29.2
II a 52	156	3.0	5.3	6.6	0.56	7.8	7	6	1	177.3	159.1	12.3	1.0	2.7	2.7	1.0	1.0	1.6	42.5
II a 62	162	5.8	5.5	4.7	0.63	7.5	7	9	1	212.5	194.6	14.6	1.0	2.7	2.3	1.0	3.0	2.3	37.5
II b 10	137	6.3	4.7	6.5	0.53	7.0	7	9	1	183.5	176.3	12.8	1.0	2.0	3.0	1.0	1.0	1.5	15.5
II b 14	151	4.0	4.8	6.0	0.57	7.0	8	9	1	236.8	276.7	14.6	1.0	3.0	2.3	1.0	1.0	1.6	14.5
II b 47	128	3.2	4.8	4.6	0.64	5.5	7	9	1	184.6	201.0	14.3	1.0	3.7	3.7	1.3	1.0	3.1	26.2
III a 30	147	4.3	5.0	6.0	0.74	5.8	7	9	4	185.8	181.7	14.3	1.0	3.7	3.3	1.7	1.0	1.6	34.5
III a 36	168	4.8	5.2	5.6	0.66	7.3	7	6	1	207.8	167.3	13.3	1.0	3.3	3.0	1.3	1.0	1.3	30.0
III a 68	136	4.7	4.3	6.3	0.67	6.3	9	9	1	240.1	164.7	13.6	1.0	3.3	3.3	1.3	1.0	1.5	38.7
Iyunskaya	102	2.2	5.0	2.4	0.97	5.3	4	9	1	249.2	220.8	14.2	1.2	3.0	3.0	1.3	1.7	2.8	55.6
Yadrenaya	100	3.0	6.0	5.5	1.92	6.4	1	1	1	162.1	191.9	10.5	1.0	3.0	3.0	3.0	1.0	4.5	45.0
Joniniai	100	3.1	5.3	5.1	1.12	5.8	3	9	1	170.1	249.6	14.0	1.1	2.6	3.0	1.0	1.0	1.9	50.4
Josta	173	3.9	5.7	2.9	1.69	3.6	1	1	1	75.2	116.8	14.5	1.0	1.7	1.9	1.7	1.0	4.1	72.6
Katyusha	123	5.2	5.3	7.6	0.86	7.8	8	4	1	205.5	110.4	13.1	1.0	2.0	2.3	1.0	1.5	2.3	32.0
Keep 39	149	4.9	4.5	5.0	0.52	6.6	7	9	1	249.4	193.8	13.6	1.0	5.7	3.1	1.3	1.0	2.2	16.5
Kroma	153	2.9	6.2	3.0	1.60	3.8	1	1	1	122.5	94.1	14.5	1.0	1.8	2.0	1.3	1.0	2.1	47.6
Laimiai	106	2.3	4.3	5.2	0.81	6.6	7	9	1	233.3	194.1	14.8	1.0	2.9	3.4	2.3	1.3	2.4	36.1
Lentyai	115	3.0	6.0	7.5	1.23	7.0	6	9	1	134.6	109.1	13.9	1.0	2.5	2.3	1.3	1.0	1.6	37.5
Lunnaya	112	4.0	6.0	6.5	1.13	6.0	5	6	1	177.8	164.3	15.0	1.0	2.3	4.3	1.3	1.0	1.7	53.3

