

Pathogenicity of *Ilyonectria mors-panacis* on American Ginseng Using Chlorophyll Fluorescence Measurements

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Introduction

- American ginseng, *Panax quinquefolius* L., cultivation is negatively impacted by ginseng replant disease (GRD) – a fungal root rot, primarily caused by *Ilyonectria mors-panacis* (*Imp*) (formerly *Cylindrocarpon destructans*), when former-ginseng gardens are used.
- Bioactive ginsenosides produced by ginseng accumulate in ginseng garden soils during cultivation and are growth stimulants of *Imp*.
- Presently, it is not clear if (1) prior exposure to ginseng enhances *Imp* virulence, (2) different *Imp* isolates are affected by ginsenosides equally, and (3) there is a relationship between *Imp* virulence and ginsenoside exposure.
- To address these **three** questions, we obtained 12 *Imp* isolates from various geographic regions and host plants (Table 1)¹. Herein we confirm their virulence towards American ginseng.

Methods

- One-year old American ginseng seedlings were inoculated with one of twelve *Imp* isolates (Table 1) and monitored for disease onset (Figure 1). Non-invasive chlorophyll fluorescence (F_v/F_m) was measured daily for 28-days using Opti-Sciences OS30p+ fluorometer (Opti-Science, Inc) (Figure 2)². Disease load was also scored on a five-point scale at 28-days post infection (dpi) using a disease severity index (Figure 3 & 4)².

