

**Expression of resistance to
Leptosphaeria maculans conferred by
major gene resistance in *Brassica napus*.**

Angela Van de Wouw¹, Vicki Elliott² and Steve
Marcroft²

¹School of Botany, University of Melbourne;

²Marcroft Grains Pathology



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Grains Research and Development Corporation



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Resistance to *L. maculans* conferred by major and minor resistance

- Blackleg disease results in 5-10% yield losses annually, up to 95% yield loss
- Control strategies include breeding for resistance
- Two types of resistance
 - Seedling (major or single gene)
 - Adult plant genes (minor gene resistance)



No resistance
= disease



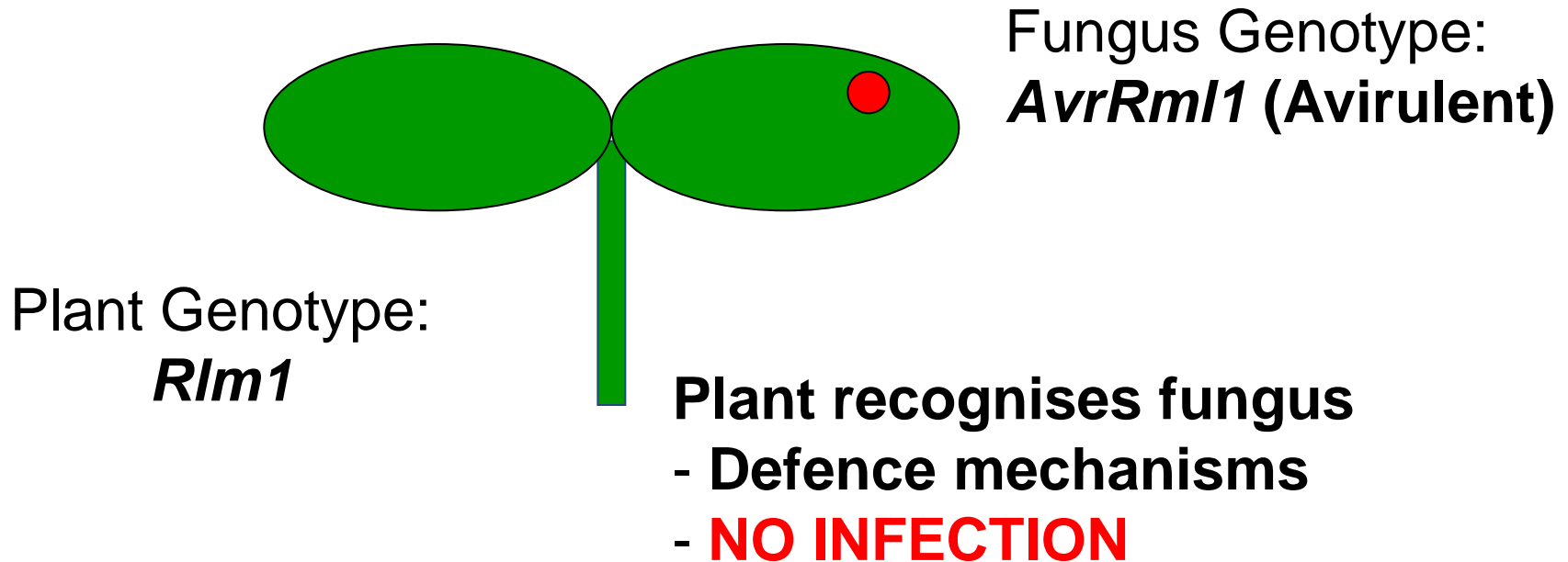
Seedling resistance
= no disease



Adult resistance
= some disease