T a b l e 1 (end)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Malling Jet	137	3.0	4.3	4.5	0.55	13.0	6	9	1	198.6	174.6	12.8	1.3	2.3	1.7	1.3	1.7	2.6	58.3
Mara (NK 78)	122	3.1	4.3	5.9	1.38	9.4	8	9	1	154.9	160.8	13.6	1.0	4.2	2.3	1.3	1.3	1.6	26.0
No. 100	161	6.6	4.7	6.5	0.58	8.0	7	5	5	192.3	153.2	11.8	1.0	2.6	2.7	1.3	1.9	1.5	18.4
No. 14	150	3.5	3.7	5.5	0.42	21.0	5	4	4	173.7	201.3	14.5	1.0	3.7	1.7	1.3	1.0	2.3	57.5
No. 17	80	2.7	3.0	1.5	0.76	19.5	9	1	9				1.0	2.7	2.3	1.0	1.3	5.8	85.0
No. 2255	138	4.8	4.5	5.4	0.44	18.0	6	1	9	228.8	88.3	13.4	1.0	2.5	2.7	1.0	1.0	3.1	61.7
No. 24	141	3.6	4.1	3.0	0.51	14.2	6	1	9	118.9	142.1	14.8	1.0	2.3	2.1	1.0	1.0	1.6	89.1
No. 3579	145	5.0	4.0	5.5	0.50	17.8	6	1	6	243.4	81.8	12.9	1.0	2.7	2.7	1.3	1.0	3.1	60.0
No. 36	146	4.6	5.3	5.9	1.00	6.6	4	9	1	174.1	152.5	13.1	1.0	1.9	2.7	2.3	1.3	2.3	25.3
No. 3897	132	4.5	3.5	4.3	0.57	14.5	6	9	1	136.5	95.6	15.0	1.0	2.7	3.0	1.3	3.3	1.7	47.5
No. 4	153	6.0	5.3	6.1	0.87	6.1	4	6	4	206.9	168.6	14.6	1.0	3.6	3.2	1.7	1.3	1.8	17.3
No. 61	123	3.2	6.2	6.5	0.82	6.8	5	9	1	132.8	145.2	12.7	1.0	2.3	2.0	1.3	1.3	1.9	26.0
No. 6455	99	1.7	4.3	1.8	0.39	14.8	2	1	1	259.3	131.4	12.2	1.0	4.0	3.0	1.3	8.0	2.7	87.5
No. 67	126	6.1	5.7	6.6	0.90	7.7	5	4	5	219.1	176.2	12.1	1.0	4.9	3.7	1.0	2.0	1.7	19.7
No. 675/10	70	4.0	6.0			8.0							3.0	1.7	2.8	1.0	1.3	4.6	97.5
No. 6751	80	4.0	6.0			14.0							1.7	2.0	1.8	1.0	1.0	5.6	100
No. 77	129	4.1	5.7	5.9	0.73	6.3	9	9	1	235.6	149.5	14.4	1.0	4.1	2.8	1.0	1.3	1.3	46.1
No. 7727	110	3.5	5.5	4.0	0.90	7.0	5	6	4	121.4	165.7	15.5	1.0	2.0	2.3	1.0	1.0	1.7	53.3
No. 81	148	4.2	5.0	3.9	0.79	7.0	6	5	1	164.5	118.3	13.3	1.0	2.6	3.1	1.0	3.4	1.6	51.4
No. 89	141	4.0	5.1	7.4	0.84	6.9	5	9	1	234.8	148.9	13.3	1.0	2.0	2.9	1.3	1.3	1.5	40.3
No. 95	153	5.2	5.0	6.3	1.00	8.8	5	6	1	161.6	130.6	12.6	1.0	2.0	2.4	1.3	1.7	1.5	15.8
Ojebyn	126	3.0	4.7	6.1	0.73	5.7	5	9	1	196.8	136.1	14.7	1.0	2.5	2.3	1.7	1.1	1.9	21.7
Pamyati Ravkinu	101	2.6	5.1	7.4	0.85	5.0	6	6	1	209.2	146.3	14.3	1.0	2.9	3.9	1.0	1.7	1.5	25.3
Pileniai	100	2.2	4.4	5.0	0.80	6.7	2	9	1	209.4	163.6	13.4	1.0	3.2	3.1	1.7	1.3	2.2	33.3
