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Addition of Beneficial Microorganisms to Growth Media: An Overview

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Addition of beneficial microbiological products, also called "biopesticides", and other beneficials to growth media has become increasingly explored during the last 10 to 15 years. This is due, in part, to increasing pest and pathogen resistance to chemical products and due to banning of many environmentally harmful pesticides.

INTRODUCTION

Until 1995 there were no legal prohibitions in European Union (EU) against adding microbiological products against pests and pathogens to growth media. In 1995 registration rules for microbiological products where established in EU. Products that had been sold prior to 1993 where allowed to continue if they could pass national registration rules but new microbiological products introduced after 1993 have to pass new tough EU rules. This meant that many "new" products used between 1993 and 1995, especially against pests, suddenly had to be taken off the market in Denmark.

The microbiological product Supresivit (*Trichoderma harzianum*) is one of the products that was in use before 1993. Borregaard BioPlant registered this product nationally in 1995 and in accordance with the new rules (new products with similar active organisms do not need to be registered) this has opened up the market for many other *Trichoderma*-based products on the Danish market.

The tendency in plant production for many years has been to develop as sterile a growth medium as possible. A negative consequence of this has been the difficulty controlling pest and pathogen outbreaks. The natural microbiological balance that exists in nonsterile media almost always helps to suppress such outbreaks to a certain degree. So because of these factors it is highly relevant to consider active incorporation of beneficial organisms in to growth media. For this purpose there are products consisting of: (A) beneficial arthropods, nematodes, etc.; (B) beneficial bacteria; and (C) beneficial fungi. Against pathogens there are commercial products available from the two last groups and against insect pests there exists products from all three groups.

PRODUCTS AGAINST PESTS

Amongst the different species of *Diptera* (flies) associated with peat, only sciarids (*Bradysia* spp.) may be present in the peat when delivered to the grower. During 1995 to 1998 Borregaard BioPlant made 78 sciarid hatching trials on new peat from different producers delivered to different growers. As shown in Figure 1, hatching of the adult sciarids occurs approximately 3 to 6 weeks after irrigation of the peat. Considering the life cycle of sciarids this indicates that it is the eggs of sciarids, and not larvae or pupae, that are present in the peat when delivered to the grower. When planning a sciarid-control programme it is important to consider the above mentioned facts.

Beneficial Nematodes. Persistence trials made by Borregaard BioPlant with *Steinernema* nematodes in peat have shown live nematodes for more than 2 months after application (peat stored under natural conditions outdoors below 30°C in 200-liter plastic bags). The *Heterorhabditis* species (against vine weevils, etc.) generally have a lower persistence in peat. Incorporation of nematodes to the peat is a good idea because the nematodes will persist long enough to infect larval stages hatching from the eggs present in the peat (and larvae hatching from eggs laid on the peat at the grower as well).

Beneficial Bacteria. The use of available commercial *Bacillus thuringiensis* products (Vectobac and Bactimos) is only relevant after the commencement of plant production in the growth media because the bacteria will not persist long enough to have effect when sciarid eggs hatch.

Beneficial Fungi. Worldwide there exist many beneficial fungi products available for incorporation into growth media. Unfortunately these products are not yet allowed for sale in Denmark. Only products based on *Verticillium lecanii* (Mycotal and Vertalec) are available commercially. The registration of *Paecilomyces*

