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## Control of potato late blight by caraway oil in organic farming

M.Keskitalo<sup>1</sup>, A-L.Fabritius<sup>2</sup>, K.Hakala<sup>1</sup>, A.Hannukkala<sup>1</sup>, E.Ketoja<sup>3</sup>, A.Lehtinen<sup>1</sup>, P.Mikkonen<sup>1</sup> and A.Vuorema<sup>1</sup>

<sup>1</sup>MTT Agrifood Research Finland, Plant Production Research, 31600 Jokioinen, Finland

<sup>2</sup>University of Helsinki, Department of Applied Biology, Plant Pathology, P.O. Box 27, 00014 Helsinki, Finland

<sup>3</sup>MTT Agrifood Research Finland, Research Services, 31600 Jokioinen, Finland

### Abstract

One of the most severe threats to organic potato production in Finland is potato late blight (*Phytophthora infestans*, *P.i.*), because there are currently no compounds available for its direct control. Caraway (*Carum carvi*) seeds contain biologically active essential oils, which have shown potential in controlling *P.i.* An attempt is being made to develop a *P.i.* control strategy for organic farming based on caraway oil. In addition, knowledge is sought on the interactions among the essential oil-based anti-fungal agents, the plants sprayed with them and the *P.i.* pathogen. The economic feasibility of controlling *P.i.* with caraway oil will be also surveyed. Caraway essential oil delayed the onset of *P.i.* for about 10-14 days under field conditions. The efficacy of the oil is based on the prevention of *P.i.* spore production and growth already at a low oil concentration. In contrast to previous findings, caraway oil had some systemic effect on potato plants. Formulation decreased volatilisation of the caraway oil and changed its adhesiveness to spores, but efficacy against *P.i.* was not improved in greenhouse tests.

**Keywords:** plant protection, *Phytophthora infestans*, potato growth, caraway essential oil, carvone

### Introduction

A new sexually reproducing potato late blight (*Phytophthora infestans*, *P.i.*) population characterised by early oospore-derived epidemics is one of the most severe threats to organic potato production (Fry et al, 1993; Lehtinen & Hannukkala, 2004). The first symptoms of the new *P.i.* are apparent in the field about one month earlier than was the case ten years ago. Currently control is based on crop management practices that delay the onset of epidemics. These include methods such as: using only healthy seed, implementing crop rotation, taking care of sanitation during composting (Zwankhuizen et al, 1998), increased aeration in potato stands by wider row spacing (Karalus 1998; Glass et al, 2001) and favouring varieties with early tuber formation capacity and reasonable tolerance to leaf and tuber blight (Karalus & Rauber, 1997). However, blight management based on cultural practices alone results in considerable yield losses even under a moderate disease pressure. In Finland there are no compounds available for direct blight control in organic production.

Different plant and compost extracts have been studied for their efficacy against foliar pathogens of vegetables and ornamental plants, including *P.i.* on tomato and potato. The overall results of these studies have been variable but on several occasions a reasonable delay in onset of a blight epidemic has been achieved, resulting in higher yield compared with an untreated crop (Jackel et al, 1995; Schmitt, 1996; Blaeser et al, 1999). One of the successful examples is crude steam distillate from the herb, *Ocimum gratissimum* on the pathogen *Phytophthora palmivora* on cocoa pods (Awuah, 1994).

Caraway products are used as sprouting inhibitors, and they also considerably reduce losses caused by storage fungi (Bång, 1995a, 1995b, 1999). However, very limited published data on the efficacy of caraway oil based extracts against *P.i.* are available.

The aim of the research is to develop a *P.i.* control strategy for organic farming based on caraway oil. We also want to obtain knowledge about the interactions among the essential oil-based anti-fungal agents, the plants sprayed with them and the *P.i.* pathogen.

## Materials and methods

The research includes several experiments started in 2000, some of which are still continuing. During the initial stage laboratory, greenhouse and field experiments were carried out to study the effects of caraway oil on *P.i.* Possibilities for different oil extraction methods were also investigated. The aims of the second stage of the research were to improve the efficacy of caraway oil through oil formulation, and to reveal its mode of action on the pathogen and potato plant.

## Results and discussion

Caraway essential oil delayed the onset of late blight for about 10-14 days under field conditions (Hannukkala et al, 2002; Keskitalo, 2002). The control activity of the oil is based on the prevention of late blight sporangia production and growth already at a low oil concentration. In contrast to previous findings, caraway oil had some systemic effect on potato plants. Formulation decreased volatilisation of the caraway oil and changed its adhesiveness to spores, but efficacy against *P.i.* was not improved in greenhouse tests.

## Conclusions

It is possible to delay the onset of *P.i.* for 14 days by using caraway oil. The aims of the ongoing studies are to find ways to delay it further. This improves the economic feasibility to control *P.i.* with caraway oil. Use of caraway oil in combination with other plant-based extracts is being studied.

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