Pilot A. Mamkin	125	3.7	3.7	3.0	0.82	7.8	8	9	1	192.1	174.9	16.6	1.0	1.7	3.0	1.0	1.0	3.9	70.8
Polar	111	2.8	5.7	4.9	0.74	5.7	4	9	1	238.7	101.9	12.5	1.0	3.3	3.2	1.3	1.1	2.1	54.3
R. americanum	119	3.3	5.7	1.0		7.5	9	1	1				1.0	1.5	1.3	1.0	1.0	1.7	23.8
R. bracteosum x petiolare	85	2.0				15.5							1.0	2.8	3.5	2.0	1.0	4.3	99.5
Rosenthals Langtraubige	103	2.3	5.8	4.8	0.71	8.0	4	7	1	326.5	240.0	16.8	1.3	2.5	3.0	2.3	1.0	1.6	51.7
Sanyuta	112	3.0	5.2	5.3	1.06	6.5	8	6	1	217.0	155.3	13.6	1.0	2.2	2.3	1.0	1.3	1.9	27.5
Selechenskaya	94	4.2	5.3	5.4	1.01	5.6	3	7	1	181.9	163.0	13.4	1.0	4.4	3.2	2.3	1.5	1.8	47.6
Sevchanka	105	3.3	4.7	4.5	0.95	6.5	3	6	1	184.4	190.1	15.2	1.0	4.3	2.8	1.7	1.3	2.0	46.7
Silvergieters Swarze	108	2.0	4.8	6.0	0.64	6.7	6	9	1	171.7	173.0	12.7	1.7	3.0	3.7	2.3	1.0	2.5	43.4
Stor Klas	112	2.9	6.0	5.6	0.90	5.6	2	7	1	174.2	115.6	14.6	1.0	3.0	3.0	1.3	1.3	2.2	40.7
Svita Kievskaya	120	3.2	5.1	5.6	0.90	5.7	7	1	4	200.9	115.8	11.5	1.0	2.9	3.9	1.0	1.7	2.1	45.8
Titania	157	4.8	4.6	5.4	0.88	5.5	4	9	1	236.6	136.7	15.3	1.0	3.7	2.4	0.7	1.0	1.5	27.7
Triton	139	3.5	4.7	5.6	0.71	6.8	5	9	4	248.2	172.0	15.8	1.0	3.3	2.6	1.3	1.0	1.7	41.6
Vakariai	107	3.4	4.8	6.9	0.56	6.1	5	7	1	210.7	294.0	15.5	1.0	2.7	2.6	1.7	1.3	2.1	10.3
Veloi	93	2.3	4.3	6.5	0.87	5.5	2	9	1	240.4	127.6	14.0	1.0	3.0	3.0	2.3	2.0	2.2	37.3
Vernisazh'	121	3.1	5.0	7.3	0.75	6.8	5	6	1	263.7	124.0	13.3	1.0	2.5	3.0	1.3	1.4	1.5	35.0
Viuchiai	85	2.2	5.6	5.2	0.97	5.7	4	9	1	187.5	149.0	13.1	1.0	2.5	2.9	1.0	1.8	1.9	43.7
Vologda	98	3.0	5.3	6.3	0.92	6.0	4	4	1	134.5	176.2	12.6	1.0	3.0	3.7	1.3	1.3	1.5	51.7
Zagadka	118	2.8	3.1	4.9	0.93	6.3	7	9	1	217.3	133.7	15.6	1.0	3.0	3.2	1.3	1.1	2.0	32.5
Average	122	3.6	5.0	5.3	0.83	7.8	5	7	2	201.8	167.6	14.0	1.1	2.9	2.9	1.4	1.4	2.2	43.0
Standard deviation	23	1.1	0.8	1.4	0.28	3.5	2	3	2	43.6	46.9	1.3	0.2	0.9	0.6	0.4	0.9	0.9	19.6
Minimum	70	1.7	3.0	1.0	0.39	3.6	1	1	1	75.2	81.8	10.5	1.0	1.5	1.3	0.7	1.0	1.3	10.3
Maximum	173	6.6	6.7	7.6	1.92	21.0	9	9	9	326.5	294.0	17.3	3.0	5.7	4.3	3.0	8.0	5.8	100

