EFFECTS OF OPEN AND SELF POLLINATION OF FOUR CULTIVARS OF HIGHBUSH BLUEBERRY (*Vaccinium corymbosum* L.) ON FLOWER FERTILIZATION, FRUIT SET AND SEED FORMATION

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A B S T R A C T

Open and self pollination of four highbush blueberry cultivars ('Bluecrop', 'Heerma', 'Darrow', and 'Croatan') were compared during 2000 and 2001 at an Experimental Station of the Department of Pomology in Garlica Murowana near Cracow. Open pollination was beneficial as it resulted in significantly higher number of pollen grains on pistil stigma, higher number of fertilized ovules as well as higher percentage of fruit setting, higher mean fruit weight, and higher number of seeds per fruit.

Key words: blueberry, fertilization, open-pollination, self-pollination

INTRODUCTION

There are various mechanisms which have been developed by flowers of numerous species protecting them from self pollination. Owing to some protection mechanisms the pollen grains of the same cultivar can not compete with pollen grains of other cultivars as they either do not germinate on the stigma or germinate very slowly. The growth of pollen tube can frequently be disrupted in the middle of style, as in the case of self pollination. This self incompatibility can be interrupted at the end of the flowering period and successful pollination can be accomplished with the pollen of the same cultivar. In such a case, however, the number of seeds developed is lower and consequently the fruit weight is smaller. Such biological mechanisms were observed in blueberry. Ehlenfeldt (2001)

presented lower fruit setting and a longer time required for fruit ripening in self pollinated blueberries. The results of Huang et al. (1997) confirm the favourable effects of cross pollination. Fruit formed after self pollination were 51% smaller and ripened 10 days later than fruit set after cross pollination. According to Lang and Danka (1992) cross pollination can increase the weight of individual fruit by 13.6%, compared to those formed after self pollination. All this suggest that for this species a pollinator plant is necessary.

The aim of this experiment was to study the effect of open and self pollination on fruit set, yield and fruit quality of highbush blueberry (*Vaccinium corymbosum* L.).

MATERIAL AND METHODS

The highbush blueberry (*Vaccinium corymbosum* L.) plantation was established at the Garlica Murowana Experimental Station near Cracow (Southern Poland) in 1986 on brown soil developed from loess, at pH 5.8, and a mulching of sawdust was applied over the whole area. The experiment was carried out during the years 2000-2001 on four cultivars 'Bluecrop', 'Heerma', 'Darrow', and 'Croatan'. Open pollination and self pollination were compared. Each treatment consisted of four replications, each consisting of between 100-150 flowers. From each replication 30 flowers were sampled for microscopic observations.

The following characteristics were evaluated under luminescent microscope: the number of germinating pollen grains, the number of pollen tubes in the half of the length of the style, the number of fertilized ovules. Besides, the fruit setting, weight, and the number of seeds in one berry were recorded. The results were evaluated by the analysis of variance. Duncan's multiple range t-test was used for mean separation at $P \leq 0.05$.

RESULTS AND DISCUSSION

In open pollination, all parameters describing the process (pollen germination, tube growth and ovule fertilization) reached high values within few days after flowering. Over 90% pollen grins germinated and fertilization rate reached 60-70% (Fig. 1). As opposite, in self pollination percentage of germinating pollen grains did not exceed 30% and less that 10% of ovules were fertilized (Fig. 2).

Open pollination was beneficial for all the blueberry cultivars studied (Tab. 1). In all cases the number of germinating pollen grains, pollen tubes at the half length of style and finally fertilized ovules, was higher when open pollination was applied.

The mean percentage of fruit setting was significantly higher for open pollination in the first year of the experiment for the cultivars 'Heerma', 'Croatan' and 'Darrow', while in 'Bluecrop' there were no significant differences between self and open pollination (Tab. 2). However, in the second year of the experiment fruit setting was significantly higher with open pollinated flowers in all of the cultivars tested.

