

THE ROLE OF HONEY BEES AND BUMBLEBEES IN POLLINATION OF SOME CRANBERRY (*V. macrocarpon* Aiton) VARIETIES

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Abstract

Over the last 15 years the American large-fruited cranberries (*V. macrocarpon* Ait.) have become some of the most popular berries grown in Latvia. Growing of the large-fruited cranberries in Latvia is possible due to the favourable growing conditions and wide territories of large moss swamps; cranberries take up a space of 130 ha in our country yet there is a plan to enlarge the territory up to 300 ha in future. Cranberry planters are looking for opportunities to boost both the berry harvest and their quality, which is possible by attracting additional pollinators – honey bees and bumblebees.

Cranberry pollination study was commenced in 2010 by establishing berry harvest (kg m⁻²), 100 berries mass (g m⁻²), and size of berries (mm). During the blooming 1 honey bee - Romanian Carpathian bee (*Apis mellifera carpatica*) - and 1 Tripol (*Bombus terrestris*) race bumblebee family were put in the cranberry plantations. Three cranberry species were used in the study: 'Bergman', 'Lemonyon', and 'Stevens'. Four variants of pollination were set up for the study: by honey bees, by bumblebees, free and the isolated pollination.

Analysis of the acquired data shows that pollinators – bumblebees – boost berry quality in the 'Bergman' species yet bumblebees don't impact the boost of the harvest. Pollination variant data of the 'Lemonyon' species don't show significant changes in the harvest volumes. Cranberry species 'Stevens' is responsive towards specific pollinators – honey bees and bumblebees – that boost the berry harvest.

100 berries mass is boosted by different pollinators in each species. Wind pollination boosts the size of the berries and the 100 berries mass in the 'Lemonyon' species. Results of the study show that berry quality in the 'Bergman' species is impacted by bumblebees (berries are bigger) yet the overall volumes of the harvest are not impacted. Pollination by honey bees boosts the harvest volumes, quality and size of the berries in the 'Stevens' species.

The results show that in the large-fruited cranberry species pollination there is a significant difference in harvest volumes and quality depending on the employed pollination variant

Introduction

Due to good growth conditions in Latvia and wide areas of oligotrophic marshes, large cranberries cover an area of 130ha in this country, but there is a plan to

enlarge this area to 300ha. Considering the good conditions for cranberry cultivation in Latvia, it is important to look for new effective methods for improving yield amounts. One of these methods is using additional pollinators and it has not been widely studied in the conditions of Latvia.

Over the last 15 years the American large-fruited cranberries (*V. macrocarpon* Ait.) have become some of the most popular berries grown in Latvia. Growing of the large-fruited cranberries in Latvia is possible due to the favourable growing conditions and wide territories of large moss swamps; cranberries take up a space of 130 ha in our country yet there is a plan to enlarge the territory up to 300 ha in future. Cranberry planters are looking for opportunities to boost both the berry harvest and their quality, which is possible by attracting additional pollinators – honey bees and bumblebees.

It is known that bees are rarely found in large amounts in cranberry plantations. A variety of bee species in cranberry plantations can only be found in the state of Massachusetts in USA where mostly honey bees and bumble-bees, *B. impatiens* and *B. bimaculatus*, inhabit the plantations (MacKenzie un Averill, 1995).

Bumblebees typically inhabit abandoned and natural marshes while honey bees are only found in cultivated marshes where hives have been taken. Abandoned and natural marshes are also populated by a much larger number of solitary bees than in cultivated fields. Honey bees and bumblebees *B. mixtus*, *B. occidentalis* and *B. sitkensis* act as cranberry pollinators in Washington, USA (Patena et al., 1993). Approximately 25 insect species visit cranberry plantations in marshes in Ontario, Canada (Kevan et al, 1983).

Honey bees are not effective cranberry pollinators. Bumblebees are more active in flowers and their pollen baskets are less polluted with pollen from other flowers than in honey bees. Honey bee hives were taken into cranberry plantations in Ontario marshes but the amount of honey bees in cranberry flowers was small regardless of the distance between hives and plantations. Several honey bee colonies fed from nettles - a competing plant- more than 220 feet (200 m) away (Kevan et al, 1983). A study shows that the amount of yield and seeds does not depend on the distance between a plantation and a honey bee hive. Honey bees got attracted by several competing nectar sources, and the authors of this study point out that the activity of honey bees can be effective in very large marshes where the number of competing nectar plants is relatively low.

