Busy Bees are Controlling Crop Diseases and Pests

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Have you heard the latest buzz? It may be in your own field, the result of busy bees. Not only are bees the most important animal pollinator, they are also capable of producing healthy crops and protecting your organic produce from pests and disease. How? By taking advantage of relationships already present in nature, such as predation and disease. This simple yet elegant method is called bee-vectored biocontrol, or BVB.

Imagine a strawberry field (Figure 1). Bloom time is important as each blossom has the potential to become a juicy sweet strawberry; but first, each blossom must be visited by a pollinator — in this case, a bee. Pollination occurs when pollen grains from the male part of a flower are transferred to the female part of the flower (Figure 2a). In many crops, such as wheat and other grasses, that pollen transfer can happen through the action of wind. However, one-third of our crops require animal pollinators, such as bees, wasps, flies, beetles, butterflies and moths, birds or bats. Bees are the major pollinators. They simply do what nature has designed them for — gathering pollen and nectar for their own nutrition. As bees are foraging, they visit hundreds of blossoms, picking up pollen from one flower and inadvertently leaving that pollen on another flower. Once the pollen makes its way onto the female part of the flower and reaches the ovules, fertilization occurs, and the plant is able to produce seeds and form fruit (Figure 2b). Therefore, the process of pollination is related to the plant's reproduction and providing a bountiful crop of strawberries. Bees and plants have co-evolved to achieve efficient pollen transfer.

Figure 1. Strawberry field (photo courtesy of Jessica Waldegar).

Blooming strawberries are a concern to farmers for another reason. Some diseases enter plants through their blossoms. For example, the fungus *Botrytis cinerea* enters the plant primarily through its flowers and causes grey mould (Figure 2c). In a strawberry field affected by grey mould, the fruit rots, the crop is severely diminished, and the strawberry's shelf life at market is significantly reduced. Conventional farmers spray a synthetic fungicide to protect against these losses that would adversely affect their income. Grey mould, however, does have natural enemies and can be considerably reduced by antagonistic, and therefore beneficial, strains of other fungi. Using an ecological solution to manage agricultural crops is called "biocontrol."

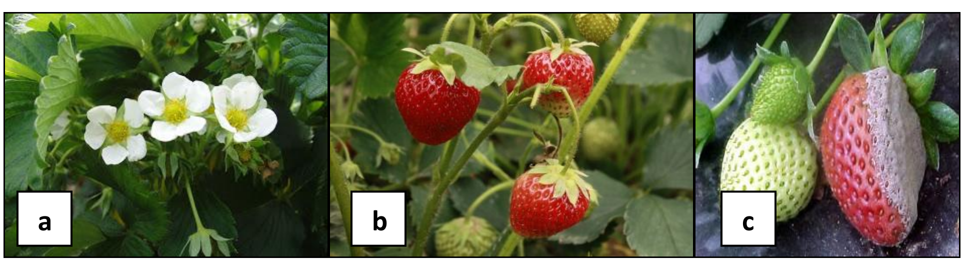

Figure 2. Strawberry blossoms (a) and fruit (b). Grey mould (caused by fungus *Botrytis*) on strawberry (c).

BVB studies

Bees' fuzzy bodies carry an electrostatic charge, which helps pollen grains stick to them. As bees travel from flower to flower, they also pick up other microscopic particles, making them very effective carriers (vectors) of bacteria, fungus spores, and other micro-organisms (microbes). This capacity of the bees has led professors Peter Kevan, John Sutton and colleagues at the University of Guelph, as well as Les Shipp and colleagues at Agriculture and Agri-Food Canada's (AAFC) Greenhouse and Processing Crops Research Centre in Harrow, ON, to run successful experiments over the past 20 years, using both bumblebees and honeybees to deliver natural biocontrol agents (e.g., beneficial fungi) that restrain diseases and pests in food produce.

The technology uses trays, loaded with a powder inundated with the biocontrol agent, that clip onto the honeybee hive or fit into the bumblebee box (Figure 3c). As the bee exits its home to forage, it is coated with the beneficial fungus, which it delivers to the blossoms of the target crop. The results indicate that the bee-delivered beneficial microbes are just as effective as synthetic fungicide spraying, in suppressing the incidence of grey mould. When bees return to their domiciles, they enter via a route that by-passes the biocontrol agent so that the powder is conserved.