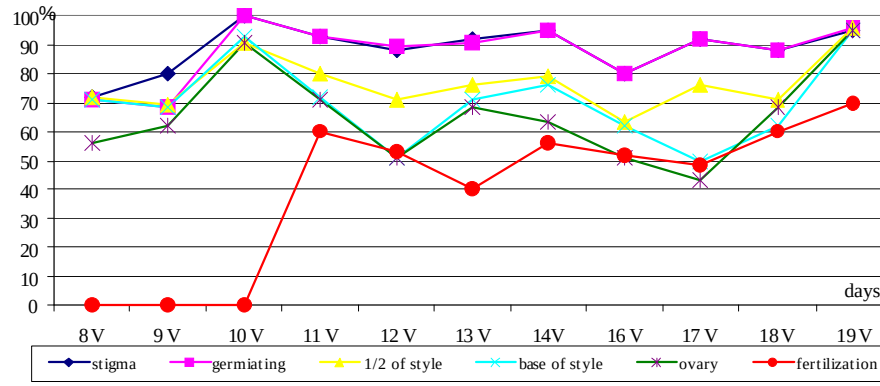

Figure 1. Effect of open pollination on pollen germination, tube development and ovule fertilization

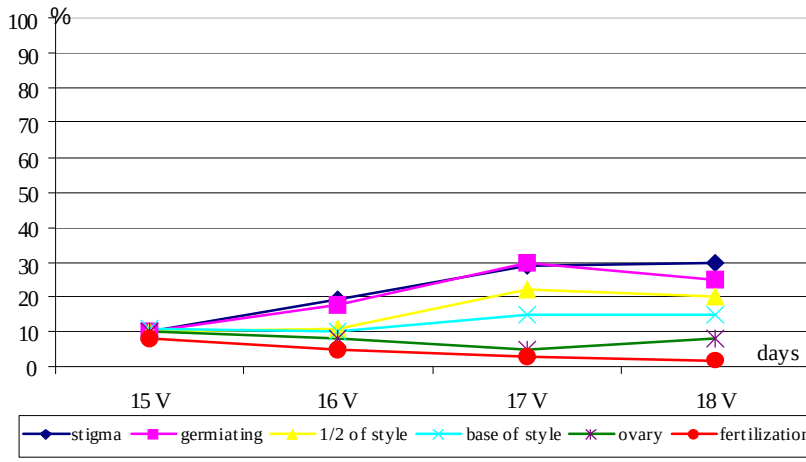

Figure 2. Effect of self pollination on pollen germination, tube development and ovule fertilization

Table 1. Pollen germination, pollen tube development and ovule fertilization in four blueberry cultivars, depending on the way of flower pollination (means for two years)

Type of pollination	Cultivar	No. of germinating pollen grains	No. of pollen tubes at 1/2 of style	No. of fertilized ovules
Open pollination	Bluecrop	168.5 h*	162.7 h	104.8 g
	Heerma	138.4 e	124.2 e	63.8 f
	Croatan	142.4 f	133.14 f	32.1 e
	Darrow	161.9 g	151.5 g	31.2 d
Self pollination	Bluecrop	11.8 d	10.56 d	0.7 b
	Heerma	2.9 a	2.0 a	0.7 b
	Croatan	5.8 b	4.3 b	0.8 c
	Darrow	8.8 c	6.3 c	0.4 a

*Mean following by the same letter do not differ significantly at P≤0.05

Table 2. The percentage of fruit setting in four blueberry cultivars, depending on the way of flower pollination

Cultivar	2001		2002	
	open pollination	self pollination	open pollination	self pollination
Bluecrop	54 a*	52 a	78 b	38 a
Heerma	41b	28 a	60 b	40 a
Croatan	55 b	40 a	78 b	45 a
Darrow	51 b	39 a	72 b	36 a

*For explanation, see Table 1

The results presented here corroborate those of Ehlenfeldt (2001), who noted lower fruit setting and a longer period of fruit ripening for self pollinated blueberries, while there was no significant difference in the fruit setting of 'Bluecrop'. However, fruit formed after self pollination had 10% lesser mean weight.

