

## Introduction and Objective

*Plasmodiophora brassicae* (Woronin) is the cause of clubroot of cabbage and other brassica crops. Infection causes distorted (clubbed) roots, resulting in wilting, chlorosis, stunting and plant death. The entomopathogenic fungus *Beauveria bassiana* (Balsamo) Vuillemin can also colonize plants as an endophyte that can stimulate resistance to disease. Commercial formulations containing *B. bassiana*, BotaniGard and BioCeres (Fig. 1), are registered for management of several insect pests in Canada.

Cabbage is typically started as transplants in a greenhouse and then planted into the field. Applying *B. bassiana* to seedlings could allow colonization of the plants before exposure to *P. brassicae* in the field.

The objective of this study was to evaluate the potential of commercial formulations of *B. bassiana* as an endophyte for suppression of clubroot on cabbage and under controlled environment conditions.

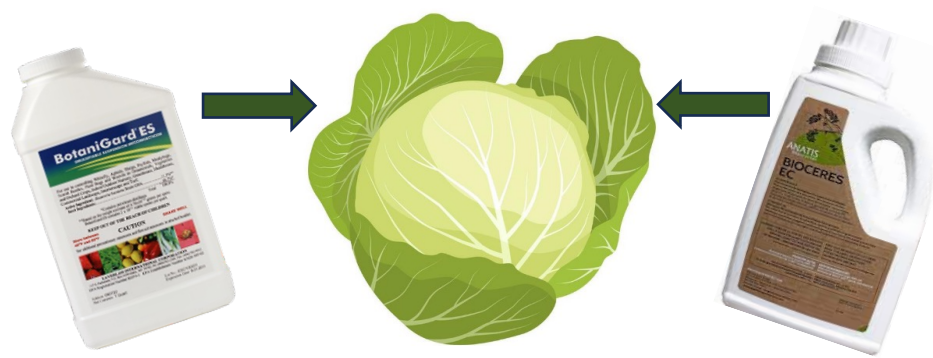









Fig. 1. Commercial formulations of *B. bassiana* in BotaniGard and BioCeres.

## Methods

**Experimental design:** Randomized complete block as a two-factor factorial with four replicates; Factor 1: BioCeres, BotaniGard, untreated. Factor 2: *P. brassicae* inoculum at 0, 1 x 10<sup>5</sup>, 1 x 10<sup>6</sup>, and 1 x 10<sup>7</sup> spore/mL, 5 mL per plant (Fig. 2)

Fig. 2. Cabbage plants in growth room study and clubroot symptoms on cabbage roots.



-  ➤ Cv. Bronco cabbage planted in plug trays in growth room
-  ➤ Drench with BotaniGard (8 mL L<sup>-1</sup>) or BioCeres (10 mL L<sup>-1</sup>) at the 2-leaf stage (500 mL tray<sup>-1</sup>)
-  ➤ Seedlings (4<sup>th</sup> leaf) transplanted to containers (Fig. 2)
-  ➤ Seedlings inoculated with 5 mL of 1 x 10<sup>5</sup>, 1 x 10<sup>6</sup> and 1 x 10<sup>7</sup> resting spore suspension of *P. brassicae* or control.
-  ➤ Cabbage harvested 6 weeks after inoculation and assessed for disease severity on the standard 0–3 scale to calculate the disease severity index (DSI) (Fig. 2)
-  ➤ Tissue samples of each treatment collected and plated on PDA to assess colonization by *B. bassiana* root and leaves
-  ➤ Statistical analysis, two-factor ANOVA and LS means separation using Tukey's test.

## Results

- Clubroot severity was highest with the highest conc. of *P. brassicae*, as expected (Fig. 3).
- There was an interaction between *P. brassicae* inoculum concentration and *B. bassiana* treatment under in the growth room study.
- Drench appl. of BotaniGard reduced clubroot severity at all concentrations of *P. brassicae*; BioCeres reduced severity only at 10<sup>5</sup> (Fig. 3).
- Isolations demonstrated that *B. bassiana* was present in leaf and root cuttings of cabbage plants

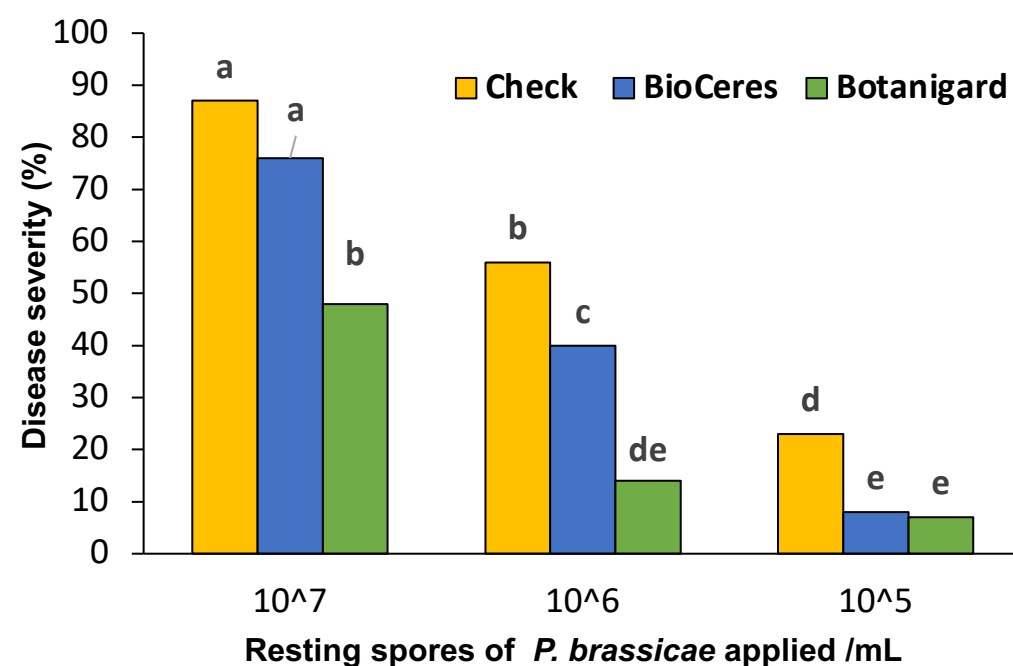


Fig. 3. Clubroot severity (disease severity index) on cabbage treated with formulations of *Beauveria bassiana*, BioCeres and BotaniGard, and inoculated with three concentrations of resting spores of *Plasmodiophora brassicae*. Bars topped with the same letter are not different at  $P = 0.05$ .

## Discussion and Conclusion

- BotaniGard, and to a lesser extent, BioCeres, reduced clubroot severity on cabbage
- Both products more effective at lower disease pressure
- Plants treated with BotaniGard had visually less insect damage and greater biomass than other treatments
- Endophyte growth was confirmed in leaf and root tissue samples
- This approach has potential for use on other Brassica crops, including canola

## Acknowledgements

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