THE USE OF BUMBLEBEES AS POLLINATORS IN U.K. TOMATO CROPS

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Rapid uptake

The use of bumblebees to pollinate tomato crops was probably the most rapidly adopted innovation in the recent history of horticulture in northern Europe. Trials with bumblebees began in U.K. tomato crops in 1989 and were so successful that by 1992 they were being used by virtually all long-season tomato growers. It didn't require detailed scientific evaluation to determine the benefits because they were immediately obvious:

- Large savings in the labour used for mechanical pollination
- Much improved fruit set
- Increased fruit size and shape

At first, the hives required quite a lot of attention. They had external feeders containing sugar solution, which had to be checked, cleaned and topped up on a regular basis. Furthermore, growers were very cautious and monitored hives and fruit set almost daily to make sure everything was working correctly. However, the system has proved to be very reliable and the products have evolved over the years to become almost completely maintenance free. It is fair to say that the use of bumblebees has now become routine practice in tomato crops.

Bumblebees in the wild

In the wild, fertilised female bumblebees (queens) hibernate in isolation through the winter and emerge in spring to begin a colony in a small hole in the ground. Each queen lays a batch of eight to sixteen eggs and forages for pollen and nectar to feed the developing young. This brood is composed of sterile females (workers). When mature, these workers take over the task of gathering food, allowing the queen to devote herself to egg production. By midsummer, the colony may contain over one hundred individuals. Towards autumn, the production of workers stops and consecutive swarms of males and functional females are produced. The workers then die, as do the males after mating, and the fertilised females disperse for hibernation. There is only one such cycle per year.

Commercialisation of bumblebees

The commercialisation of bumblebees became possible with the development of reliable systems of mass rearing that could provide a continuous supply of bees throughout the entire tomato-growing season. As pollination was required in late winter and early spring when the bees were normally inactive, the rearing system had to include a means of breaking their hibernation. Colonies are established from individual queens in the rearing units and they are supplied to growers in disposable hives when they have built up to about eighty workers.

The workers visit the tomato flowers to collect pollen to feed the young in the hive and in doing so effect pollination. When they cling onto the flower, they leave distinct brown bruising marks on the pistil-tube, which makes it very easy to determine whether the flower has been visited. As there is no nectar in tomato

flowers, a concentrated sugar solution is supplied within the hive. Each colony can pollinate up to 3000 m^2 of classic round tomatoes for about two months, and colonies are replaced systematically throughout the growing season.

Hive design

The design of the hives supplied to growers in the U.K. vary in detail but include similar basic features. A robust hive compartment is enclosed within a moisture resistant cardboard carton. The hive compartment houses the brood above a sugar feed container so that the bees can feed upon it within the hive. This system also helps to prevent problems with wasps, wild bees and ants becoming associated with the hives.

The hives are fitted with mechanisms to enable growers to control the flight of the bees. For example, one hive design has two entrances that can be opened or closed by use of a simple sliding door. One opening allows the bees to fly in or out while the other is fitted with a tapered tube, which allows the bees to enter but not to leave. This allows growers to collect the bees in the hive and prevent flight at any time of the day. A similar system can be used to allow workers to move freely in and out of the hive but to retain the larger queens. One company is developing a wireless operated system that will allow the doorways to be controlled from a central point on the nursery.

Integration with pesticides

Bumblebees are susceptible to many of the insecticides and acaricides used in agricultural and horticultural cropping systems. This hasn't proved to be a problem in U.K. crops because all growers use integrated pest management (IPM) based on biological control agents with minimal applications of chemical products.

Bumblebees can be used in chemical-based pest control systems if those chemicals are chosen with care and guidelines provided by the suppliers are followed closely. Compatibility of bumblebees with chemical pesticides is generally classified in four categories, which allow or exclude the use of bees, or recommend a period of time after the application of the pesticide during which the hives should be kept closed or removed from the greenhouse. The introduction of the "one-way" doorway to the hive (described above) has made it much easier to keep the bees inside during pesticide applications.

All the U.K. suppliers now provide comprehensive lists about the side-effects of pesticides with recommendations about how they may be integrated with bumblebees.

Quantifying the benefits

The production of pollen in tomato flowers isn't constant but is linked to environmental conditions within daily cycles. When pollination is done manually, the nursery manager must first judge the best time of day to do this and then deploy his staff to get round all the plants as quickly as possible. It can be difficult to fit this in with other important tasks and it is inevitable that many plants will not be visited at the optimum time. As a consequence, fruit set, size and shape are rarely as good as they could be.

On the other hand, bumblebees search the plants constantly during daylight hours, each visiting and revisiting hundreds of flowers per hour. They only alight when the condition of the flower is correct and this ensures excellent pollination.

It is difficult to put this benefit into monetary terms because different growers

have very different approaches to manual pollination and the cost of bees varies depending on the size of the nursery and the number of hives purchased in a season. To make a fair comparison, we should consider the best method of manual pollination (ie use of a vibrating wand on every truss every day) because this is the only method that gives a result anywhere close to biological pollination. In this example, the cost of bees to an average sized U.K. nursery would be approximately 13% of the cost of the labour for manual pollination. This represents a huge saving over the season.

In addition, the use of bees increases marketable tomato yield. Estimates of the increased income that can be attributed to biological pollination vary tremendously – once again this is due to differences in the method and success of manual pollination. However, increases of 25-30% are realistic where the less labour intensive methods are used, which are based on tapping crop support wires.

In the U.K., growers are so used to obtaining these benefits that they no longer bother to calculate the actual figures. In fact, given the current value of the product and economic climate, it would be impossible for them to return to production systems without bees.