Lang and Danka (1992) compared cross and self pollination for the south highbush blueberry 'Sharpblue'. Although cross pollination did not increase fruit setting, the mean fruit weight was significantly higher. During the first 10 days of the picking period, 92% of marketable yield was collected in the case of cross pollination, and 72% for self pollination. According to Harrison et al. (1994ab) multiple self pollination increases the fruit setting by as much as 10%.

The weight of 100 fruit, from the studied cultivars, was significantly higher for open pollination in both years of the experiment, with the exception of 'Bluecrop' in 2002, when no differences were observed (Tab. 3).

Our findings, with regards 'Bluecrop", confirm those of previous research results. It was noted that fruit formed after cross pollination of 'Northlad' and 'Patriot' were bigger and ripened earlier, in comparison to the fruit set after self pollination, while there was no effect of the way of pollination on the fruit weight of 'Bluecrop' (MacKenzie, 1997). The results of Huang et al. (1997) also confirm the favourable effects of cross pollination. Fruit formed after self pollination were 51% smaller and ripened 10 days later than fruit set after cross pollination. According to Lang and Danka (1992), cross pollination can increase the weight of individual fruit by 13.6%, compared to those formed after self pollination.

The mean number of seeds per berry was higher for open pollination in all four cultivars tested (Tab. 4). In the experiments of Lang and Danka (1992) a higher number of seeds was also noted in fruit developed after cross pollination. The number of seeds per berry, noted after open pollination, was 63 for 'Bluecrop' and 41 for 'Earlyblue' (Darrow, 1957). Ehlenfeldt (1996) pollinated flowers of 'Rubel', 'Jersey', 'Blueray', 'Bluecrop', 'Spartan' and 'Eliot' with

Table 3. The weight of 100 fruit in four blueberry cultivars, depending on the way of flower pollination

Cultivar	2001		2002	
	open pollination	self pollination	open pollination	self pollination
Bluecrop	150.0 b*	80.2 a	151.4 b	142.4 b
Heerma	80.2 b	42.1 a	117.6ab	80.4a
Croatan	90.4 b	70.6 a	152.0 b	85.2 a
Darrow	206.0 c	137.4 a	216.0 c	144.0 b

*For explanation, see Table 1

Table 4. The number of seeds per fruit and percentage of small or malformed seeds („B-seeds") in four blueberry cultivars, depending on the way of flower pollination

Cultivar	Open pollination		Self pollination	
	mean number of seeds per fruit	percentage of „B-seeds"	mean number of seeds per fruit	percentage of „B-seeds"
Bluecrop	123.7 e*	43.5	50.7 b	32.0
Heerma	67.8 c	60.5	44.2 a	43.5
Croatan	99.2 d	36.0	50.1 b	16.5
Darrow	69.6 c	45.5	46.0 a	35.0

*For explanation, see Table 1

their own pollen or with a mixture of pollen from various cultivars and concluded that the viability of seeds formed after self pollination was smaller than of seeds formed in flowers pollinated with the mixture of pollen.

CONCLUSIONS

The following results were observed:

1. Open pollination increased fruit setting of four evaluated high bush blueberry cultivars by 2-40%, depending on the year;
2. It also increased both the number of seeds per fruit and the fruit weight of blueberry cultivars;
3. Among the tested cultivars, the negative effect of self pollination was less pronounced in the case of 'Bluecrop'.

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WPŁYW ZAPYLEIA WŁASNYM PYŁKIEM ORAZ ZAPYLENIA SWOBODNEGO NA ZAWIĄZANIE OWOCÓW I NASION CZTERECH ODMIAN BORÓWKI WYSOKIEJ

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S T R E S Z C Z E N I E

Doświadczenie prowadzono w latach 2000-2001 w Garlicy Murowanej koło Krakowa. Uwzględniono 4 odmiany borówki wysokiej: 'Bluecrop', 'Heerma', 'Darrow' i 'Croatan'. Badane odmiany podano zapyleniu własnym pyłkiem oraz swobodnemu zapyleniu.

Zawiązanie owoców w przypadku zapylenia swobodnego było istotnie większe oraz wpłynęło korzystnie na masę owoców i liczbę nasion.

Słowa kluczowe: borówka, zapłodnienie, zapylenie swobodne, zapylenie własnym pyłkiem