EVALUATION OF THE BREEDING VALUE OF SELECTED BLACKBERRY GENOTYPES

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A B S T R A C T

In 2001 and 2002, thirteen blackberry crosses were evaluated at the Fruit Experiment Station in Brzezna, Poland. Seedlings were planted 0.5 x 2.5 meters apart, ten to a row, in a completely randomized block design, with four replicates. The aim of this trial was to estimate the general (GCA) and specific (SCA) combining ability of the crosses for growth vigor, plant habit, and frost resistance.

GCA and SCA were significant for all traits examined. The cultivars 'Gazda' and clone 83471 contributed the most to frost resistance. clone 89403 contributed the most to erect plant habit and low growth vigor. The best hybrid was clone 83471 x clone 89403. The best eight seedlings of the combination clone 83471 x clone 89403 were selected for further breeding.

Coefficients of heritability in broad sense ($h^2_{b.s.}$) were high for plant habit, but low for growth vigor and frost resistance.

Key words: Diallel cross, GCA, SCA, analysis of variance, heritability

INTRODUCTION

In Poland, blackberries are not grown on a large scale because of the lack of profitable, frost-resistant cultivars.

At the Fruit Experiment Station in Brzezna, recent work has been directed at developing clones and cultivars which may prove valuable for future breeding programs because of their upright growth habit, lack of thorns, and frost resistance.

The aim of this trial was to estimate the general (GCA) and specific (SCA) combining ability of the crosses for growth vigor, plant habit, and frost resistance.

MATERIAL AND METHODS

Five parent cultivars were used for this trial. Four were developed at

the Fruit Experiment Station in Brzezna: 'Orkan', 'Gazda', clone 83471, and clone 89403. The fifth was a cultivar developed in Scotland: 'Loch Ness'. Cane stiffness, number of thorns and frost resistance for these cultivars are presented in Table 1 (Danek, 2004; Jannings, 1988).

In 1997, these five parent cultivars were crossed in all ten possible combinations by controlled pollination in an incomplete, equable diallelic arrangement according to Griffing's second method (Griffing 1956). Also, three cultivars were crossed with themselves to produce three inbred crosses. The crosses are listed in the first column of Table 3.

Randomly selected progeny seedlings were planted 0.5 x 2.5 meters apart, ten to a row, in a completely randomized block design, with four replicates.

Growth vigor was recorded on a scale of 1 to 5, where 1 equals very low vigor, and 5 equals very high vigor. Plant habit was recorded on a scale from 1 to 5, where 1 equals spreading plants with trailing canes, and 5 equals erect plants with stiff canes. Frost resistance was recorded on a scale of 1 to 5, where 1 equals complete frost damage, and 5 equals no frost damage.

Results were elaborated by analysis of variance (conscious selection of parental forms) followed by Duncan's multiple range t-test at P = 0.05, consistent with the model of Griffing. Two sources of variability were considered in the analysis of variance: hybrid error and random error at the block, plot, and individual plant levels. Coefficients of heritability in the broad sense ($h^2_{b.s.}$) were also calculated.

RESULTS AND DISCUSSION

In both 2001 and 2002, general (GCA) and specific (SCA) combining ability were significant for all traits examined.

Growth vigor was recorded only in 2001. 'Orkan' x 'Gazda' had the highest growth vigor, and clone 89403 x clone 89403 had the lowest growth vigor (Tab. 3).

Plant habit was recorded only in 2001 clone 89403 x clone 89403 had the best growth habit, closely followed by clone 83471 x clone 89403 and 'Orkan' x clone 89403.

Frost resistance was evaluated in both 2001 and 2002. In 2001, clone 83471 x clone 89403 was the most frost resistant, with more than 25% of its buds not damaged by frost. In 2002, clone 83471 x clone 89403, 'Orkan' x clone 83471, and 'Orkan' x 'Gazda' were the most frost resistant. In both years, clone 89403 x clone 89403 was the least frost resistant, with almost all buds damaged by frost.

'Gazda', 'Orkan' and clone 83471 showed high GCA's for growth vigor. clone 89403 had a high GCA for plant habit. 'Gazda' and clone 83471 had high GCA's for frost resistance (Tab. 4).

