31. Using Alfalfa Leafcutter Bees to Pollinate Wild Blueberries

INTRODUCTION

The alfalfa leafcutter bee (*Megachile rotundata* (F.)) is one of the few commercially managed pollinators other than the domestic bee. It was first studied for use in pollinating wild blueberry fields in the early 1990s. As an alternative to the honeybee, its value to blueberry producers lies in its commercial availability, its qualities as a pollinator and the existence of proven management techniques. It can be used either alone or in combination with other commercial pollinators.

Alfalfa leafcutter bees (ALBs) are considered solitary bees, for unlike domestic bees they do not form true communities. The female builds her nest alone, and alone provides it with food, whereas domestic bees nest in a hive and share the various tasks. ALBs do however tolerate each other's presence, and will nest close to their neighbours, readily using prefabricated nests made of drilled wood or blocks of polystyrene. This characteristic has facilitated their domestication and commercialization.

Like honeybees and bumblebees, ALBs can be rented for the pollination period. Rental service is flexible, and depending on what equipment the producer owns, the latter may look after incubating the cocoons, conditioning the nests, even extraction and storage over the winter. Total custom pollination is also available, including rental of the bees and all the equipment needed. It is also feasible for blueberry producers to practise ALB beekeeping themselves. However, bee breeding requires time, attention to detail, specialized equipment and specific technical knowledge.

POLLINATION

As pollinators, ALBs have the following characteristics:

- they begin flying when the temperature reaches 16.3 °C, and begin foraging at 16.8 °C, in calm, sunny weather;
- they have a high affinity to the blueberry flower, as shown by the high percentage of blueberry pollen (87%) found in egg cells;
- they forage at an average of 8 flowers per minute for around 6 hours per day;
- they will forage up to 120 m from the nest, the optimal distance being 60 m.

The recommended quantity of ALBs depends on the field:

- 1 dome per 1.2 to 2.0 ha (3 to 5 acres);
- 10 000 live ALBs = 1 gal;
- 5.0 to 7.5 gal/ha (2 to 3 gal/acre);
- 10 gal per dome;
- 10 to 12 nesting blocks per dome.

Warm sunny days are ideal for conducting visual observations of ALBs working in the field.

MANAGING ALFALFA LEAFCUTTER BEES

Managing ALBs includes the following steps: initial purchase, incubation, release into the field, setting up domes and trays in the field, reproduction, relocation, harvesting from the nests, conditioning and winter storage.

Initial purchase

Producers who want to raise ALBs themselves must make their initial acquisition of cocoons from Western Canada, where the industry is well regulated. Health certificates are issued by the Canadian Leafcutter Bee Cocoon Testing Centre. Quality

is an important factor to consider when purchasing. Cocoons of excellent quality have a ratio of 40% females (Figure 1) to 60% males (Figure 2), less than 2% infestation by parasites, no diseases (certified chalk-brood free) and at least 10 361 live bees per kilogram of cocoons (4700 per pound). The price will depend on the quality of the cocoons and the harvest of bees from the previous year. When the cocoons arrive they must immediately be stored at a temperature of 5 to 8 °C with at least 50% relative humidity.

Figure 1. Female alfalfa leafcutter bee
Source: Pierre-Patrick Fillion, Mégachiles Sauvages

Figure 2. Male alfalfa leafcutter bee
Source: Pierre-Patrick Fillion, Mégachiles Sauvages

Incubation

A controlled-environment chamber is required for incubation. Its critical features include:

- ability to stay dark through the entire incubation period;
- ability to maintain a constant relative humidity (60-70%);
- ability to slowly reach, and then maintain, a constant temperature of 30 °C; and to lower its temperature to 11-15 °C;
- shelves for incubation trays;
- a ventilation system;
- an alarm to warn of temperature changes;
- black lights and water traps for monitoring parasite infestation.

In spring, trays of cocoons that have been stored at 5 °C are placed in the incubator, at a relative humidity of 60-70%. Over 2 to 3 days the temperature is gradually raised from 5 to 30 °C. When the temperature is 30 °C for one full day, that is Day 1 of the incubation calendar in Table 1.

The incubation technique gives breeders the flexibility to synchronize bee emergence with the start of the blueberry's blooming period. By following the incubation calendar (Table 1) you can predict and modify the insect's speed of development. To verify which day the ALBs have reached in their development, a few cocoons can be dissected. Note that although the calendar is divided into "days", the corresponding stage is not necessarily 24 hours long. When female emergence peaks, the new generation is ready to be released into the field.

Release in the field

The ALBs are transported to the field in their incubation trays. The move must be done at night, ideally in a refrigerated truck. This will prevent damage from occurring to their wings, because bees become active in response to light and warmth.

The bees should only be introduced into the field when the weather is good for foraging, since they will need to find food very soon after release. A prolonged period without being able to feed themselves (one week after being released) will result in many bees dying. The ideal time for releasing ALBs is when 5 to 10% of the blueberry flowers are open.