Honey bees are widely used for pollination of commercially grown cranberries regardless of their relative inefficiency. The density of honey bees in Washington state is one hive per acre (2.5 ha). Research shows that this increases the cranberry crop by 25 - 43% (MacKenzie un Vinstons, 1984). Although local bees and bumblebees are good pollinators, their number in plantations is not always sufficient. In conclusion, using honey bees is the best method for cranberry pollination. Bees of the Romanian Carpathian race have inherited their qualities from Carninica bees (*Apis mellifera carnica*) and Caucasian bees (*Apis mellifera carpatica*) which are successfully being used for pollinating cultivated plants.

Honey bee hives which are stationed in cranberry marshes for acclimatization are taken there right before the pollination season, unlike the model for pollination of other cultivation plants. The Caucasic honey bee (*Apis mellifera caucasica*) functions within cranberry plants more effectively under cool weather than the Italian bee (*Apis mellifera ligustica*) does. Bees can pollinate most cranberry flowers in approximately 4 days under good weather conditions. It usually takes about a week

under optimum climate conditions but the actual time for pollination is three weeks, considering the weather conditions.

Therefore beekeepers should give about a week for the bee hive to pollinate under good weather conditions. It can take up to three weeks of actual time if there has been a week of good conditions.

Suggested density of bees in cranberry plantations

Number of honey bee hives / acres (ha)	References
0.2-10 (0.5-25)	McGregor (1976)
3-4 (7.4-10)	Luwin (1986)
1 (2.5)	Kevan (1988)
2 (5)	Macfarlane et al. (1994)
1 (2.5)	Scott-Dupree et al. (1995)
3 (7.6)	
Other insects	
443 bumblebees / acres (1100 ha)	Hutson (1925)

Cranberries are an insignificant source of pollen and an insufficient source of nectar. Nectar is crucial in the process of pollination and the process of bees visiting older flowers as well. For example, in New Jersey the sort 'Stevens' produces 25-35% more nectar sugar per flower than 'Ben Lear' or 'Early Black'. In conclusion, using honey bees is the most efficient method for pollination of cranberries.

The process of pollination has not been studied in Latvia during the past fifty years. Cranberry planters gather information from various sources – publications, the Internet and advice from foreign colleagues. It can be concluded that the development of pollination methods in cranberry plantations might significantly improve cranberry yield and contribute greatly to the development of Latvian national economy.

Object, methods and conditions

The studies were conducted since 2010 in the Station of gardening and apiculture for education and scientific research of Latvia University of Agriculture, Institute of Agrobiotechnology in Jelgava, Strazdu Street 1, and in the farm "Strēlnieki", Babītes district.

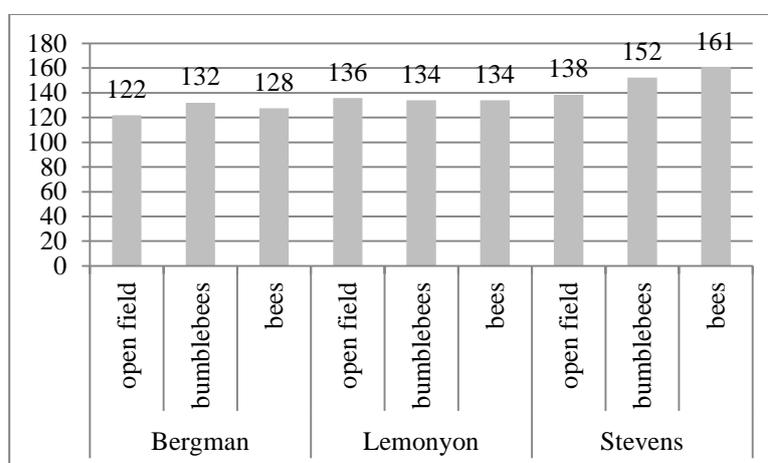
During the study tests were carried out in which bumble bees and bee colonies pollinated cranberry plantations in both open fields and under covering. During the blooming 1 honey bee - Romanian Carpathian bee (*Apis mellifera carpatica*) - and 1 Tripol (*Bombus terrestris*) race bumblebee family were put in the cranberry plantations. Three cranberry species were used in the study: 'Bergman', 'Lemonyon', and 'Stevens'. The study was carried out in eight steps formed in four groups (open field, covered field, bumble bees and honey bees). During every test additional studies were carried out in experimental fields where an initiator – sugar syrup (1kg sugar and

1l water) – was either used or not. The syrup was used to attract pollinators and was sprayed on cranberry sprouts at 10AM each morning once every two days.

Bee colonies of the Romanian Carpathian bee (*Apis mellifera carpatica*) and earth bumblebee colonies (*Bombus terrestris*) within TRIPOL hives were used in this study. In Latvia bees of the Romanian Carpathian race are the most popular. TRIPOL hives are optimal for pollinating strawberries, cherries, blueberries, raspberries, apricots, apples, pears, kiwis, etc. The TRIPOL is specially developed for outdoor use, but also fit for pollination of these crops when grown under protection of plastic or netting.