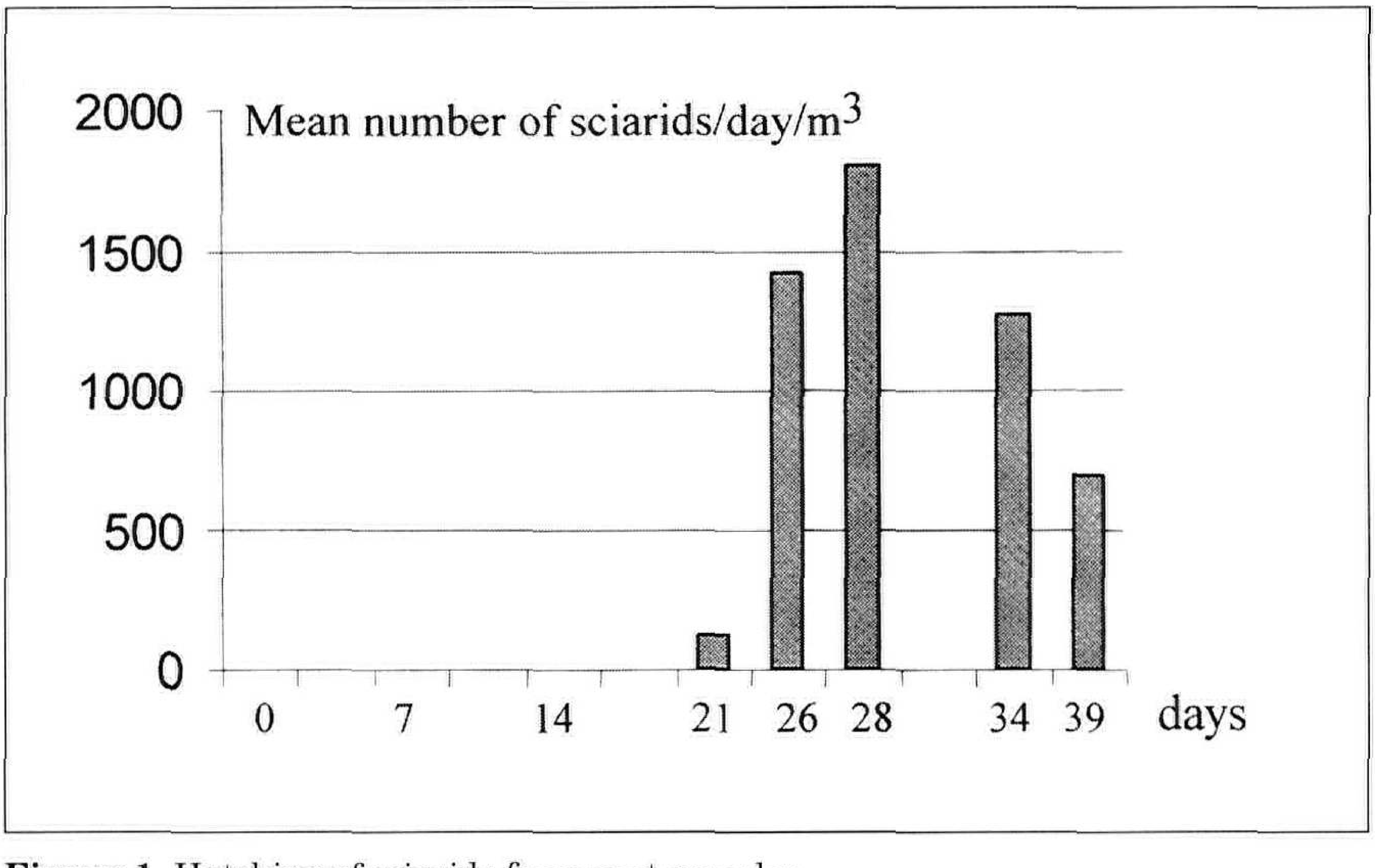

Figure 1. Hatching of sciarids from peat samples.

fumosoroseus (PreFeRal) is due shortly and for other relevant fungi like *Beauveria* spp. (*B. bassiana*: "Boverol", *B. brongniarti*, etc.) and *Metarhizium anisopliae*. It is Borregaard BioPlant's goal to register them in the near future.

Verticillium primarily works on the above-ground parts of the plant whereas *Paecilomyces* and *Beauveria* work above-ground as well as in the growth media. *Metarhizium* primarily has its effect only in the growth media. The three last mentioned fungi are likely candidates for incorporation into growth media in the future.

It is important to demonstrate the beneficial effect and a high demand for these products to make them economically possible to register them in EU and Denmark.

In conclusion, nematodes (against sciarids, beetle larvae, etc.) are the only group of macrobiological beneficials relevant for incorporation in growth media. Products containing beneficial bacteria (*Bacillus thuringiensis* and others) are not at the present time suitable for incorporation into growth media before production starts due to low persistence. In the group of beneficial fungi against pests there exists many products that would be relevant to apply, but these products are very difficult to register for sale in Denmark.