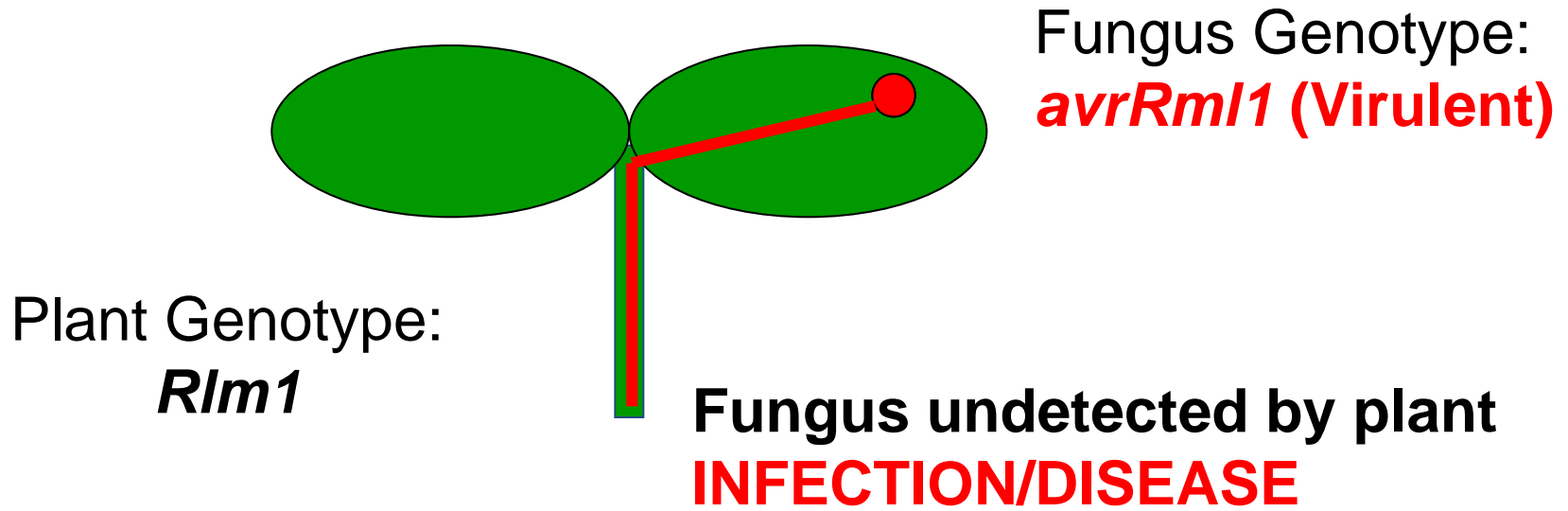
Seedling (major gene resistance) is a gene-for gene interaction

- Plant contains resistance genes (R genes)
- Pathogen contains avirulence genes (Avr genes) corresponding to R genes



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Is seedling resistance only expressed at the seedling stage?

- Inoculated by wounding and applying droplet of spores on:
 - Cotyledon
 - First four true leaves
 - 5-10 leaf stages
 - Pods
 - Stems
- Cultivars: AV-Garnet (*Rlm1*) and CB Telfer (*Rlm4*)
- Isolates: D13 (*avrLm1*, *AvrLm4*) and D14 (*AvrLm1*, *avrLm4*)

Isolates D13 and D14 differentiate major gene resistance at the cotyledon stage

cv. AV-Garnet
(*Rlm1*)

cv. CB Telfer
(*Rlm4*)

D13
(*avrLm1*; *AvrLm4*)

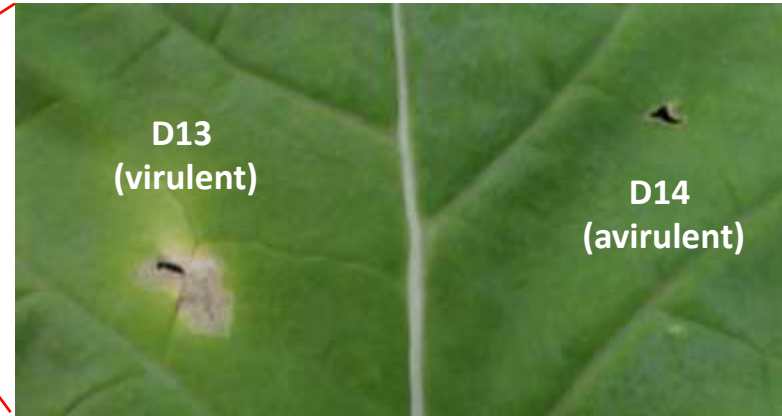
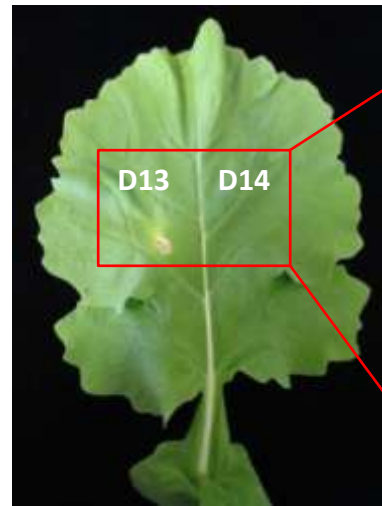


D14
(*AvrLm1*; *avrLm4*)