Bush height ranged from 70 to 175 cm (p = 0.000). The plants fell into four clusters. 5% of the genotypes were higher than 160 cm, which means they are too high for mechanical harvesting. This group included No. 100, II a 62, III a 36 and 'Josta'. 24.7% of the genotypes were from 135 to 157 cm tall, and 64% were from 93 to 132 cm tall; plants in both of these groups can be mechanically harvested. 6.3% of the genotypes were either not tall enough or not hardy enough for commercial production. This group included No. 17, No. 6751, No. 675/10, and *R. bracteosum / R. petiolare*, all of which suffered serious recurrent frost damage, and 'Viuchiai'.

Number of **basal shoots** ranged from 1.7 to 8 points (p = 0.000). The optimum number is from three to five basal shoots per bush, which corresponds to a score of 3 to 4 points. Bushes with too many basal shoots have a lot of weak branches and are too dense. Bushes with not enough basal shoots are difficult to renew. Plants fell into two clusters. 7.5% of the genotypes had too many basal shoots, and scored over 5.8 points. This group included II a 62, II a 46, No. 4, No. 67, II b 10 and No. 100. The remaining 92.5% of the genotypes had acceptable numbers of basal shoots, and scored between 1.7 and 5.2 points.

Growth habit ranged from 3 to 6.7 points (p = 0.000). 'Zagadka', 'Belorusskaya Sladkaya', 'Pilot A. Mamkin', I a 58, No. 3897, No. 14 and No. 17 had especially desirable, upright bush habits, and scored between 3 and 3.7 points. 'Zagadka' and 'Belorusskaya Sladkaya' are already widely grown in Latvia. The others may be grown commercially or used in breeding programs to contribute desirable growth habit, except for No. 17, which is not hardy enough.

Productivity ranged widely from 1 to 9 points (p = 0.000). 5.1% of the genotypes had almost no yield at all in all of the years of the trial, and scored less than 2 points. This group included *R. americanum*, No. 1296, No. 17 and No. 6455. *R. americanum* performed poorly because it is self-sterile and did not have a pollinator. No. 6455 was not hardy enough. 6.3% of the genotypes had yields too low for sustainable production and scored between 2 and 3 points. This group included No. 24, 'Pilot A. Mamkin', 'Kroma', 'Josta' and 'Iyunskaya'. The blackcurrant-gooseberry hybrids 'Kroma' and 'Josta' are nonetheless interesting plants for home gardens. 'Iyunskaya' is the earliest blackcurrant cultivar in our collection. 88.6% of the genotypes produced medium to high yields. 'Katyusha' and 'Pamyati Ravkinu' consistently had yields more than one standard deviation higher than the mean every year. This means that their high yield capacity is stable and genetically determined. These high-yielding genotypes can be recommended for commercial production in the local climate.

Average berry weight differed widely from cultivar to cultivar and from year to year. In 2001, berry weight averaged 0.96 g, whereas in 2000, it averaged 0.68 g. There was no significant correlation between berry weight and cumulative precipitation from May 1 to July 10, when the berries were developing (r = 0.46). However, the distribution of precipitation during different phases of berry development seems to be important. In 2000, there was no real drought period while the berries were developing. Precipitation was close to the long-term average. Nonetheless, blackcurrants can experience water deficiency from the end of May to the middle of June, when cell division and growth are rapid. The largest berries were recorded in 2001, when precipitation was abundant in the spring and early summer. This indicates that blackcurrants need abundant water at this specific developmental stage for maximum berry size. The following genotypes had the highest four-year average berry weights, as well as berry weights more than one standard deviation above the mean in at least two years: Josta' (1.69 g), 'Kroma' (1.60 g), 'Yadrenaya' (1.92 g), 'Lunnaya' (1.13 g), 'BRi 8707-42' (1.29 g), 'Joniniai' (1.12 g), 'Chernii Kentavr' (1.15 g), 'Almiai' (1.09 g), BRi 8707-29 (1.01 g), 'Mara' (1.38 g), and 'Lentyai' (1.23 g). These genotypes can consistently produce large berries under optimal moisture conditions.

The number of **flowers per cluster** ranged from 3.3 to 28.5, depending on the genotype (p = 0.000). The genotypes fell into three groups. 12.5% of the genotypes had 13 to 21 flowers per cluster. This group included nine inter-specific hybrids specifically bred to have high numbers of flowers per cluster by A. Melehina in Latvia. They are descendants of *R. petiolare* (No. 2255, No. 3579, No. 3897, No. 6455, No. 17), *R. bracteosum* (No. 14, No. 24, *R. bracteosum / R. petiolare,* and 'Malling Jet' from East Malling), and *R. fontaneum* (No. 6751). Many of these genotypes can be used in breeding programs to increase the number of flowers per cluster. Unfortunately, only 'Malling Jet' bears palatable berries and can be grown for food. The lowest numbers of flowers per cluster were observed in 'Josta' (3.6) and 'Kroma' (3.8). The remaining 87.5% of the genotypes had between five and nine flowers per cluster, which is typical for blackcurrants.

