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Nectar production of *Rubus arcticus*

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Abstract. The aim of the research was to study floral nectar characteristics of different cultivars of arctic bramble in Estonian conditions. The amount of nectar and sugar concentration of the arctic bramble cultivar 'Pima' (from Finland) and a clone from Estonian wild nature ('Kaansoo') were studied in 1999. The cultivars differed in their flowering intensity and nectar producing ability. The abundance of flowers of the local clone ('Kaansoo') was significantly higher compared to the cultivar 'Pima', but the cultivar 'Pima' produced much more nectar than the Estonian clone. The concentration of sugar in nectar was significantly higher in flowers of the local clone. In comparison with other plants, the amount of nectar in arctic bramble flowers was not high, consequently, pollinators prefer plants richer in nectar. Therefore it is recommendable to cut the grass around a plantation and between the rows of arctic bramble during flowering and bring additional pollinators, e.g. honeybee hives, to the plantation.

Key words: arctic bramble, Estonian clone, flower, sugar concentration

INTRODUCTION

Large-scale cultivation of arctic bramble (*Rubus arcticus*) and the processing of its berries is widespread in Finland and Sweden, where it grows in the wild as well. In Estonia, arctic bramble is a rare species under protection. However, its cultivation might have prospects in Estonia, too.

The Institute of Horticulture of the Estonian Agricultural University started experiments on arctic bramble cultivation in 1995. Finnish cultivars and Estonian local clones have been tested. The Estonian clone has shown excellent productivity when compared with Finnish cultivars and is suitable for cultivation in Estonia (Karp & Starast, 1998). The problem in cultivation of arctic bramble are its very different yields each year. The arctic bramble is a self-compatible insect-pollinated plant, therefore its productivity greatly depends on pollinators. Consequently the productivity of arctic bramble depends on its ability to be attractive to pollinating insects. One of the most important features is flower nectar, which is attractive to pollinators. The production of nectar is greatly dependent on the plant's genotype (Teuber & Barnes, 1979) and the environment (Zimmerman, 1983). Thus, nectar production can also differ between cultivars. For normal nectar secretion it is necessary that all plant parts be vital and

contain enough water and nutrients. Therefore the ensuring of optimal growth conditions for plants is important from the point of view of pollination.

The aim of the research was to study the content of nectar in arctic bramble flowers in different cultivars and different growing areas in Estonian conditions.

MATERIALS AND METHODS

The arctic bramble cultivar 'Pima' (from Finland) and the clone from Estonian wild nature ('Kaansoo') were studied in 1999. In three different experimental plantations the two cultivars of arctic bramble were planted in beds alternately, distance between plants was 33 cm and beds were covered with plastic mulch. In a young plantation plants of different cultivars are not mixed, but later it is difficult to separate the cultivars. Therefore it was possible to collect the data during one year.

No plant protection means were employed in the experimental plantation. The content of nutrients in the soil of the experimental areas was different but it was satisfactory for arctic bramble, which is a lowbrow plant (Table 1).

Table 1. Agrochemical properties of the experimental areas.

Experiment	pH_{KCl}	P	K	Ca	Mg	Fe	B	Cu	Mn
		mg kg^{-1}							
1.	5.7	91	303	2420	151	1277	2.0	3.7	200
2.	4.6	60	228	1717	149	1140	1.8	9.6	93
3.	6.9	206	251	2952	204	1809	2.4	11.0	178

Persistent warm days arrived in April and, if compared to the average of many years, the early spring was in general warm, except for May. In the first and second decade, the temperature was constantly below 0ºC during the nights and temperature on the soil surface was steadily -5ºC and -6ºC. Following cold May, June and July were warm, with the average temperature of the months 19.4ºC and 19.7ºC, respectively. Compared to the average of many years, the year 1999 was dry. In May the amount of precipitation (28 mm) constituted only half, in June (47 mm) 71%, in July (15 mm) 22%, and in August (50 mm) 63% of the average of many years.

