DRIP IRRIGATION: A NEW WAY TO SUPPLY WATER FOR CULTIVATION OF *AGARICUS BISPORUS*

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The mushroom research group at MIGAL is the only unit in Israel that deals with applied research on mushroom cultivation and mushroom products. Research efforts of our group include a wide range of topics, addressing the needs of mushroom growers in Israel, particularly those in the northern part of the country. Research is partially performed in co-operation with scientists from other institutions, especially the Faculty of Agriculture of the Hebrew University. Because of the group's research efforts, mushroom production and consumption in Israel has expanded considerably including the amount of production and number of species cultivated. Here we report the development of a new technology that has potential to improve mushroom production, not only in Israel but worldwide.

Drip irrigation

The need

Two main substrates are used in *Agaricus bisporus* cultivation: compost and casing (Levanon and Danai 2004). Compost serves as the main source of nutrition for the mushroom. The casing layer has two main functions: induction of fruit body development and water supply during mushroom growth. Water availability in both casing and compost is crucial for mushroom production, both in terms of quantity and quality. In today's practice, the use of spray irrigation is halted at certain growth stages as follows: (a) pinning, in order to avoid damage to pin formation and (b) directly on fruit bodies since free water can enhance bacterial blotch (*Pseudomonas tolaasii*) development. Restricting water may result in dehydration of the growth substrates, limiting production potential of the compost as demonstrated by Sonnenberg & Blok (2012). Restricting water application may require the use of a thick casing layer to serve as a water reservoir. Due to the decrease in compost and casing water content, mushroom quality of the third flush may deteriorate, and thus, many growers choose to produce only two flushes. In order to overcome these obstacles, drip irrigation was developed in an effort to replace spraying as a method of water application in mushroom cultivation.

Concept development

Trials reported herein were carried out on a commercial mushroom farm with rooms of two rows of 6 shelves high. Synthetic phase I compost was used along with Lambert 901 spawn (USA), Champfood E supplement (Netherlands) and casing of 5-6 cm of Harte peat (Ireland). In some experiments, thickness of the casing was reduced by 15-30% in the drip irrigation treatments. In each experiment, two rooms were used with the same compost batch: a control, with an automatic spraying system (Dofra, Netherlands) and the drip irrigation room. A special drip irrigation system (Fig. 1), developed by Netafim Irrigation Systems (Israel), was used in these experiments. Drip pipelines were incorporated into the casing during CACing with a special device connected to the ruffling machine. The system consisted of: (a) pipelines with pressure compensated, non-leaking low flow (CNL) drippers, (b) computerized controller, with a sophisticated algorithm, that used outputs from the climate control computer and from compost and casing sensors that could operate either in automatic or manual mode, and **(c)** agro mechanical solutions for implementing and retrieving the drip lines from the substrate. This technical break-through made it possible to irrigate and maintain optimal water content in compost and casing during the entire growing cycle. The system enabled implementation of computerized, sensor-controlled, automatic smart irrigation in mushroom cultivation.

Figure 1. Equipment used for drip irrigation of a mushroom cultivation bed.

Drip irrigation performance

It was demonstrated that the use of drip irrigation during mushroom cultivation retarded the decrease in casing and compost water content. These results were especially pronounced during the 2nd and 3rd flushes. Higher mushroom yields were obtained when drip irrigation was used. Drip irrigation led to improved mushroom quality and therefore higher income for the grower. Based on these results, drip irrigation, in combination with reduced casing layer thickness up to 15-30%, was compared to spray irrigation. With drip irrigation, casing moisture decrease was minimized even on a thinner casing layer. Mushroom yields were also higher with drip irrigation, even when the casing layer thickness was reduced. The incidence of

bacterial blotch was recorded when comparing the two watering methods. It was observed that up to 6% of the mushrooms were affected by bacterial blotch when watered by spraying. No bacterial blotch occurred with drip irrigation.
BTI (biological insecticide) was applied through the drip irrigation system and reduced fly populations were observed in the cultivation room. The use of drip irrigation decreases disemination of fungal spores of disease-causing fungi (*Verticilium*, *Mycogone*, etc.). It was demostrated that the drip system could also deliver nutritional supplements, pesticides, and other substances according to specific cultivation needs. This situation opens the way for new product applications for mushroom cultivation.

Conclusions

The new drip irrigation system provides the mushroom industry with a new tool. So far, we have found the following benefits: Use of under-surface drip irrigation allows continuous water supply to the casing and compost throughout the entire cultivation cycle. It was demonstrated that the use of this system minimized the decrease in casing and compost water content. Furthermore, the use of drip irrigation allowed a decrease of 15-30% in thickness of the casing layer. World resources of peat-moss, the main ingredient of casing, are decreasing leading to supply limitations and increased prices. There are continuous efforts to recycle peat and develop peat alteratives for its use as casing (Levanon and Danai 2004). Therefore, reduction of peat consumption means not only cost reduction for mushroom growers, but also contibution to preserving a limited natural resource. Another important outcome of the use of drip irrigation, is the (almost) elimination of bacterial blotch and supression of other diseases. In previous studies, means of watering, other than spray irrigation, were suggested, but they were not further developed, to an operation-available technology. Therefore today, there are no under surface water supply systems that allow watering, while keeping casing surface and mushrooms dry. Drip irrigation allows this option, insuring better mushroom quality and higher yields. This system is also energy saving, since there is no need to dry the cultivation rooms, after irrigation. It is estimated that, with the use of drip irrigation, the combined value of reduced costs of casing and energy, plus increased income due to better mushroom yields and quality, allows a fast return on investment. These benefits, along with the advantages of drip irrigation, as mentioned above, led to initial commercialization of the system, after three years of research. A drip irrigation model farm became recently operational in Israel. The next model farm soon will be established in Europe.

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