

## Experiences With Biological Control in Outdoor Container-Grown Nursery Stock®

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### INTRODUCTION

Gunnar Christensens' nursery was started on farmland more than 40 years ago by Nina and Gunnar Christensen. It is now run by the second generation of the family, Lotte and Henrik. The nursery covers 11 ha and has 25 employees during the season. Production is approximately 600,000 flowering shrubs and perennials in containers ranging from 2 L to 10 L and the main market is garden centres in Denmark and southern Sweden.

Production has been streamlined in the last few years, including the use of Visser's potting and spacing systems. The dispatch systems are currently being developed with the aim of reducing labour input by at least 30% and to improve the working environment significantly, with less harmful lifting and poor posture.

Reducing the environmental impact of production is an important consideration in the Danish market. During 2010 the area of the standing beds has been expanded and the area of roads and paths reduced so that productivity can be increased without necessarily increasing use of water or fertiliser. It also means there is less space to keep free of weeds and the opportunity to either produce more plants or produce a better quality by increasing plant spacing — we have chosen the latter.

We use re-circulated water from our new container beds and greenhouse roofs. All pots are covered with bark to prevent weeds and to reduce evaporation and water consumption. And following the experiences described below, all the plants are grown with the use of biological control as the primary means of crop protection.

### EXPERIMENTS ON THE USE OF BIOLOGICAL CONTROL OUTDOORS

For over 20 years, biological control has been used with great success on the nursery, in both propagation and the production greenhouses. Initially the nursery was forced into using biological control, because of the lack of effective chemical agents available in Denmark. The nursery has continued to work with biological control, in addition to chemical pest control, to provide a better working environment.

Because of our experience we offered to host a study of biological control in outdoor container plant production. The trials are being organised by the Danish Nursery Owners Association.

The trials began in 2008 with a small study in which we examined whether it was realistic to use biological control in open-field production. The following year we hosted a larger scale experiment, in which 10%–15% of our production was grown with the use of biological control. In 2010 we hosted further trials with biological control, including the use of air-assisted knapsacks to apply the biological agents. All the plants in the trials, which included a range of shrubs and perennials, are watered by drip lines to prevent over-watering. Predators work best with a RH of 60%, or more.

The trials have shown that it is possible to use biological control in open-field production. The 2009 trials showed that it cost almost twice as much to produce the plants with biological control as with chemical control.

However, since the beginning of the 2010 season, our thinking has changed from asking “which plants we should grow with biological control” to “which of the plants should not be grown with the primary use of biological control” for reasons which will be explained below.

## BIOLOGICAL CONTROL IN PRACTICE

**Preparation.** During the winter we plan the following season’s production and crop protection. We assess each crop, what pests and diseases they typically can get and at what time of year. Planning is informed by our records from previous years which we keep as a knowledge base in a Microsoft Excel document.

**Propagation.** We run a fixed programme of biological control in our propagation. We start our propagation in early April and biological control starts in the propagation houses in early May. We put predators out weekly onto the new planted cuttings until mid August.

**Production.** We start biological control in the outdoor container beds at the end of May when night temperatures should be above 10 °C when the predators will perform well. Typically, there are very few major pest attacks until night temperatures are above this level.

**Pest Management Outdoors.** Crop inspections begin in early May. We go through the entire crop once a week with a primary focus on the subjects that are likely to see the first attacks by pests, guided by our knowledge base. We also get regular reports from the staff who are working in the crop. When pests are found we decide whether we should control at this stage or wait and observe.

Small attacks will be observed but major attacks will be addressed using predators. If an attack is detected late — that is, immediately before marketing — we can either put out many predators and wait 2 or 3 weeks for them to work, or we can choose to use pesticides. We only resort to pesticides if the plant quality will be significantly impaired without them and the chemicals we choose are compatible with biological control. Against aphids we use flonicamid as Tepeki®. It works on aphids via ingestion and they stop feeding after about 2 days. Against spider mites we use hexythiazox as Nisserun®. It also works via ingestion and reduces the spider mites’ ability to reproduce.