Clone 83471 x clone 89403 has the best overall SCA for growth habit, plant habit and frost resistance (Tab. 5). The best eight seedlings of the combination clone 83471 x clone 89403 were selected for further breeding, and have been assigned numbers from clone 97461 to clone 97468. They are erect, thornless, and frost resistant.

Table 1. Characteristics of parent cultivars

Cultivar	Cane stiffness	Thorns	Frost resistance
'Orkan'	moderate	absent	moderate
'Gazda'	high	scant	high
Clone 83471	moderate	abundant	high
Clone 89403	very high	absent	low
Loch Ness	moderate	absent	low

Table 2. Analysis of variance of diallelic system with five parental blackberry cultivars for growth vigor, plant habit and frost resistance

Source of variability	L s.s.	Growth vigor		Plant habit		Frost resistance			
		2001		2001		2001		2002	
		Ms	Femp	Ms	Femp	Ms	Femp	Ms	Femp
GCA	4	0.37	35.75**	0.12	64.78**	0.15	25.82**	0.60	40.28**
SCA	8	0.20	19.17**	0.01	6.39**	0.27	45.91**	0.35	23.37**
Random error	36	0.01		0.00		0.01		0.01	
Ms CCA / Ms SCA *		1.85		12.0		0.56		1.71	

Growth vigor was recorded on a scale of 1 to 5, where 1 equals very low vigor, and 5 equals very high vigor.
Plant habit was recorded on a scale from 1 to 5, where 1 equals spreading plants with trailing canes, and 5 equals erect plants with stiff canes.
Frost resistance was recorded on a scale of 1 to 5, where 1 equals complete frost damage, and 5 equals no frost damage.
* – Quotient of mean squares for GCA and SCA ** – Effects different from zero at P = 0.

Table 3. Mean values of growth vigor, plant habit and frost resistance in blackberry crosses (Brzezna 2001-2001)

Cultivar Clone	Growth vigor	Plant habit	Frost resistance	
	2001	2001	2001	2002
'Orkan' x "Gazda'	4.02 f	3.15 a	3.06 ef	3.00 e
'Orkan' x clone 83471	3.90 ef	3.05 a	2.91 ef	3.00 e
'Orkan' x clone 89403	3.31 cde	3.42 bc	2.70 de	1.72 b
'Orkan' x 'Loch Ness'	3.05 bc	3.17 ab	1.98 b	2.00 bc
'Gazda' x clone 83471	3.14 bcd	3.20 ab	2.78 def	2.23 bcd
'Gazda' x clone 89403	3.60 cdef	3.30 ab	3.08 ef	2.48 cde
'Gazda' x 'Loch Ness'	3.71 def	3.05 a	2.71 def	2.73 de
Clone 83471 x clone 89403	3.86 ef	3.60 cd	3.17 f	3.00 e
Clone 83471 x 'Loch Ness'	3.60 cdef	3.02 a	2.74 def	2.23 bcd
Clone 89403 x 'Loch Ness'	3.20 bcd	3.22 ab	3.09ef	2.50 cde
Clone 8347' x clone 83471	3.66 cdef	3.20 ab	2.38 cd	2.73 de
Clone 89403 x clone 89403	2.30 a	3.72 d	1.60 a	1.22 a
'Loch Ness' x 'Loch Ness'	2.70 ab	3.07 a	1.14 bc	1.00 a

*Means followed by the same letter do not differ significantly at P = 0.05 according to Duncan's t-test

T a b l e 4 . GCA's of the five parental blackberry cultivars (Brzezna 2001-2001)

Cultivar Clone	Growth vigour	Plant habit	Frost damage	
	2001	2001	2001	2002
'Orkan'	0.20* b	-0.04 a	-0.01 ab	0.13 b
'Gazda'	0.26* b	-0.09* a	0.33* c	0.37* b
Clone 83471	0.19* b	-0.02 ab	0.06 b	0.29* b
Clone 89403	-0.28* a	0.22* c	-0.10* a	-0.26* a
'Loch Ness'	-0.22* b	-0.11* a	-0.16* a	-0.36* a
SE(gi) x 2.72	0.08-0.14	0.03-0.05	0.08-0.11	0.11-0.16
SE (gi-gi) x 2.99	0.15-0.24	0.06-0.09	0.12-0.18	0.21-0.30

