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Integration of natural seed treatments in organic and open-pollinated corn systems

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Abstract
Essential oils from the aromatic plants, such as thyme, oregano, cinnamon, clove, and savory, were used to effectively control several common seed and soil pathogens in the laboratory, and could be used as seed treatments in corn. Results from field experiments showed some oils protected the seeds from pathogens but not others. Before these natural products can be widely adopted, however, issues of volatility of the oils at ambient temperature and appropriate application rate must be addressed.

Keywords
Agronomy, Horticulture, Biocontrol and Integrated Pest Management, Organic production practices and comparisons

Disciplines
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Question & Answer

Q: What are the options for organic farmers who are interested in organic seed treatments?

A: This work shows that while the essential oils of thyme, oregano, cinnamon, clove, and savory don't harm seeds and effectively control three pathogens in the lab, it is still not proven that they would be effective in the field.

Background

The number of alternative crop production systems has increased in recent years in response to growing concerns about agricultural concentration and interest in a more ecological, farm-based agriculture. In these low-input systems, planting dates for open-pollinated corn may be delayed to avoid the cold, wet spring soils. Conventional farmers use synthetic fungicide treatments to protect the emerging seedlings, but there are few organic fungicides available. The objective of this project was to determine whether the essential oils of aromatic plants can be used successfully as a contact fungicide seed treatment for organic corn.

Approach and methods

Eighteen plant essential oils were screened for their ability to control three common corn pathogens: Penicillium ear rot, *Fusarium* ear and root rot, and *Pythium* seedling blight and stalk rot. The oils screened were: anise (*Pimpinella anisum*), basil (*Ocimum basilicum*), bay (*Laurus nobilis*), caraway (*Carum carvi*), cinnamon (*Cinnamonum zeylanicum*), clove (*Eugenia caryophyllata*), coriander (*Coriandrum sativum*), lavender (*Lavendula officinalis*), lemongrass (*Cymbopogon citratus*), nutmeg (*Myristica fragrans*), oregano (*Origanum minutiflorum*), pepper (*Piper nigrum*), peppermint (*Mentha piperita*), rosemary (*Rosmarinus officinalis*), sage (*Salvia officinalis*), savory (*Satureia montana*), tea tree (*Melaleuca alternifolia*), and thyme (*Thymus vulgaris*). An initial concentration of 1,000 ppm of the essential oils was used to determine their effect on pathogen growth in the laboratory.

To determine the minimum inhibitory concentration (MIC, lowest concentration for pathogen control), the oils were diluted to concentrations of 100, 200, 400, and 800 ppm. To determine the presence of phytotoxicity problems related to use of the oils, artificially infected corn seeds were treated with rates up to 16,000 ppm (MIC x 20) of the essential oils and germinated.

Results and discussion

Of the initial 18 plant essential oils screened, five (cinnamon, clove, oregano, savory and thyme) completely inhibited the growth of the three corn pathogens (*Fusarium* sp., Penicillium sp., and *Pythium* sp.) in vitro. The minimum

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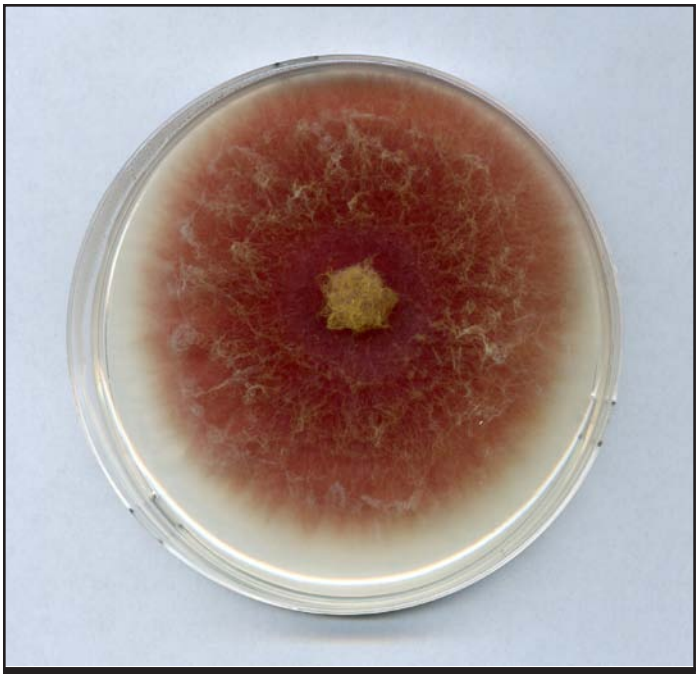
$25,000 for year one
$25,000 for year two

inhibitory concentration of the essential oils in the laboratory was 800 ppm. The growing seedlings were not affected (i.e., no phytotoxicity symptoms were seen) at rates up to 16,000 ppm concentration of the essential oils.