Separation of berries from the stalk was good in 19.5% of the genotypes. These included 'Belorusskaya Sladkaya', 'Black Dawn', II a 23, II a 46, II a 62, II b 14, III a 68, 'Katyusha', 'Mara', No. 100, No. 17, No. 77, 'Pilot A. Mamkin', *Ribes americanum* and 'Sanyuta'. Berries of these genotypes are not damaged during picking and can be stored under appropriate conditions. Berries of the remaining 80.5% of the genotypes had juicy wounds when separated from the stalk and need to be processed immediately.

Flavor is important for both fresh consumption and processing. Europeans traditionally demand the flavor characteristic of *R. nigrum* var. *europaeum* (Brennan, 1996). 76.6% of the genotypes had the desired characteristic flavor. The flavor and flavor intensity of the best tasting genotypes has to be studied in more detail. Flavor can be lost or changed when other species, such as *R. nigrum* var. *sibiricum*, or *R. dikusha*, are used in breeding programs. The desired flavor was as absent or weak in 23.4% of the genotypes: No. 2255, No. 3579, No. 6455, No. 14, No. 24, No. 17, 'Josta', 'Kroma', No. 67, No. 81, No. 100, BRi 8707-29, *R. american,,*'Svita Kievskaya', 'Yadrenaya', 'Detskosel skaya', 'Viologda', 'Katyusha', No. 67, No, 81, and No. 100. No. 2255, No. 3579, and No. 6455 are *R. nigrum / R. petiolare* hybrids. No. 14 is an *R. nigrum / R. bracteosum* hybrid. No. 24 is an *R. bracteosum* / *R. nigrum* hybrid. No. 17 is an *R. petiolare* / *R. dikusha* hybrid. 'Josta' and 'Kroma' are *R. nigrum / R. grossularia* hybrids. 'Svita Kievskaya', 'Yadrennaya', 'Detskosel'skaya', 'Vologda', 'Katyusha' are descended either from *R. nigrum* var. *sibiricum* or *R. dikusha*. No. 67 ('Black Naples' / 'Seyanets Golubki'), No. 81 and No. 100 ('Black Naples' / 'Katyusha') are hybrids of either *R. nigrum* var. *sibiricum* or *R. dikusha*.

Astringency was present in 5.2% of the genotypes: No. 24, No. 3579, No. 17, and No. 2255. These genotypes inherited this undesirable taste from their ancestors, *R. bracteosum* and *R. petiolare*. However, astringent taste was absent in No. 14, which is an *R. nigrum / R. bracteosum* hybrid, and in No. 6455 and No. 3897, which are *R. nigrum / R. petiolare* hybrids.

Anthocyanin content differed significantly between genotypes ($p = 0.003$). I a 58 had the highest content and was in a cluster of its own. Its anthocyanin content was consistently more than one standard deviation above the mean in each year of the trial, averaging 307.8 mg $100g^{-1}$. I a 58 can be recommended for use in breeding programs to increase anthocyanin content. There was a second cluster of fifteen genotypes with high anthocyanin content ranging from 225 to 263 mg $100g^{-1}$, including 'Bagira', AA-98, 'Triton', 'Keep 39' (ancestor of I a 58), 'Vernisazh'', and 'Ben Alder', though they did not have as consistently high anthocyanin contents as I a 58.

Ascorbic acid content varied widely among genotypes ($p = 0.000$). 'Detskosel'skaya', 'Vakariai', 'Belorusskaya Sladkaya', II b 14, I a 47, I a 58, and 'Joniniai' consistently had ascorbic acid contents more than one standard deviation above the mean in each year of the trial, averaging from 225 to 293 mg $100g^{-1}$. These genotypes can be recommended for use as food, and can be used in breeding programs to increase ascorbic acid content. Unfortunately, blackcurrants lose most of their ascorbic acid content when subjected to common processing technologies. Therefore, high ascorbic acid content is no longer a priority for industry today (Iversen, 1999). On the other hand, interesr on healthy food of both consumers and industry are rising, therefire high contents of ascorbic acid is stillin in high priority in breeding programs.

