Pollination Biology of Lingonberry, *Vaccinium vitis-idaea* subsp.

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Abstract

Bumblebees (Bombus spp.) are prominent pollinators of lingonberries (subsp. vitis-idaea) growing in wild and cultivated fields in Sweden and Norway. Bumblebees are only occasional visitors to lingonberry fields in Alaska. Other pollination mechanisms including self pollination, wind, syrphid flies, and mosquitoes are considered important although none have been shown to predominate. The purpose of this research was to study the pollination biology of lingonberries to determine important mechanisms necessary for fruit set in managed wild stands and cultivated fields. Wild stands covered with mosquito netting to exclude large insects and reduce wind speeds averaged 4.7 percent fruit set, whereas unscreened controls averaged nearly 40 percent fruit set. The number of seeds per fruit in unscreened plants was at least double that of screened plants. Greenhouse plants subject to controlled wind speeds between 0.3 and 1.4 m s-1 showed no pollen release at anytime during anthesis. Greenhouse grown flowers buzz-pollinated with frequencies ranging from 170 to 740 Hz showed ample pollen release at all frequencies with no trend or correlation toward any one range of frequencies. These experiments show that self pollination probably is not important in lingonberries, and wind speeds frequently encountered in woodland fields of lingonberries are not sufficient to effect pollination. Wind speeds greater than 1.4 m s-1 or vibration by insects will be necessary for adequate pollination of lingonberries.

Introduction

Autogamy, entomogamy and anemogamy have been identified as important methods of pollination in lingonberry, Vaccinium vitis-idaea. Most authors consider entomogamy to be essential for fruit production (Fernqvist 1977, Hjalmarsson 1997, Hasterud 1974, Jacquemart 1997, Knuth 1909, Lehmushovi 1977, Lovell 1948, Pojar 1974, Ritchie 1955), but it is considered accidental or optional by others (Tikhonenev 1979). Hagerup (1954) and Torrey (1914) believe anemogamy is the most important method of pollination; damp calm weather during flowering is a major factor in reduced berry yields.

Autogamy has also been reported in lingonberry; some authors consider it the most important factor in fruit set, whereas others report a significant reduction in fruit set with self pollination (Hagerup 1954, Hasterud 1974, Hjalmarsson 1997, Tikhonenev 1979). These conflicting results may be due, in part, to the wide geographic range of studies, from tundra to subarctic forest ecosystems, and to variation between the major subspecies of lingonberry, ssp. vitis-idaea and minus.

The first cultivated field of lingonberries in Alaska was begun in 1996, but little is known about methods of pollination. The purpose of this experiment was to explore pollination methods that might be managed for improved field crop production.

Effect of Exclusion Screens on Pollination and Fruit Set

Purpose

to determine if autogamy occurs in lingonberries and if large insects or wind influence fruit set and quality in lingonberries.

Methods

- six, 60x60x60 cm plots selected at random at two woodland locations: floodplain site within a white spruce forest and upland site within a birch/aspen forest near Fairbanks, Alaska.
- three plots covered with wood frames (60x60x30cm) enclosed in mosquito netting, 3 plots open controls.
- 10 reproductive stems selected at random within each plot composed the experimental unit.
- data included: number of flowers per stem, number of ripe fruit, fruit weight, fruit diameter, seeds per berry.
- analysis: Analysis of variance for completely randomized design with sub sampling.

Exclusion Screen Results

Fruit set differed significantly between screened and open pollinated treatments at both floodplain and upland sites. All fruit parameters: diameter, berry weight and seeds per berry were significantly lower in screened plants (Table 1). This experiment showed that self pollination is not important in lingonberries. The action of insects and/or wind is necessary for significant fruit set.

Table 1. Effect of exclusion screens (mosquito netting) on fruit set and development of lingonberries.

Location	Treatment	Number per stem		Fruit diameter	Fruit weight	Seed number per fruit	Fruit set
		Flowers	Fruit	(cm)	(g)		(%)
Floodplain	Open	5.7	2.8**	0.80**	0.27**	12.7**	38.9**
	Screened	5.1	0.1	0.52	0.16	5.2	4.7
Upland	Open	5.3	0.4**	0.39	0.13	8.9	9.4**
	Screened	4.9	0				0.0

1 Floodplain, open white spruce/paper birch forest site.
2 Upland mixed paper birch/quaking aspen forest site.
** Means within location differ significantly at the 1 percent level.