PRODUCTS AGAINST PATHOGENS

Suppliers of growth media normally have a good idea of the potential pest problems at their customers and, therefore, also have the possibility of adding beneficial organisms targeted against these pests. With regard to pathogenic fungi, that is another matter and more complex. To prevent development of pathogens, incorporation of beneficial organisms (antagonists) will be of more prophylactic nature and the organisms will have to protect against a relatively wide range of pathogens. There is also the possibility of incorporating "soil improvers" like mycorrhiza forming fungi which will help the plants in stressful situations by improving the uptake of nutrients (especially phosphorus).

Typical biological plant protection products against pathogens can be grouped in three categories: (1) beneficial bacteria, (2) mixed organisms, and (3) beneficial fungi. From these groups there is registered one bacteria product and several fungi products.

Beneficial Bacteria. Mycostop (*Streptomyces griseoviridis*) is presently the only bacteria containing product registered for use in Denmark. Several other products consisting of, for example, *Bacillus subtilis* and *Pseudomonas* spp., would be interesting to use in the future.

Mixed Products. Effective microorganisms were widely used in Denmark as a "soil improver" but should have been registered as a plant protection product according to the official registration rules from the Danish Environmental Ministry.

Beneficial Fungi. Among the countless beneficial fungi relevant for incorporation in growth media, only *Trichoderma*-based products are legal in Denmark. *Pythium* spp., *Fusarium* spp., *Gliocladium* spp., *Tilletiopsis* spp., etc. are amongst the beneficial fungi that probably will be registered in the future.

Coniothyrium minitans (Contans) against *Sclerotinia* spp. is expected to be registered by Borregaard BioPlant in the near future, but because Contans works against sclerotia it makes more sense to apply it to growth media with a registered attack. The beneficial fungi, *Trichoderma, Gliocladium,* etc., are generalists suppressing a wide range of pathogens. The primary effect of these products is based on the establishment of the beneficial fungi in the growth media before the pathogen can develop into a problem. Therefore, the growth medium has to be treated as early as possible.

Supresivit is an example of a registered product containing the beneficial fungi *Trichoderma harzianum*. Supresivit contains 1.4×10^{10} spores per gram. This high concentration of spores makes it possible to distribute the product very evenly in, for instance, peat. The high concentration together with a broad spectrum effect makes Supresivit a very suitable product for incorporation into growth media.

Cabbage Seedlings Grown Organically in Plugs — Substrate Liming and Fertilizer Supply

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INTRODUCTION

Organic vegetable production in Denmark has increased rapidly during the last decade. In 1997, the acreage of organic horticultural crops — mainly vegetables — had increased to 769 ha. Accordingly, there is a demand for development of propagation methods with special emphasis on organic farming.

In Danish propagation nurseries, it is common practice to raise seedlings of cabbage in plug trays filled with sphagnum peat. In organic farming, sphagnum peat is usually mixed with limestone and an organic fertilizer. Besides the ability to increase pH of the peat, limestone is an important calcium source. If dolomitic limestone is chosen, a large quantity of magnesium is added at the same time as dolomitic limestone contains about 10% magnesium.

The main purpose of the present study was to assess optimum quantities of dolomitic limestone and fertilizers as additives to sphagnum peat used as a propagation substrate for seedlings of white cabbage raised organically in plug trays. Due to the small volume of plugs it may be necessary to supply extra fertilizer to the plug plants during the propagation period. In the present study, it was investigated whether it is feasible to use diluted recirculated or nonrecirculated liquid cattle manure as a supplementary fertilizer.

EXPERIMENTS WITH SEEDLINGS OF WHITE CABBAGE

Two experiments with organically grown seedlings of white cabbage (*Brassica oleracea* L. Capitata Group 'Bartolo') were carried out to investigate the possibilities for improved fertilization during germination and subsequent growth in plug trays under glasshouse conditions. Each plug tray (60 cm × 40 cm, VEFI A/S), with 54 conical plug cells, each 90 cm^3 and 6.5 cm high, constituted one plot. The seeds were sown on 10 Aug. 1995 (Experiment 1) and 18 April 1996 (Experiment 2) and the experiments were terminated 27 or 25 days after sowing, respectively. The treatments were replicated twice in Experiment 1 and three times in Experiment 2