The amount of nectar that was measured was taken from flowers which had been bagged to avoid pollinators for 24 h, and from unbagged flowers. As flower the colour of arctic brambles tends to turn pale during ageing, the measured flowers were carefully selected with the same colour intensity. The content of nectar was measured from receptacles using a 1µl micropipette (with the tube length 32 mm) (Prys–Jones & Corbet, 1987). The length of the column of the nectar in the micropipette was used to calculate the volume present. The nectar solute concentration was measured by using a hand-held refractometer modified for small quantities. The results were given in %. Test samples were taken from 20 flowers. Measurements were made in different experimental areas at the same time. The data were analysed by a one-way analysis of variance (ANOVA) and *t*-test.

RESULTS AND DISCUSSION

Phenology of flowering. Arctic bramble plants start to grow with the arrival of the first warm days. In plantations with black plastic mulch soil warmed up quickly, and plants renewed their growth during the first warm April days. The first flowers opened in the first half of May and continued flowering during the whole summer. The peak is in June, when there can be 120 flowers/m^2. In warm and dry summers flowering ended in July.

The amount and sugar concentration of nectar. The attractiveness of the flowers to pollinators and therefore also the productivity of self-sterile arctic brambles depend on the amount of nectar and sugar concentration in the flowers. The diurnal production of nectar of arctic bramble flowers was 0.15–0.37 µl, and the amount of nectar in freely (unbagged) pollinated flowers was 0.01–0.02 µl (Fig. 1). Thus, the average amount of nectar in the flowers of *Rubus arcticus* was relatively low compared with *Rubus idaeus,* for example. According to Willmer et al. (1994), the nectar volume in the flowers of *Rubus idaeus* was 4.8–7.2 µl. On comparing three different plantations, it appeared that area as a factor did not influence the amount of nectar significantly (F = 2.58, P = 0.700). We suggest that the results of our research were influenced by moisture conditions, because weather was very warm and dry during the flowering period of the experimental year. During the collection of data, the daily temperature was 30°C, the moisture content of the soil 25–30% and the mean temperature of the month 19°C, which was higher than the average of many years (15°C).

From the experiments carried out by Rubani and Kurlovich (2000) with *Oxycoccus macrocarpus*, and Willmer et al. (1994) with *Rubus idaeus*, it became evident that the amount of nectar was dependent on the characteristics of the cultivar. According to our results, the production of nectar depended on the cultivar in *Rubus arcticus* flowers, too (F = 25.84, P = 0.000) (Fig. 1). One of the reasons for that could be the cultivars' different intensity of flowering. Comparing the number of flowers per plant during the time when nectar was gathered, it appeared that the difference was significant, the average for the cultivar 'Pima' was 21 ± 7 and 'Kaansoo' 40 ± 6 flowers (Fig. 2A). A plant with a smaller number of flowers is spending less energy and nutrients for flowering; therefore its flowers are containing more nectar. There were no differences between the content of nectar in freely pollinated cultivars (t = 1.12, df = 178, P = 0.256), but there were significant differences between diurnal productions of nectar: the cultivar 'Pima' produces much more nectar within 24h than the Estonian clone (t = 5.11, df = 118, P = 0.000). In the case of free pollination, the flowers of both cultivars were emptied to approximately the same level by bees. This is in accordance with the theory of marginal value published by Stephens and Kreps (1986).

Nectar is simply a solution of sugars and, therefore, we can estimate sugar content according to the results. The concentration of sugar in the flower nectar of the cultivar 'Pima' was 29 ± 11% and in the local clone from 'Kaansoo' 38 ± 9% (Fig. 2B). Sugar content appeared to be lower in flowers with higher nectar production and higher in flowers with lower nectar production (Fig. 1 & 2B).