Upland mixed paper birch/quaking aspen forest site.

Wind and Pollination of Lingonberries

Purpose:

to determine if low-level wind currents during anthesis promote pollination and fruit set in lingonberries.

Methods

- lingonberry plants with flower buds were collected from wild stands, potted up, and exposed to a 4 months chilling period at 4 degrees C to fulfill dormancy requirements.
- plants were randomly assigned to a position inside a 4.9 m tunnel constructed of a wood frame and clear polyethylene with a fan at one end and window screen opposite.
- plants were randomly assigned along a wind speed gradient within the tunnel. Plants were exposed to 0.2 - 1.4 m s-1 (up to 3 mph) during anthesis.
- microscope slides coated with glycerin jelly were placed throughout the tunnel to detect pollen movement in the air.
- data included number of flowers per plant, number of fruit, fruit weight, diameter and number of seeds per fruit.
- data analysis: regression analysis of the effect of wind speed on fruit set.

Results- wind speed and fruit set

Fruit set consisted of three fruit from a total of 556 flowers. The fruit occurred on two plants, and air movement from the fan had no influence on fruit set. No pollen was captured on the glycerin-coated microscope slides during the entire six-week experiment. Low wind speeds, up to 1.4 m s-1 (3mph) that might be encountered in woodland habitats do not promote fruit set in lingonberries.

Anther Vibrational Frequency and Pollen Dehiscence-Trial 1

Purpose

to determine if vibration of the corolla (simulating either buzz pollination or wind movement) enhances fruit set in lingonberries and to determine if a specific vibrational frequency is necessary for dehiscence of pollen grains.

Methods

- fifteen plants were grown beneath insect screen in midwinter in a greenhouse, 20 degrees C, daylight supplemented with sodium vapor HID lamps for 20 hr photoperiod.
- one flower cluster per plant was vibrated for 5 seconds daily at a specific frequency recorded by a WAVETEK digital Frequency Measuring Device
- a microscope slide coated with glycerin jelly was suspended beneath each flower cluster, and pollen counts were made daily throughout anthesis.
- 8 weeks after anthesis, fruit set was recorded for each flower cluster and frequency

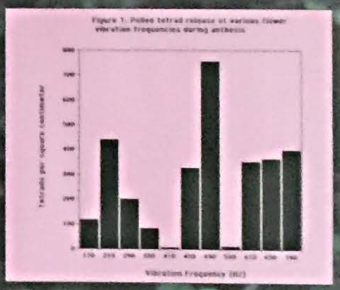
Results- vibrational frequency and pollen release

Pollen was released 4-12 days (most frequent, 5 days) following corolla opening and continued for 18 days in the greenhouse. Most pollen was released between days 4 and 13. The results of this first trial show that most pollen was released at 490 Hz (Figure 1), but there was no statistical relationship between tetrad release and vibration frequency. This project will be repeated with more plants. Fruit set amounted to no more than 4 fruit per cluster at all frequencies. This indicates that movement vibration of the flowers, by itself, is not sufficient for fruit production.

Wind and Pollination

To the right is the wind tunnel being constructed. Below left shows a plant in the wind tunnel with slides positioned to collect pollen. Below right shows all the plants in the wind tunnel.

The WAVETEK digital frequency device used to vibrate flower clusters.



Floodplain, open white spruce/paper birch forest site.

Conclusions

Entomogamy is probably the most important method of pollination in lingonberries, Vaccinium vitis-idaea subsp. minus. Autogamy may occur in wild stands but is not sufficient to provide ample fruit set for commercial harvest. Anemogamy does not occur at wind speeds less than 3 mph. Pollen tetrads are released by a range of vibrational frequencies from 170 Hz to 740 Hz indicating that a variety of insect pollinators probably contribute to optimum fruit set.

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Harvesting mature fruit at lowland site.

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