Gas chromatography analysis determined the major constituent compounds of the five oils. The antifungal properties of the essential oils seemed to be associated with aromatic compounds. The concentration of these compounds varied among the oils and from those reported in the literature. Further research should be conducted comparing the efficacy of the pure forms of the constituent compounds and the essential oil as a whole.

Field emergence of inbred and hybrid seed treated with essential oils was significantly lower than seed treated with commercial fungicides Maxim XL, a conventional fungicide, and Natural 2, an organic fungicide; however, the emergence rates were not different from the organic fungicide Yield Shield or an untreated control.

The standard germination test was used to evaluate the germination of artificially infected inbred and hybrid corn seeds treated with two rates of the five essential oils. There were no significant differences in germination percentage between the two rates of essential oil treatments. The germination percentage of seeds treated with the essential oil was significantly lower than the commercial seed treatments Natural 2 and Maxim XL. However, some essential oil seed treatments were not significantly different from the commercial organic seed treatment Yield Shield.



Pathogen (Fusarium) used in the experiment

Conclusions

The essential oils of cinnamon, clove, oregano, savory, and thyme control common seed and soil borne pathogens in the laboratory at very low (800 ppm) rates; are not phytotoxic to the growing seedlings; and can potentially be used as seed treatments. In the laboratory and field experiments, the essential oils are not as effective, possibly due to volatilization and consequent loss of the essential oils. Further research should be conducted to determine the correct application rate for the essential oils and possible methods to reduce the volatilization of the aromatic compounds from the seed surface.

Impact of results

The essential oils of thyme, oregano, cinnamon, clove, and savory effectively controlled three pathogens *in vitro*. *In vivo* results were mixed and further research is necessary to determine the true potential of these essential oils as seed treatments.

Education and outreach

Results from these experiments were shared with farmers and colleagues at Practical Farmers of Iowa and the Michael Fields Institute at their annual farmer meetings and field demonstrations. Results also were reported at the ISU Seed Science Center-sponsored workshops, including the seed quality workshops.

An article based on the project findings on aromatic plant oils as a fungicide for organic corn production was to appear in *Crop Science* journal. (See: Christian, E.J. and A. S. Goggi. 2008. Aromatic plant oils as fungicide for organic corn production.)

Leveraged funds

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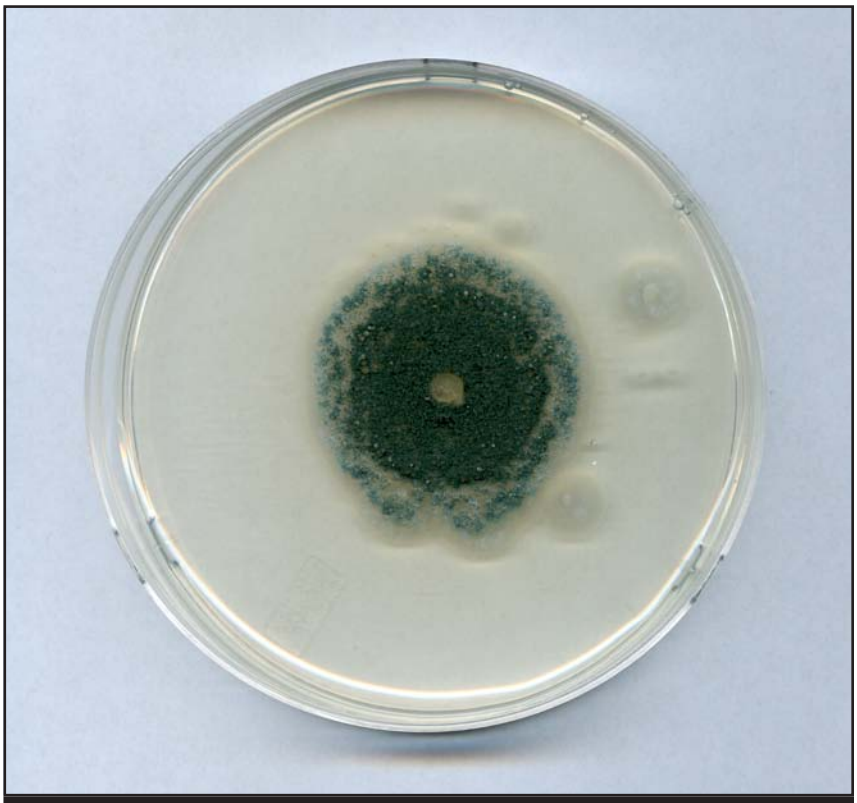

Pathogen (Penicillium) used in the experiment

Photos by Erik J. Christian

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