Biological control cannot usually be used to prevent pest attacks. The exception we have found, by experience, is that we can prevent spider mite attacks with the release of the predatory mite *Amblyseius cucumeris*. Predatory mites eat spider mite eggs and therefore are able to restrict spider mite infestations. They will never be able to handle a major outbreak however.

**Application.** From the time of ordering predators it will typically take 2 to 3 days until we receive them. It is possible to keep them for up to a couple of days in cool storage but, unlike chemicals, they cannot be stored long-term on the nursery. It is best to use them as soon as possible after delivery, while they are still in the best condition. They can be put out on the crop at any time of day. However, it is best in the morning when there is dew on the plants, which catches the predators so they

do not fall off. They also acclimatise better at this time — midday sun can burn very brightly and makes for a sharp transition from storage for the predators.

All control agents except nematodes and *Hypoaspis miles* can either be spread directly from the container onto leaves, in branch angles and onto shoot tips, or spread with an air-assisted knapsack applicator. This piece of equipment is best described as a modified leaf blower. It has a tank mounted on top into which the predators are put. From there they are blown through the machine and out onto the crop through a large diameter hose. It takes some practice to dose the crop correctly. Effective distribution is achieved using the fan at a faster speed.

*Hypoaspis miles* is spread directly from their container onto the ground. Nematodes are applied through the irrigation in the spring when the soil temperature reaches 12 °C. This will be repeated in early September.

At the end of August we stop releasing predators. Night temperatures in Denmark are too low after this time and both pest and predator activity decreases.

Table 1 shows the predators used on the nursery. We also use the biopesticides Spruzit® (plant extracted pyrethrum) against caterpillars, beetle larvae, and leaf wasp larvae; and Dipel® (*Bacillus thuringiensis*) against butterfly larvae.

**Table 1.** Predators used in biological control at Gunnar Christensens Planteskole during the 2010 season.

Common name	Scientific name	Activity
Predatory mite	<i>Amblyseius cucumeris</i>	Nymphs and adults eat first instar thrips; larvae eat spider mite eggs
Common flower bug	<i>Anthocoris nemoralis</i>	Nymphs and adults feed on all stages of beech aphids
Parasitic wasp	<i>Aphidius colemani</i>	Parasitizes around 40 species of aphids
Parasitic wasp	<i>Aphidius ervi</i>	Parasitize aphids, including potato aphid
Gall midge	<i>Aphidoletes aphidimyza</i>	Feed on aphids
Parasitic wasp	<i>Encarsia formosa</i>	Parasitizes whiteflies
Nematodes	<i>Heterorhabditis bacteriophora</i>	Parasitizes black vine weevil larvae
Ground-living predatory mites	<i>Hypoaspis miles</i>	Feed on ground-living organisms including springtails, mites, the larvae of fungus gnats, beetles, flies. Its nymphs and adults feed on thrips pupae
Predatory bug	<i>Orius majuscules</i>	Nymphs and adults feed on all stages of thrips, aphids, mites, and other small arthropods
Spider mite predator	<i>Phytoseiulus persimilis</i>	Nymphs and adults feed on all stage of spider mites

## THE RELATIONSHIP WITH CHEMICAL PESTICIDES

We have significantly reduced the numbers of fungal sprays since we stopped using chemical insecticides. Chemical insecticides are formulated with organic solvents that break down the wax layer on the crop leaves to help them penetrate into the tissues the pest feeds on. However this wax layer is part of the plant's defence against fungal diseases. We believe reduced use of chemical insecticides has therefore helped to preserve the crop's natural defence against disease, which is why we have seen a reduced need to apply chemical fungicides.

In Denmark we have unpredictable weather and the likelihood of wind and rain is always a consideration when spraying. As we have to rely less on chemical sprays, we are more able to choose to apply them at the optimum times in relation to weather, wind, and workflow. Thus, they become more efficient and this also means fewer applications are needed.