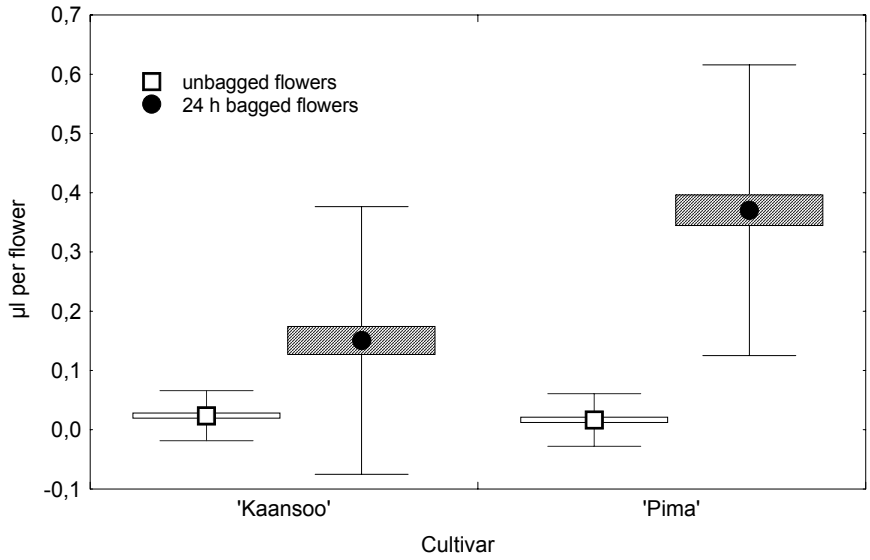

Fig. 1. Nectar volumes per flower in two cultivars of arctic bramble. Vertical bars represented ±s.d., boxis ±s.e.

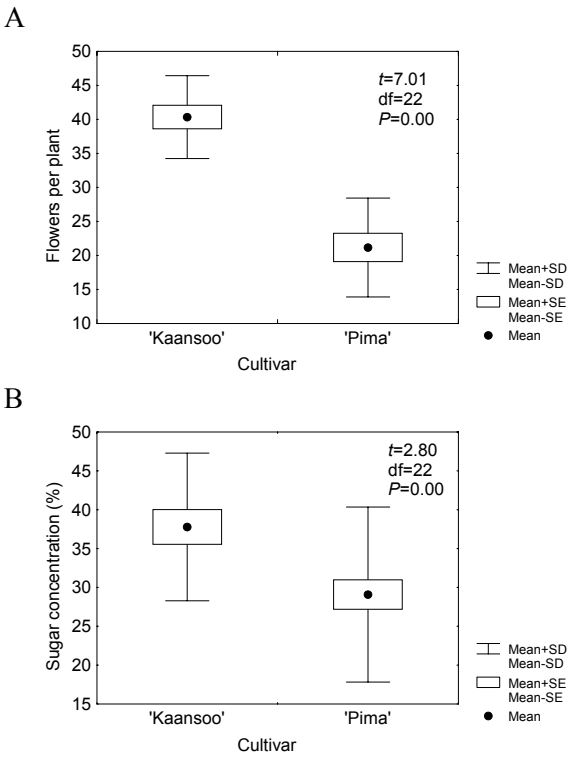

Fig. 2. A – Flower abundance of the cultivar ‘Pima’ and the Estonian clone (‘Kaansoo’) of the arctic bramble (*Rubus arcticus*). B – The sugar concentrations in the nectar of flowers of the arctic bramble cultivar ‘Pima’ and the Estonian clone (‘Kaansoo’).

The sugar concentration of nectar is greatly dependent on weather conditions. Differences in air moisture can change sugar content 2.8–5.3 times (Ruban & Kurlovich, 2000). Sugar concentration of nectar also depends on the age of the flower and air temperature. Nectar solute concentration increases with the rise of temperature and with the ageing of the flower (Willmer et al., 1994). Therefore we suggest that our results were also influenced by the very warm and dry period during flowering.

CONCLUSIONS

Arctic bramble cultivars differ in their flowering intensity and nectar producing ability. In comparison with other plants, the amount of nectar in arctic bramble flowers is not high, so the pollinators prefer plants richer in nectar. Also the sepals inside the flower are gathered tightly together, which makes pollinators spend a lot of energy for reaching nectar. According to research carried out in Finland, honeybees preferred *Trifolium repens* and *Fragaria* x *ananassa* to arctic bramble (Kangasjärvi & Oksanen, 1989). Therefore it is recommendable to cut the grass around a plantation and between the rows of arctic brambles during flowering and bring additional pollinators, e.g. honeybee hives, to the plantation.

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