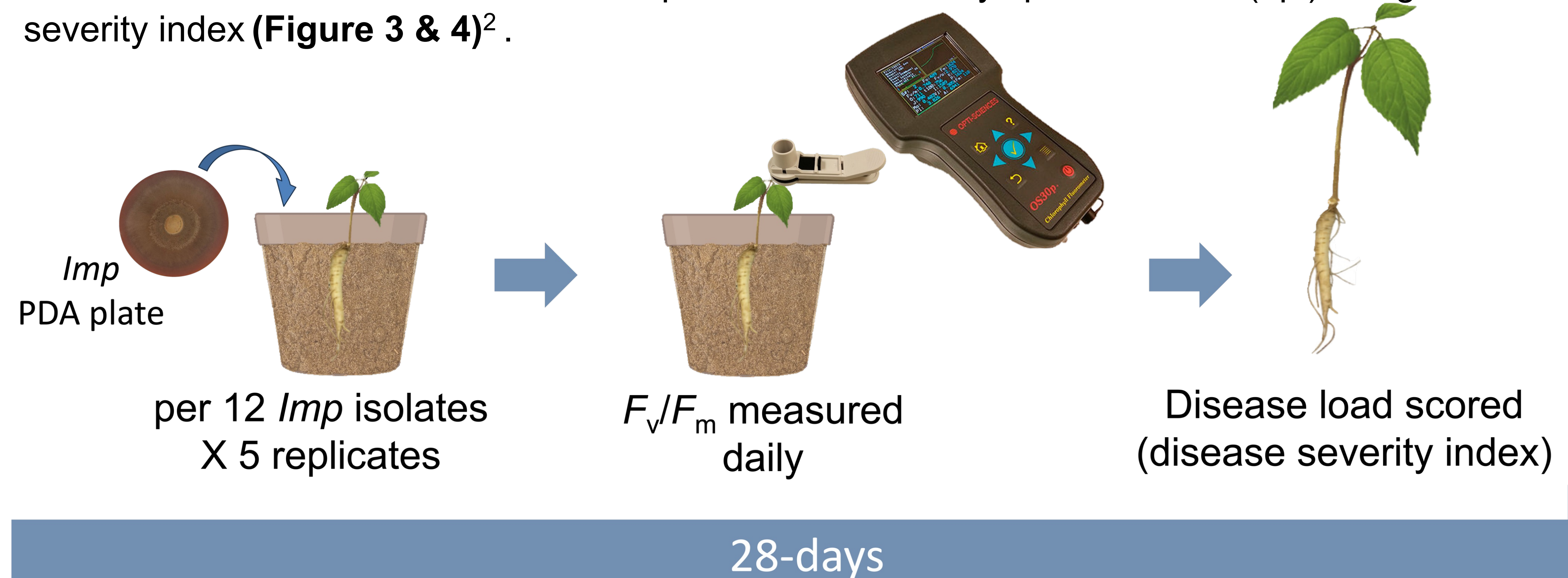


Figure 1. Schematic representation of American ginseng seedlings inoculated with one plate of one of twelve *Imp* isolate treatments or non-inoculated with one PDA plate (control) ($N = 4 - 5$) in four-inch pots filled with sterile construction sand (Bomix). F_v/F_m was measured daily for 28-days and disease load was scored at 28-dpi.

Results and Discussion

Table 1. Twelve *Imp* isolates. Collection code (DAOMC), host plant, and location, were obtained from Canadian Collection of Fungal Cultures (CCFC).

Collection Code (DAOMC)	Host Plant	Location
226721	<i>Pseudotsuga menziesii</i> (Douglas fir)	British Columbia, Canada
251609	<i>Picea glauca</i> (White Spruce)	Quebec, Ontario
251610	<i>Panax quinquefolius</i> (American ginseng)	Ontario, Canada
150670	<i>Poa pratensis</i> (Blue grass)	Alberta, Canada
251608	<i>Pseudotsuga menziesii</i> (Douglas fir)	British Columbia, Canada
139398	<i>Prunus cerasus</i> (Montmorency sour cherry)	Ontario, Canada
251602	<i>Panax quinquefolius</i> (American ginseng)	Ontario, Canada
251603	<i>Panax quinquefolius</i> (American ginseng)	Ontario, Canada
230337	<i>Panax</i> sp.	Nagano Prefecture, Japan
230338	<i>Panax</i> sp.	Nagano Prefecture, Japan
234582	<i>Panax quinquefolius</i> (American ginseng)	Ontario, Canada
251601	<i>Panax quinquefolius</i> (American ginseng)	Ontario, Canada

- When compared to non-inoculated American ginseng seedlings (control), five *Imp* isolates were avirulent (226721, 251609, 251610, 150670, 251608) and seven *Imp* isolates were virulent (139398, 251602, 251603, 230337, 230338, 234582, 251601), when using a one-way ANOVA with Dunnett's post-hoc test for both average F_v/F_m at 28 days dpi (Figure 2) and average disease severity at 28-days dpi (Figure 4).



Figure 3. Representative images of American ginseng seedlings scored using disease severity index (1 – 5)².