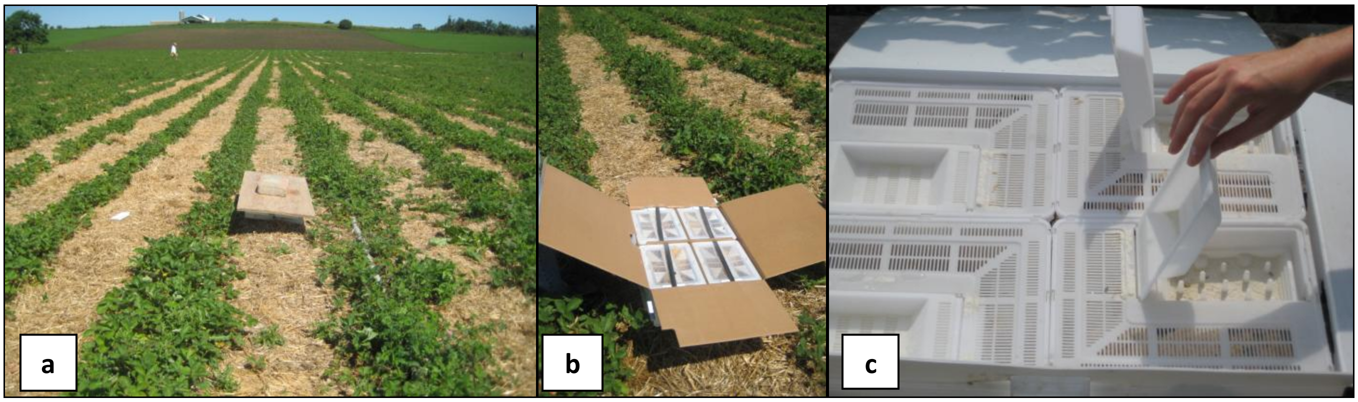

Figure 3. A bumblebee box (actually containing four domiciles) is placed in the strawberry field, with a brick holding down a rain-proof cover (a). Opened bumblebee box showing the four domiciles (b). The opened trays contain a powder of the biocontrol agent (the beneficial fungus) which the bumblebees must walk through, in order to exit the box and start foraging on the strawberry blossoms (c).

Numerous BVB studies have successfully used the natural partnership among flowers, bees, and micro-organisms, developing chemical-free ways to fight plant diseases and pests. In Canada, commercial BVB testing in greenhouse and field crops has progressed over the past two years, thanks to funding which Seeds of Diversity Canada received from AAFC. BVB tends to extend the shelf life of both strawberries and raspberries by a week. BVBalso successfully controls mummy berry on lowbush blueberries, head rot on sunflowers, and pests such as whiteflies, tarnished plant bugs, western flower thrips, banded sunflower moths and peach aphids, as they affect the named crops, as well as tomatoes, peppers, eggplant, and canola.

In a spring 2012 field trial in Ontario, bumblebees delivered beneficial microbes to four acres of blossoming strawberries. On average, only 6% of those berries developed grey mould, compared to 60% of the strawberry samples from the untreated field.

In Ontario field trials conducted in 2011 and 2012, bumblebees reduced the incidence of the fungus that causes sunflower head rot (*Sclerotinia sclerotiorum*) by 70-100%. That is, in fields where no bees delivered the biocontrol agent, 8-14% of the sunflowers suffered head rot, whereas the bee-vectored biocontrol fields grew sunflowers that displayed merely 0-4% head rot. These tests used one bumblebee colony per three acres of sunflowers.

Benefits of BVB

This innovative technique boasts other beneficial side effects. By using managed bees, growers ensure the presence of pollinators, which naturally increases crop quality and yield. In the case of the 2011 sunflower experiments, bushel weight was increased by 11%. Other benefits include improved seed quality and germination rates (up to 20% more in 2011 sunflower trials), higher seed-set, and improved yields on crops other than the target. For example, self-compatible sunflowers (referring to those flowers that set seed via pollen from the same flower head) tend to produce smaller, lighter seeds that neither contain as much oil nor germinate as well as seeds produced by cross-pollination, facilitated by the bees. Without the use of chemicals to control pests and disease, pollinator health is markedly improved. Finally, as pathogens tend to grow resistant to chemical sprays, coupled with an increasing public demand for chemical-free produce, BVB provides an ideal solution. BVB is compatible with and approved for organic crop production.

BVB can also be economical, as the need to spray several times while the crop sets new blooms daily, is eliminated. Since bees naturally forage on a daily basis, BVB provides an effective delivery of the biocontrol agent to freshly opened flowers without the extra expense and human labour involved in several sprays.

Interested growers are encouraged to contact the scientific team at beevectoring@gmail.com

Acknowledgments

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AAC agricultural adaptation council

Agriculture and Agri-Food Canada Agriculture et Agroalimentaire Canada

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*now called *Clonostachys rosea*