Management of the Alfalfa Leafcutting Bee In Northwestern Canada

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1. ALFALFA POLLINATION AND SEED PRODUCTION IN NORTHWESTERN CANADA

Alfalfa has been grown for seed in northwestern Canada for a number of years. Records of alfalfa seed production in the Peace River region of northern Alberta indicate that the average annual production for the period 1935-1955 was 1,500 tonnes. To produce seed, alfalfa like other forage legumes requires an insect for pollination. Alfalfa seed fields in the Peace were traditionally surrounded by uncleared land -- the natural habitat of bumble bees, native leafcutting bees and other insect pollinators. Large acreages of bush were cleared for cultivation in the mid 1950's thus resulting in a depletion of the natural habitat for insect pollinators. This coincided with a decrease in alfalfa seed production. Annual production between 1955-1958 was 50 tonnes. The introduction of the leafcutting bee, Megachile rotundata Fab. into the region in the early 1970's and the development of a successful management system for the bee in the north by scientists at Agriculture Canada's Beaverlodge Research Station and Fort Vermilion Sub-Station resulted in the successful re-establishment of the alfalfa seed industry in northwestern Canada in the late 1970's.

2. AN INSECT POLLINATOR -- THE LEAFCUTTING BEE

There are a number of species of native leafcutting bees in northwestern Canada. They are good pollinators of alfalfa and nesting tunnels of these native bees can often be found in farm buildings, abandoned equipment or in native bush in the vicinity of forage legume seed fields. Native leafcutting bees are not gregarious - i.e., large numbers of bees do not nest in the same area. They tend to drift to other areas and are therefore not reliable pollinators. In most areas in northwestern Canada, native leafcutting bees are usually present in alfalfa or other legume seed fields for varying periods during the growing season. In seed fields in more remote parts of this region farmers often rely on native bees for pollination.

Megachile rotundata Fab. is the species of leafcutting bee that has been successfully domesticated and used as a pollinator of alfalfa. This bee is a native of Eurasia and was unintentionally introduced into North America during and after World War II in crated war equipment. Large populations of this bee gradually developed in the western United States. Scientists in the area realised the bee's potential as a pollinator of alfalfa and in the late 1960's a new pollination industry was gradually developed. It was during this period that scientists with Agriculture Canada introduced this insect pollinator to western Canada and gradually developed management systems for the bee in Canada. Agriculture Canada scientists at Beaverlodge and Fort Vermilion are credited with the introduction of this pollinator to northwestern Canada and with the development of a management system for the continued propagation of this insect in the

region. Leafcutting bee cells from northwestern Canada are used extensively in the region and have found their way to international markets - a far cry from the 400-500 cells that were first introduced into the Peace River region in 1966.

3. LIFE CYCLE OF Megachile Rotundata Fab. -- THE LEAFCUTTING BEE

Megachile rotundata is a reliable insect pollinator because it is gregarious - i.e., large numbers of this species can be made to nest in a given area with the provision of man-made nesting material. During the growing season, female bees construct cells in nesting tunnels with oblong-shaped leaf cuttings. These cells are then provisioned with nectar and pollen that the bee collects from the alfalfa florets. It is during this process of nectar and pollen collection that the bee transfers pollen from the florets of one plant to the florets of another plant (cross pollination) - a pre-requisite for good seed set. The female bee then lays an egg in each cell and uses more leafcuttings to cap the cell. The egg hatches in its cell, and the larva feeds on the nectar and pollen. During this developmental phase, the larva has a blind gut and cannot defecate and contaminate the cell. After eating all the nectar and pollen, the larva deposits its fecal pellets at the end of the cell and separates itself from this fecal matter by spinning a tough silken cocoon. The full grown larva spends the winter in this cocoon.

The female bee constructs the first cell at the back end of the tunnel. A total of 7 to 9 cells are constructed in each tunnel. Commercially manufactured wood and polystyrene nesting tunnels, that are used predominately in northwestern Canada, vary from 8 to 10 cm in length. After all the cells in a tunnel have been constructed, tunnels are capped with a number of leaf cuttings. One to three tunnels are usually filled by a bee during an average growing season in northwestern Canada.

Adult bees die at the end of the growing season. Nesting tunnels are

brought indoors in the fall and are stripped after 4 to 6 weeks of storage at 18°C to 20°C. This initial storage is essential to ensure that most of the larvae complete development and spin cocoons prior to removal of cells from the nesting material. These cells are then stored at 5°C during the winter months. In the following spring, cells are incubated at 30°C. Incubation is timed to enable the emergence of adult bees to coincide with bloom on the alfalfa crop.