Soluble solids content also differed between genotypes (p = 0.021). The genotypes fell into four clusters. The cluster with the highest soluble solids content comprised I a 58 and 'Detskosel'skaya'. I a 58 consistently had a soluble solids content more than one standard deviation above the mean in each year of the trial.

Mildew (*Sphaerotheca mors-uvae*) infection was low because of the limited infection source. There were no significant differences between genotypes (p = 0.616). Only 8.1% of the genotypes showed some infection up to 3 points.

There were significant differences between genotypes in resistance to **septoria leafspot (*Mycosphaerella ribis*)** (p = 0.000). None of the genotypes were completely immune. Cluster analysis separated only two groups. 87.2% of the genotypes were relatively resistant, scoring 2 to 3 points). However, only damage to 'Josta', 'Pilot A. Mamkin' and *R. americanum* were more than one standard deviation below the mean in each year of the trial.

Leafspot (***Pseudopeziza ribis)*** infection was observed only in 2000 and 2001. There were no significant differences between genotypes (p = 1.000).

Blister rust (*Cronartium ribicola*) infection was observed only in 2001. 36.3% of the genotypes were unaffected, including 'Almiai', 'Bagira', BRi 8707-29, 'BRi 8707-42, I a 58, II a 23, II a 40. II a 52, II a 62, II b 10, II b 14, 'Joniniai', 'Katyusha', No. 17, No. 2255, No. 24, No. 67, No. 675/10, No. 6751, No. 77, No. 7727, No. 81, 'Pamyati Ravkinu', 'Pilot A. Mamkin', *R. americanum,* 'Sanyuta', 'Svita Kievskaya', 'Titania', and 'Viuchiai'. Some of them are potential donors of resistance. However, it is difficult to make conclusions based solely on one year of data.

Gall mite (*Cecidophyopsis ribis*) infection was not observed at the beginning of the trial, but started to spread later. At the end of the trial, 95% of the genotypes had little or no damage (1-2 points). No. 3897, No. 81 and II a 62 showed slight damage (3 points). No. 6455 (*R. nigrum / R. petiolare)* was heavily damaged (9 points). Gall mite had just started to spread through the plantation toward the end of the trial. Therefore, concluding that the genotypes which showed little damage are in fact resistant is not justified.

Winter frost damage differed significantly between genotypes (p = 028). 91.3% of the genotypes had negligible damage, scoring 1 to 3 points. Therefore, it is difficult to identify the hardiest genotypes. No. 17, No. 6751, No. 675/10, *R. bracteosum x R. petiolare*, 'Pilot A. Mamkin', 'Yadrenaya', and 'Josta' showed more serious damage (>4 points) and are not recommended for cultivation in the local climate of Dobele. No. 17, No. 6751, No. 675/10, and *R. bracteosum / R. petiolare* lost most of their shoots every winter, and thus did not bear the next season. The lack of significant yield made it impossible to score these genotypes for several of the trial parameters.

Although there were notable differences between genotypes in **spring frost** damage, the differences were not significant at the 95% level ($p = 0.096$). The timing and severity of spring frosts differed from year to year. This affected different genotypes in different ways. ‘Josta’, ‘Pilot A. Mamkin’, No. 24, No. 6455, No. 17, No. 6751, *R. bracteosum / R. petiolare*, and No. 675/10 were seriously damaged in each year of the trial.