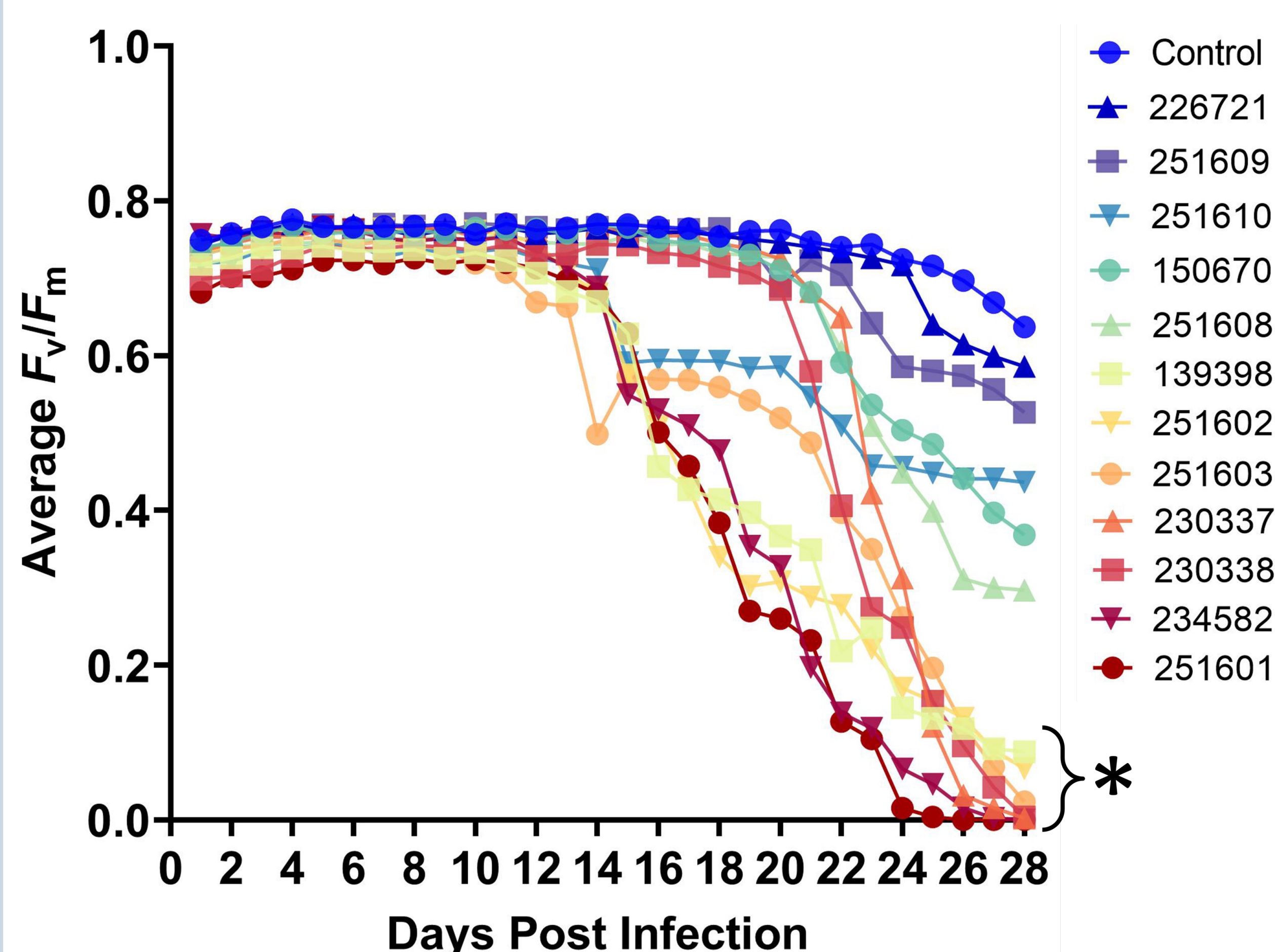


Figure 2. Daily average F_v/F_m measurements for one-year old American ginseng seedlings inoculated with one of twelve *Imp* isolates or non-inoculated (control). Statistical analysis was done for measurements at 28-dpi using one-way ANOVA with Dunnett's post-hoc test, * $p < 0.05$.