Table 1. Incubation calendar pour ALBs

Day 1	Cocoons containing larvae in the prepupal stage are placed in the incubator at a temperature of 30 °C and a relative humidity of 60%.
Day 7	To control parasites, dichlorvos strips (VAPONA) are placed in the incubator, using ¾ of a strip per 28 m^3 (1000 ft^3). If the incubator is not full of cocoons, reduce that quantity.
Day 8	The ALBs undergo their final moult into the pupal stage. At this stage they are particularly sensitive to changes in temperature (do not let the incubator cool).
Days 8-12	Parasites emerge. If there is enough VAPONA they will die in the trays, otherwise they should drown in the water traps set under the UV lamps.
Day 10	Pupae start to show pink eyes.
Day 12	Eyes and back of the pupae darken.
Day 13	Remove the VAPONA strips and air the incubator for 24-48 hours, while keeping the temperature at 30 °C.
Days 14-15	Native leafcutter bees emerge that also used the tunnels for nesting.
Days 14-22	At this point, the bees' development can be slowed if necessary to synchronize their emergence with the start of blooming. This is done by lowering the temperature in the trays (not just the air temperature) to 10-15 °C for several days. Research has shown that this period can be extended up to Day 22, but most beekeepers are cautious about doing so.
Day 16	The most advanced pupae, mostly males, are completely dark.
Days 18-19	Males start emerging. Pay close attention to the temperature at this point, since bees generate heat and the incubator could get too warm. ALBs are very sensitive to high temperatures.
Days 21-22	Females start emerging. This is also the peak of emergence for the males, and the start of emergence for the second generation of parasites.
Days 23-24	Female emergence peaks. Release the bees into the field when 75% of females have emerged.
Day 28	Emergence of adults is practically complete.

Source: Agrall et al., 1996

Installing domes and trays in the field

Domes (Figure 3) should be positioned in the field with their entrances facing south or south-east. This orientation ensures maximum exposure to the light and warmth of the morning sun. Nesting blocks (Figure 4) are then installed inside the domes.

Last of all, the incubation trays (Figure 4) are placed in the domes, well back from the entrance and raised off the ground, to protect them from rain, predators, cold and moisture. After a few days, when the bees have left the trays, the latter should be removed from the domes and taken away from the fields.

Figure 3. Dome for ALBs in a blueberry field
Source: Club Conseil Bleuet

Figure 4. Nests and incubation trays in a dome
Source: Club Conseil Bleuet

Reproduction and pollination

The process of gathering pollen (Figure 5), and indirectly the process of pollination, begins after sexual maturation and mating. At this point, each female selects a nesting tunnel (Figure 6). At the back of the tunnel she builds a thimble-shaped cell using around 15 pieces of leaves. Soft and pliable, the oval leaf pieces are cut from various plants and cemented together with saliva and leaf juices. She deposits in the cell a provision of pollen moistened with nectar. Then she lays an egg, before sealing up the cell with 2 or 3 more leaf pieces. Subsequent cells will be added one after the other until the tunnel is full. She then closes the tunnel with several more leaf pieces stuck solidly together. In ideal conditions, an ALB can produce 12 to 15 cells over the 40 to 60 days of her lifetime.

Figure 5. Foraging
Source: Pierre-Patrick Fillion, Mégachiles Sauvages

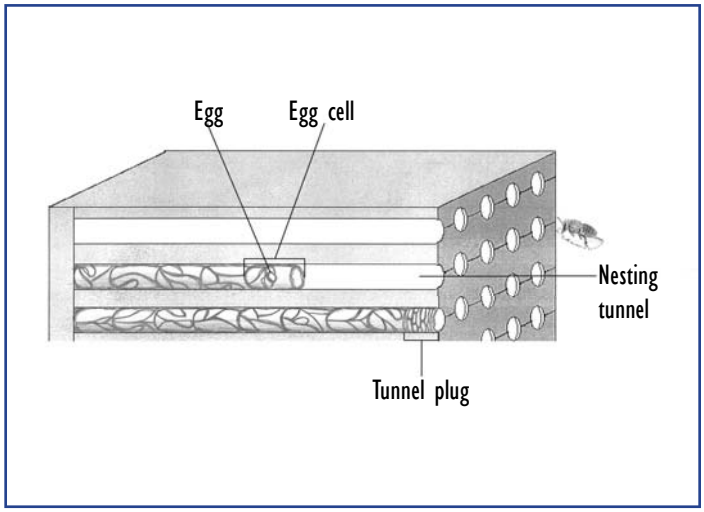

Figure 6. Nesting tunnel and egg cell
Source: Stéphanie Claveau

Relocating ALBs

When the blueberries have finished blooming, the ALBs will not yet have completed their biological cycle. As long as there are other sources of food nearby, such as foraging patches or weeds at the edge of the field, they can complete their life cycle in the blueberry field. The presence of foraging patches and other such areas will therefore increase their reproductive rate and the harvest of cocoons for next year.