Multicriteria analysis

According to multicriteria analysis, the best genotype for berry production, is II b 14 (Keep39 x ‘Pamyat' Vavilovu’), followed by ’Black Dawn’, I a 58 (Keep39 x ‘Vinogradnaya’), No. 89 (‘Black of Naples’ x ‘Katyusha’), ’Triton’, ’Vakariai’, ‘Ben Alder’, ‘Intercontinental’, III a 68 (Keep39 x ‘Zagadka’), ‘Mara’, ‘Vernisazh’’, and ‘Zagadka’ (Fig. 1). These genotypes scored high in total yield, average berry weight, number of flowers per cluster, anthocyanin content, and winter and spring frost hardiness. ‘Zagadka’ is widely grown in Latvia and can be recommended for future cultivation. The potential of the other strains for commercial production is currently under study. ‘Triton’, ‘Mara’, and ‘Ben Alder’ are the most promising genotypes, and can also be recommended for commercial production. They can also be recommended for use in breeding programs as donors of good overall value for sustainable production, even though some other genotypes performed much better with regard to single parameters, especially average berry weight and the number of flowers per cluster.

CONCLUSIONS

1. Valuable donors for bush morphology, ascorbic acid content, anthocyanin content, berry weight, and number of flowers per cluster were found in the blackcurrant genetic resources collection in Latvia. These include both local and introduced genotypes.
2. According to multicriteria analysis, the best genotypes for sustainable production were II b 14, ’Black Dawn’, I a 58, No. 89, ’Triton’, ’Vakariai’, ‘Ben Alder’, ‘Intercontinental’, III a 68, ‘Mara’, ‘Vernisazh’’, and ‘Zagadka’. These genotypes scored high in prodductivity, average berry weight, number of flowers per cluster, anthocyanin content, and winter and spring frost hardiness.

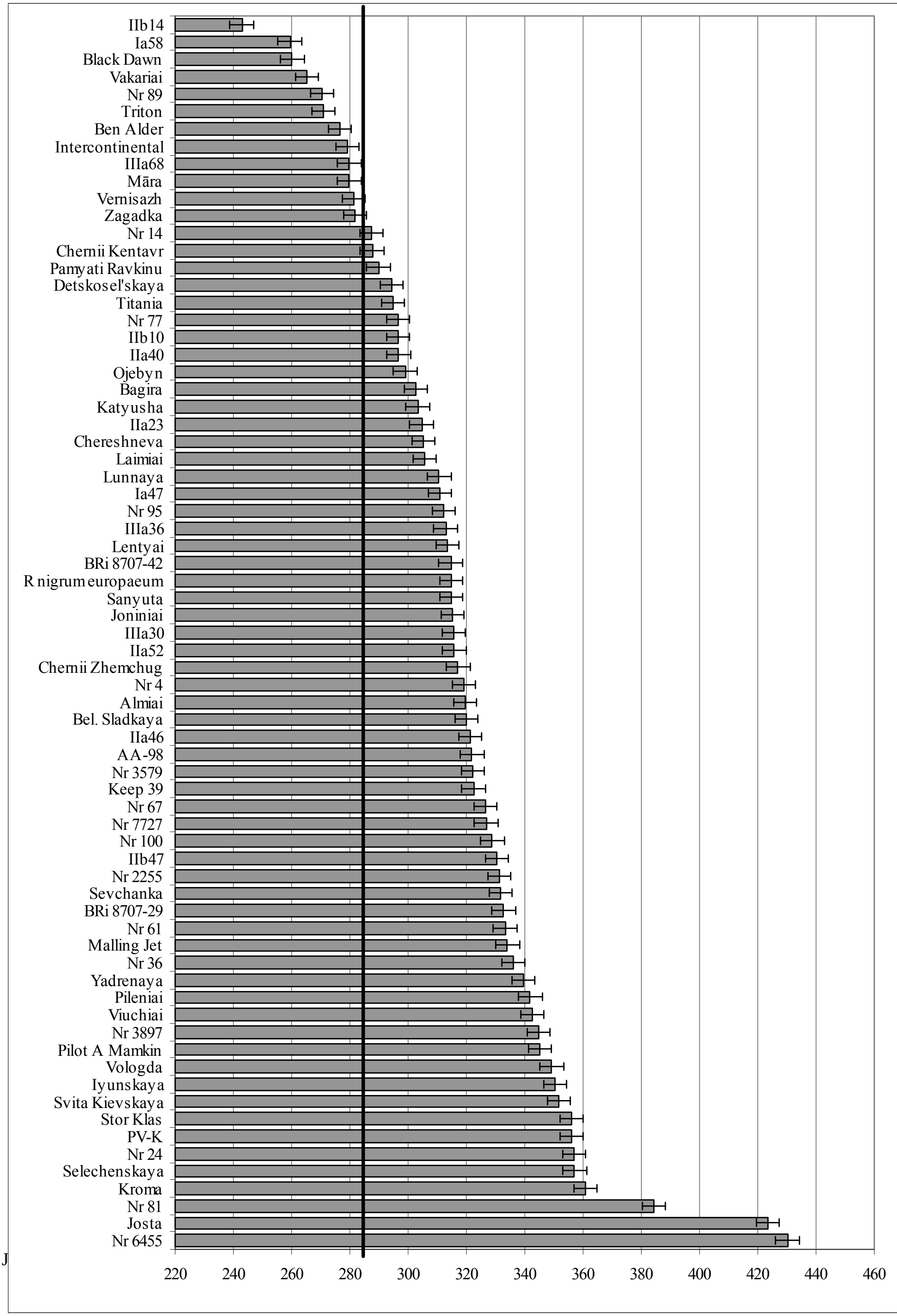
IIb14
Ia58
Black Dawn
Vakariai
Nr 89
Triton
Ben Alder
Intercontinental
IIIa68
Māra
Vernisazh
Zagadka
Nr 14
Chernii Kentavr
Pamyati Ravkinu
Detskosel'skaya
Titania
Nr 77
IIb10
IIa40
Ojebyn
Bagira
Katyusha
IIa23
Chereshneva
Laimiai
Lunnaya
Ia47
Nr 95
IIIa36
Lentyai
BRi 8707-42
R nigrum europaeum
Sanyuta
Joniniai
IIIa30
IIa52
Chernii Zhemchug
Nr 4
Almiai
Bel. Sladkaya
IIa46
AA-98
Nr 3579
Keep 39
Nr 67
Nr 7727
Nr 100
IIb47
Nr 2255
Sevchanka
BRi 8707-29
Nr 61
Malling Jet
Nr 36
Yadrenaya
Pileniai
Viuchiai
Nr 3897
Pilot A Mamkin
Vologda
Iyunskaya
Svita Kievskaya
Stor Klas
PV-K
Nr 24
Selechenskaya
Kroma
Nr 81
Josta
Nr 6455
220
240
260
280
300
320
340
360
380
400
420
440
460