Cranberry pollination study analyzed berry harvest (kg m^{-2}), 100 berries mass (g m^{-2}), and size of berries (mm).

100 berries mass (g m^{-2}) in cranberry varieties



Registration (g m^{-2}) of 100 berries mass was performed during the study for three large-fruited cranberry species. Upon analyzing data we came to conclusion that each species has different response to the pollinators. Berry mass of 100 ‘Bergman’ berries is bigger if pollinating is performed by bumblebees; in ‘Lemonyon’ it is bigger for large-fruited berries pollinated in an open field; yet ‘Stevens’ is more responsive towards pollinating by bees.

When comparing sizes (mm) of large-fruited cranberries data analysis testifies that pollinating by bees enlarges the cranberry size in ‘Stevens’ variety; pollinating by bumblebees in ‘Bergman’, whereas in ‘Lemonyon’ attraction of additional pollinators doesn’t make a significant difference.

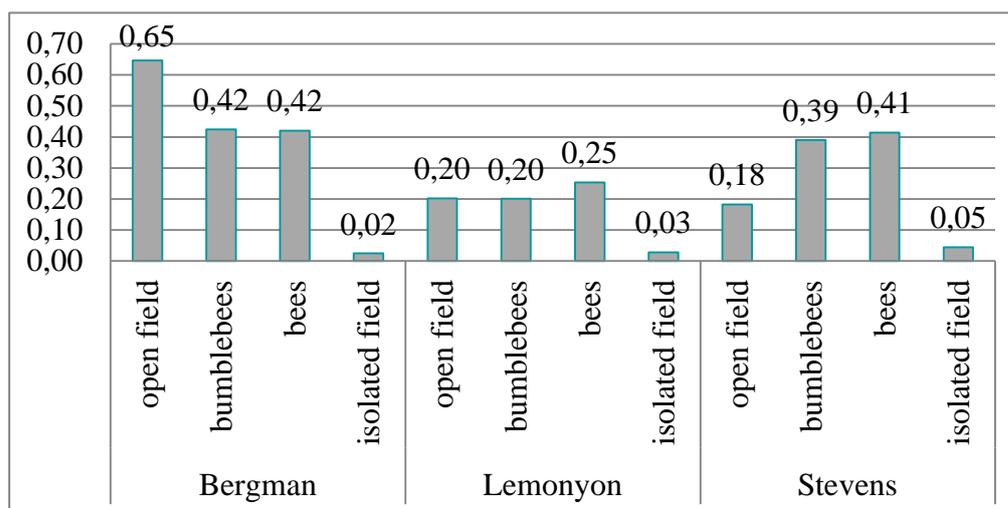
Berry size (mm) in cranberry varieties

Varieties	Pollinator	Berry quality, mm					
		> 20	18-20	15-18	15-12	12-09	< 9
Bergman	open field	0	9	14	42	25	10
	bumble bees	0	5	22	38	23	12
	bees	0	9	15	42	28	6
	isolated field	0	0	0	0	35	65

Lemonyon	open field	0	0	14	32	35	19
	bumble bees	0	4	10	28	38	20
	bees	0	1	13	26	33	27
	isolated field	0	0	0	0	25	75
Stevens	open field	0	13	26	44	16	1
	bumble bees	1	14	38	27	18	3
	bees	3	18	41	26	7	5
	isolated field	0	0	3	15	51	31

Berry harvests (kgm^{-2}) in cranberry varieties display significant differences among pollination methods and involvement of additional pollinators. Harvest increase in ‘Lemonyon’ and ‘Stevens’ varieties is caused by involvement of bees, whereas in ‘Bergman’ best results are achieved by pollination in open field. Data confirm that ‘Stevens’ variety is more responsive towards involvement of additional pollination (see Table 3), in ‘Lemonyon’ there are no significant differences, and in ‘Bergman’ involvement of pollinators is not important.

Harvest of cranberry varieties (kgm^{-2})



Involvement of additional pollinators in large-fruit cranberry plantations and their contribution is related to responsiveness of variety.

Conclusions

1. Responsiveness of cranberry varieties towards additional pollinators and increase in their harvest indicators differ.
2. In ‘Bergman’ variety the berry quality (size) is increased by bumblebees, harvest is increased unrestrictedly but 100 berries mass is increased by bumblebees, thus the variety is more responsive towards bumblebee pollination.

3. In 'Lemonyon' variety 100 berries mass and berry quality (size) is increased freely, harvest is increased by bees, thus the variety is more responsive towards the unrestricted pollination type.
4. In 'Stevens' variety all indicators analyzed in the study – harvest, berry quality (size) and 100 berries mass – are increased by bees.

Literatur cited