Values followed by the same letter do not differ significantly at P = 0.05 ($t_{0.05/10Ve=36}$ = 2.99) according to the Bonferroni t test.
Values followed by *are significantly different from zero at P = 0.05 ($t_{0.05/5Ve=36}$ = 2.72) according to the Bonferroni t-test.
SE – standard error of the estimation of GCA effects or their difference

T a b l e 5 . SCA's of blackberry crosses (Brzezna 2001-2001)

Cultivar Clone	Growth vigour	Plant habit	Frost resistance	
	2001	2001	2001	2002
'Orkan' x 'Gazda'	0.18	0.04	0.10	0.21
'Orkan' x clone 83471	0.12	-0.13*	0.22*	0.29
'Orkan' x clone 89403	00.1	0.00	0.17	-0.44*
'Orkan' x 'Loch Ness'	-0.31*	0.09	-0.49*	-0.07
'Gazda' x clone 83471	-0.69*	0.06	-0.24*	-0.71*
'Gazda' x clone 89403	0.21	-0.10	0.22*	0.07
'Gazda' x 'Loch Ness'	0.30*	0.01	-0.09	0.43*
Clone 83471 x clone 89403	0.56*	0.16*	0.57*	0.68*
Clone 83471 x 'Loch Ness'	0.23	-0.08	0.20	0.01
Clone 89403 x 'Loch Ness'	0.31*	-0.12	0.72*	0.80*
Clone 83471 x clone 83471	-0.11	0.00	-0.38*	-0.13
Clone 89403 x clone 89403	-0.54*	0.04	-0.84*	-0.55*
'Loch Ness' x 'Loch Ness'	-0.27	0.06	-0.17*	-0.58*
SE(S_{ij}) x 3,14	0.22-0.28	0.09-0.13	0.16-0.22	0.25-0.35

Values followed by * are significantly different from zero at P = 0.05 ($t_{0.05/15Ve=36}$ = 3.14) according to the Bonferroni t test.
SE – standard error of the estimation of SCA effects or their difference

T a b l e 6 . Coefficients of heritability in the broad sense ($h^2_{b.s.}$) for growth vigor, plant habit and frost resistance

Coefficient of heritability in the broad sense [$h^2_{b.s}$]			
Growth vigor	Plant habit	Frost resistance	
2001	2001	2001	2002
0.36	0.86	0.41	0.32

Coefficients of heritability in the broad sense ($h^2_{b.s.}$) are presented in Table 6. The coefficients were high for plant habit, but low for growth vigor and frost resistance. The coefficient for plant habit was 0.86, which means that it is easier to develop plant habit in breeding programs. The coefficient for growth vigor was only 0.36. The coefficient for frost resistance was 0.32 in 2001, and 0.41 in 2002. The genetic contribution to growth vigor and frost resistance is relatively small and hard to predict, which makes it difficult to develop growth vigor and frost resistance in breeding programs.

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OCENA WARTOŚCI HODOWLANEJ WYBRANYCH GENOTYPÓW JEŻYNY

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STRESZCZENIE

Przedmiotem badań była populacja losowo wybranych siewek jeżyny otrzymanych z 13 kombinacji krzyżówkowych, wysadzona w układzie bloków losowych z 4 powtórzeniami po 10 roślin na poletku. Obserwacje prowadzono w latach 2001-2002 w Sadowniczym Zakładzie Doświadczalnym w Brzeznej. Celem pracy była ocena ogólnej (GCA) i specyficznej (SCA) zdolności kombinacyjnej mieszańców i na tej podstawie określenie ich przydatności jako form rodzicielskich do hodowli twórczej nowych odmian jeżyny pod względem badanych cech (przemarzanie, siła wzrostu, pokrój rośliny). Uzyskane wyniki wykazały wysoką wartość hodowlaną odmiany 'Gazda' i klonu 83471 w poprawieniu wytrzymałości na mróz oraz klonu 89403 w uzyskaniu właściwego pokroju roślin potomnych i w ograniczeniu siły wzrostu. Szczególnie korzystna okazała się kombinacja krzyżowań klonów 89403 x 83471. Wartości współczynników odziedziczalności w szerokim sensie ($h^2_{b.s.}$) były niskie dla następujących cech: siła wzrostu i wytrzymałość roślin na mróz oraz wysokie dla pokroju roślin w badanych latach.

Słowa kluczowe: krzyżowanie dialleliczne, GCA, SCA, analiza wariancji