Figure 1. Complex evaluation by multicriteria analysis for suitability to processing of blackcurrant genotypes

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OCENA ZASOBÓW GENOWYCH PORZECZKI CZARNEJ DLA ZRÓWNOWAŻONEJ PRODUKCJI OWOCÓW

Kaspars Kampuss i Sarmite Strautina

STRESZCZENIE

W latach 1999-2002 testowano osiemdziesiąt genotypów porzeczki czarnej w Stacji Hodowli Roślin Ogrodniczych w Dobele na Łotwie. Genotypy oceniano pod względem cech morfologicznych, plonowania, jakości owoców, odporności na choroby i szkodniki oraz mrozoodporności i tolerancji kwiatów na przymrozki wiosenne. Do określenia całkowitej wartości każdego genotypu zastosowano analizę wielocechową („Multicriteria") opisaną przez Martinov (1987). Najwyższą ocenę uzyskało pięć genotypów pochodzących z Łotwy: II b 14 ('Keep39' / 'Pamyat' Vavilovu'), I a 58 ('Keep39' / 'Vinogradnaya'), Nr 89 ('Black of Naples' / 'Katyusha'), III a 68 ('Keep39' / 'Zagadka') i 'Mara' ('Black of Naples' / 'Katyusha') oraz siedem wprowadzonych do uprawy odmian: 'Black Dawn', 'Vakariai', 'Triton', 'Ben Alder', 'Intercontinental', 'Vernisaz' i 'Zagadka'. Mogą być one polecane do programów hodowli jako donory wartościowych cech użytkowych przydatnych dla zrównoważonej produkcji owoców tego gatunku.

Słowa kluczowe: *Ribes*, analiza wielocechowa, składniki plonu, jakość, oporność