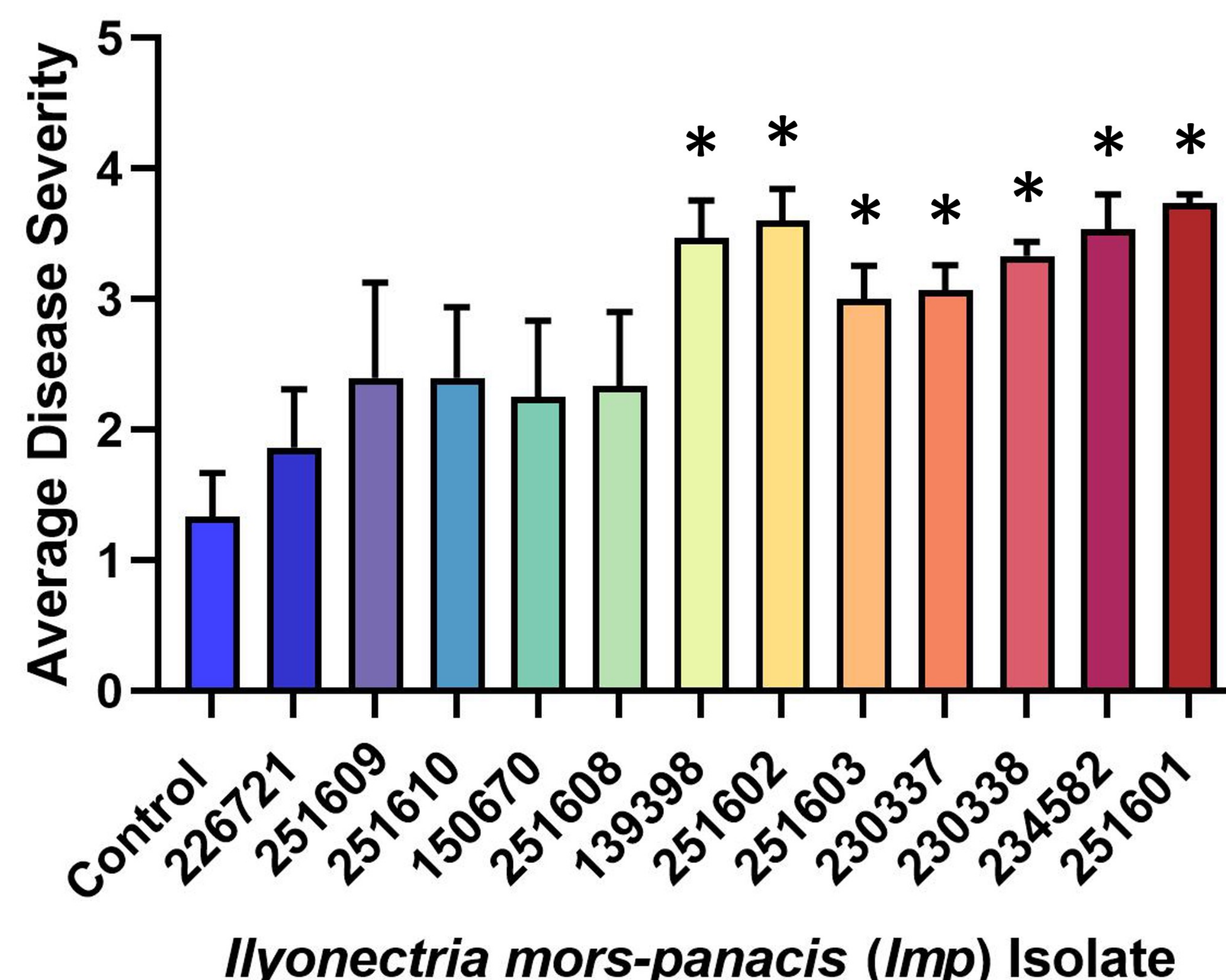


Figure 4. Average disease severity measured at 28-dpi using a disease severity index² for one-year old American ginseng seedlings inoculated with one of twelve *Imp* isolates or non-inoculated (control). Values were calculated as mean \pm SE. Statistical analysis using one-way ANOVA with Dunnett's post-hoc test, * $p < 0.05$.

Conclusion

- With the exception of *Imp* 251610 and *Imp* 139398, these results address our first (1) question, in which *Imp* isolates previously exposed to ginseng, are virulent towards ginseng.
- This data will support future experiments to answer our **two** remaining questions and ultimately further our understanding of *Imp* and its implications in GRD.

Acknowledgements



References

- Seifert *et al.* (2003). *Population Biology*. **93**(12): 1533 – 1542.
- Ivanov and Bernards (2012). *Phytochemistry*. **78**: 44 – 53.