We can spray with most fungicides without an effect on predators. The ones currently in regular use are Folicur® (tebuconazole), Amistar® (azoxystrobin), Tilt™ (propiconazole), Proplant™ (propamocarb hydrochloride), and Teldor® (fenhexamid).

Bugs and leafhopper are harmful pests for which there are no biological controls yet. However, they have not posed a problem for us. Against slugs and snails we use Ferramol (ferric phosphate), which is approved for organic food crops.

## LABOUR INPUT FOR BIOLOGICAL PEST CONTROL

The time spent per week managing biological control breaks down as 2 or 3 h for inspection and record keeping; and 1 or 2 h for spreading of predators. Our nursery records have shown us that the hours spent spraying chemical versus the time spent distributing biological control over the season are very similar.

To make a proper comparison, the time spent on chemical control is not just operating the sprayer. It must include setting up and dismantling warning signs and barriers to keep staff out of the treatment area; distributing information for affected employees and departments; putting on and taking off personal protective equipment; preparation of spray equipment and the disruption of the workforce in the affected departments.

Most spraying is done outside of normal working hours which means expensive overtime costs while for biological control the crop inspections and applications of predators typically take place within normal working hours.

In Denmark a spray certificate is required for any operator who applies chemical agents. It must be renewed every 2 years. No certification is required for use of biological control.

## INFORMATION AND MARKETING

Our aim at Gunnar Christensen's Nursery is to provide all our employees with a knowledge and understanding of biological control. We know it is at the busy times when pest damage occurs and this is why it makes sense for all employees to know how to recognise damage and learn what the pests and predators look like and how they behave. When we see damage in the crop, we try to show it to all staff members and explain the strategy to be used. Most people know what a badly infested plant looks like, what is important is to teach them all what the earliest stages looks like and how the attack will evolve.

Knowledge about our strategy is just as important for our sales team. For example, there may be times when we have to withhold a consignment of plants, because

biological control has not yet cleared up the problem. When customers are informed that they will have to wait for delivery due to the biological control, there is a very good understanding. None of our customers have said: "Then use chemical spraying instead!" They also have employees and customers to consider. We explain to our customers that there is a natural balance in the plants, which lasts all the way to the final customer's garden, and we find this is a good selling point. A plant which has just been cleaned up chemically is very receptive to many kinds of pests and diseases after it has been transplanted into a garden.

### **STARTING FOR YOURSELF**

Before starting you need to make an assessment of whether biological control can work on your nursery. It is important that you really want to succeed. It requires good nerves and a strong will as it is still so easy to resort back to chemicals at the first sign of a problem.

Start by listing your crops and your known historic pest and disease issues and their typical times for attack. It is useful to put this into a spreadsheet such as Excel which makes it easy to search for historic data. Your records can then help you to develop a suitable strategy for your own range of crops.

It helps if you have an employee with an interest in and desire to use biological control, to whom you can give this responsibility. But you also need to find a serious and experienced supplier who will come to advise and also use an experienced horticulture consultant.

Expect to devote time to crop inspections and start them earlier in the season than for chemical control. Be very aware of the possible impacts on your biological agents of any chemicals that you do use. Record in detail all that is done over the season. Evaluate the process. Use the experience to plan next year's strategy.

Start with a small part of nursery. It's better with a little success than a big failure

Inform clients and their customers about your use of biological control. It will be a good selling point.

### **CONCLUSION**

Our biggest lessons have been in how to observe and how to be patient — knowing your enemy. Some pests are very dependent on your crop management.

The philosophy with chemical controls was to prevent attacks rather than cure but this destroys a natural balance. When we were using chemical sprays, we had no major fluctuations from year to year. There were always some aphids, spider mites, larvae, etc. Now we have aphids one year, next year spider mites, and so on. It is easier to deal with one problem at a time.

A bonus effect of not using insecticides is the very high incidence on the nursery of natural predators such as ladybirds, lacewings, all kind of spiders, gall midges, hoverflies, and wasps.