In the absence of other sources of food nearby, when just 10% of the blueberry flowers are left the ALBs should be relocated. Like before, this move too must be done at night, but only after a sunny day. This will ensure that the females are back in their nesting tunnels, not sheltering in the field due to a sudden change in the weather. The relocated domes should be positioned so that their entrances face in the same direction as before, and the nesting blocks should be re-installed inside them in the same order and the same arrangement.

Harvesting, conditioning and winter storage

Once the bees' biological cycle is over, the nests are removed from the field and conditioned for three weeks at 20 °C, to dry the cocoons and allow immature eggs to complete their development. Remove the nests sooner if one of the following is observed: 1) emergence of a second generation of ALBs; 2) tunnels 75% full; or 3) larvae on the ground. After removal, the cocoons are stripped from the nests and stored over the winter until spring, at a constant temperature of 5 to 8 °C and a relative humidity of at least 50%.

When all goes well and weather conditions are favourable, the harvest of ALBs can represent 30 to 75% of the initial population.

TEXT ADAPTED FROM

Argall, J., K. MacKenzie, S. Javorek and G. Chiasson. 1996. *Alfalfa Leafcutter Bees for the Pollination of Wild Blueberries*. Fact sheet B.7.0. New Brunswick Department of Agriculture and Rural Development. [Online]. www.gnb.ca/0171/10/0171100007-e.asp (Page consulted on September 15, 2010).

OTHER REFERENCES

MacKenzie, K., L. Eaton, S. Javorek and D. McIsaac. 2004. *Use of Alfalfa Leafcutting Bees in Wild Blueberry Pollination*. Lowbush Blueberry Factsheet. Nova Scotia Agricultural College. Truro, Nova Scotia. 4 pp. [Online]. http://nsac.ca/wildblue/facts/pollination/alfalfa_bees.pdf (Page consulted on September 15, 2010).

Richards, K.W. 1984. *Alfalfa Leafcutter Bee Management in Western Canada*. Publication 1495E. Agriculture Canada. 53 pp.

Saskatchewan Alfalfa Seed Producers Association. 2010. *Alfalfa Leafcutting Bee Management* [Online]. www.saspa.com/beeManagement.htm (Page consulted on September 15, 2010).

Simard, B. Personal communication (May 2010). Les pollinisateurs inc. (On renting alfalfa leafcutting bees to pollinate blueberry fields). Dolbeau-Mistassini.

Stubbs, C., F.A. Drummond and D.E. Yarborough. 2002. *How to Manage Alfalfa Leaf Cutting Bees for Wild Blueberry Pollination*. Wild Blueberry Fact Sheet No. 300. The University of Maine. Cooperative Extension. [Online]. http://umaine.edu/blueberries/factsheets/bees/300-how-to-manage-alfalfa-leafcutting-bees-for-wild-blueberry-production/ (Page consulted on September 15, 2010).

PROJECT COORDINATION
Sophie Gagnon, Agronomist, Project Management Coordinator, Agrinova, Alma

ADAPTATION
Véronique Moreau, Agronomist, Coordinator, Club Conseil Bleuet, Dolbeau-Mistassini

COLLABORATION
Gérald Savard, Proprietor, Centre multiservices agricoles Dolbeau-Mistassini (Rental of alfalfa leafcutting bees for pollinating blueberry fields), Dolbeau-Mistassini.

REVISION
Madeleine Chagnon, Ph.D., Entomologist, Université du Québec à Montréal, Montréal

Gaétan Chiasson, Agronomist, Development Officer, New Brunswick Department of Agriculture, Aquaculture and Fisheries, Bathurst

Jean Lafond, M.Sc., Researcher in Soil Fertility, Agriculture and Agri-Food Canada, Normandin

Laurier Tremblay, Agronomist, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Bergeronnes

PUBLISHING
Chantale Ferland, M.Sc., Publishing Project Officer, CRAAQ, Québec

Lyne Lauzon, Publications Coordinator, CRAAQ, Québec

TRANSLATION
Rod Willmot, M.A.

LAYOUT AND GRAPHIC DESIGN
Sylvie Robitaille, Computer Graphics Technician, CRAAQ, Québec

PRODUCED BY
AGRINOVA Recherche et innovation en agriculture
Club Conseil Bleuet
Agriculture, Pêcheries et Alimentation Québec
CRAAQ Centre de référence en agriculture et agroalimentaire du Québec

FUNDED BY
SPBQ Syndicat des Producteurs de Bleuets du Québec
Association des producteurs de bleuets de la Côte-Nord
CDAQ Conseil pour le développement de l'agriculture du Québec — Financé par : Agriculture et Agroalimentaire Canada / Agriculture and Agri-Food Canada Canada
M.R.C. du Fjord-du-Saguenay
MRC de Maria-Chapdelaine
MRC de Lac-Saint-Jean-Est