4. MANAGEMENT OF THE LEAFCUTTING BEE: THE ANNUAL ROUTINE

(i) Obtaining leafcutting bee cells

It is important to purchase good quality cells - i.e., a large percentage should be viable and not contaminated by diseases or infected by parasites. It is recommended that a quality test be done, by an unbiased third party, on the bees you wish to purchase prior to finalization of a sale. The Cocoon Testing Centre at Brooks, Alberta provides such a service.

Cells can be purchased from producers in western Canada. In most years, cells that have been produced in northwestern Canada are available for sale. Studies have shown that bees brought into the area from lower latitudes gradually adapt to foraging under the environmental conditions of northwestern Canada and until this occurs, they are not as productive as the bees produced locally in the first few generations of use. If you wish to obtain bees from outside Canada, a permit from Agriculture Canada, Plant Quarantine Division, is required.

(ii) Incubation

A controlled-temperature room in which temperatures between 5°C and 30°C and a relative humidity (RH) range of 50 to 70 percent can be maintained is ideal. This will allow for:

- the incubation of bees at 30°C and a RH of about 70 percent from June to early July;
- cool storage for bees in nesting boxes at 15 to 16°C with a RH of about 50 percent from early August to mid-November when larvae are spinning cocoons;

- cold storage at 5°C at a RH of about 50 percent for cells (stored in honey pails or other mouse-proof containers) that have been stripped from nesting material from November to June.

Depending on the size of the pollinating operation and the crops to be pollinated - e.g., bloom is likely to be delayed in some crops and/or areas as compared to others hence bees are required 5 to 7 days later -- it may be advisable to have two smaller rooms instead of one large room. The former would facilitate commencement of incubation at different times. Some factors - e.g., control measures for emerging chalcid parasites between days 8 to 12 - warrant that two batches of cells, each with a different requirement for date of emergence of bees, not be incubated in the same room.

It is recommended that this controlled-temperature room have an insulated door and that the walls and ceiling be adequately insulated. Minimum R-values of 10 and 30 for the walls and ceiling, respectively, are desirable. Other requirements are a compressor for cooling, baseboard heaters, two thermostats with a control sensitivity of $\pm$ 0.5°C - one for refrigeration and one for heating, and a humidifier with a capacity of 10 to 20 litres a day. In addition to the above, the electric wiring should be adequate to operate lights, fans, a time clock and other electrical equipment as required, e.g., uv and black lights for attracting parasites, a vacuum cleaner etc. The fan and lights must be on a different circuit from the heating equipment so that they can be left on when the thermostatically controlled heat circulating unit is off. Maximum-minimum thermometers could be placed in the room to check temperatures. The installa-

tion of an alarm system to inform the operator when temperatures exceed the critical high and low levels of safe operation is recommended.

The size of the controlled environment room will depend on the size of the operation. As a guideline, a 3.6 x 3.6 m (12 x 12') room is adequate for 2 million bees. There are other alternatives such as the use of chick incubators for incubation of cells and freezers for storage of cells at 5°C.

Cells are usually incubated in trays. Trays vary in size and can be made or purchased. Trays are usually constructed to hold 20,000 cells to correspond to the recommended stocking rate in the area -- 20,000 per acre equivalent to 50,000 per hectar. Cells should not be spread more than 5 cm (2") deep in trays. A 56 cm (22") x 61 cm (24") x 7.6 cm (3") deep plywood tray is sufficient for 20,000 cells. A 56 x 51 cm (22 x 20") wire screen attached to a 56 x 10 cm (22 x 4") plywood strip is used to cover the tray. Trays are usually stacked on a rack for convenient placement and transfer into and out of the controlled-temperature room. A minimum free space of 30 cm (12") at the top and bottom of the rack and 5 cm (2") between trays is required for air circulation to remove heat released by the bees (during hatch) and vapours from introduced pest strips during incubation. Consequently, if trays are stacked one on top of the other, a build-up of lethal temperatures and/or toxic fumes will result in high levels of bee mortality. Interspersing 2 x 4" lumber strips between incubation trays will facilitate adequate air circulation in cases where a rack for stacking trays is not available.

Incubation is usually started 16 to 18 days before 10 percent crop