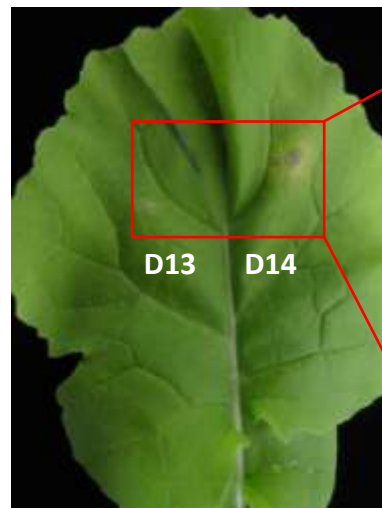


Similar responses to isolates D13 and D14 on leaves to those on cotyledons

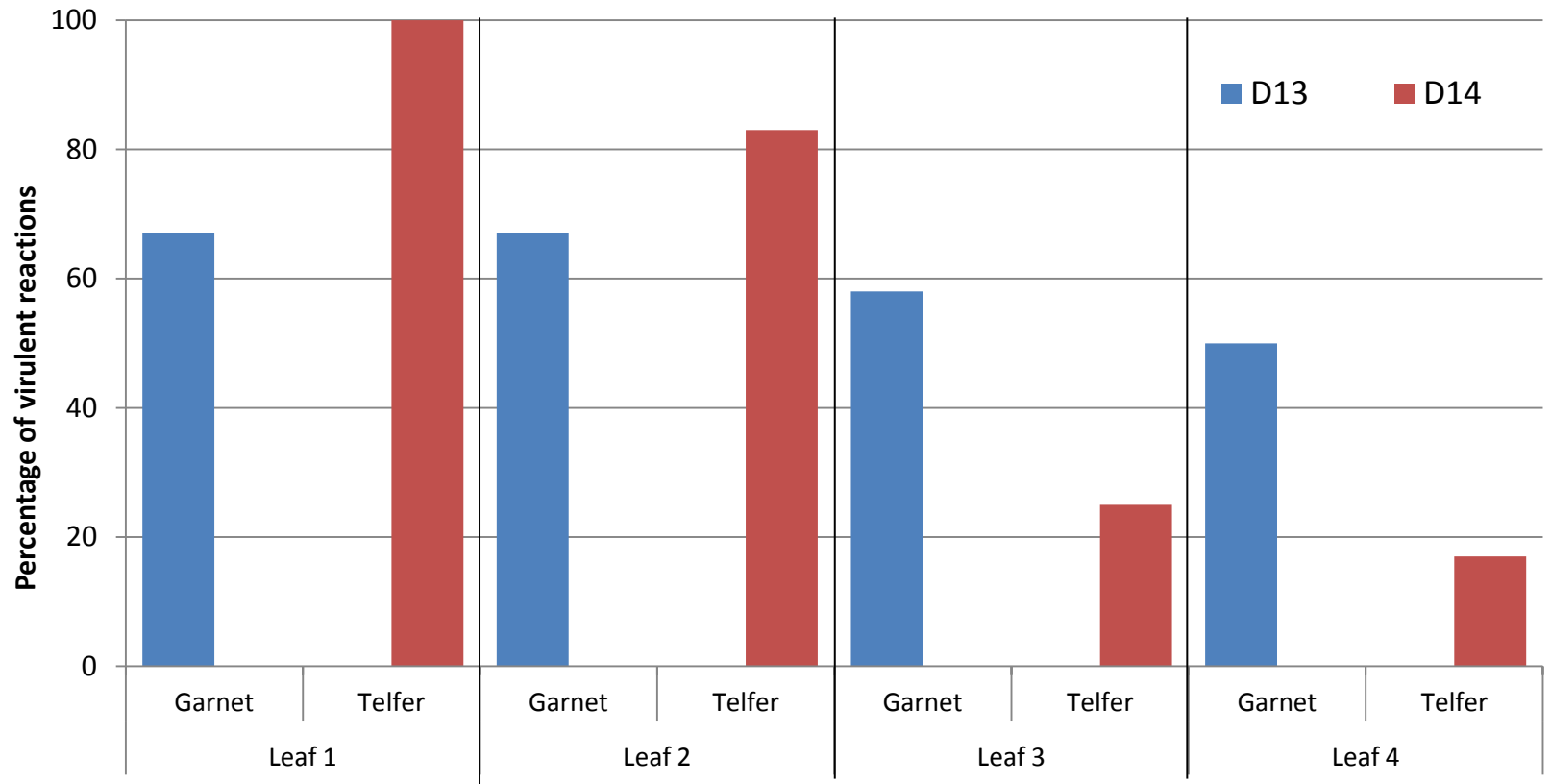
cv. AV-Garnet
(*Rlm1*)



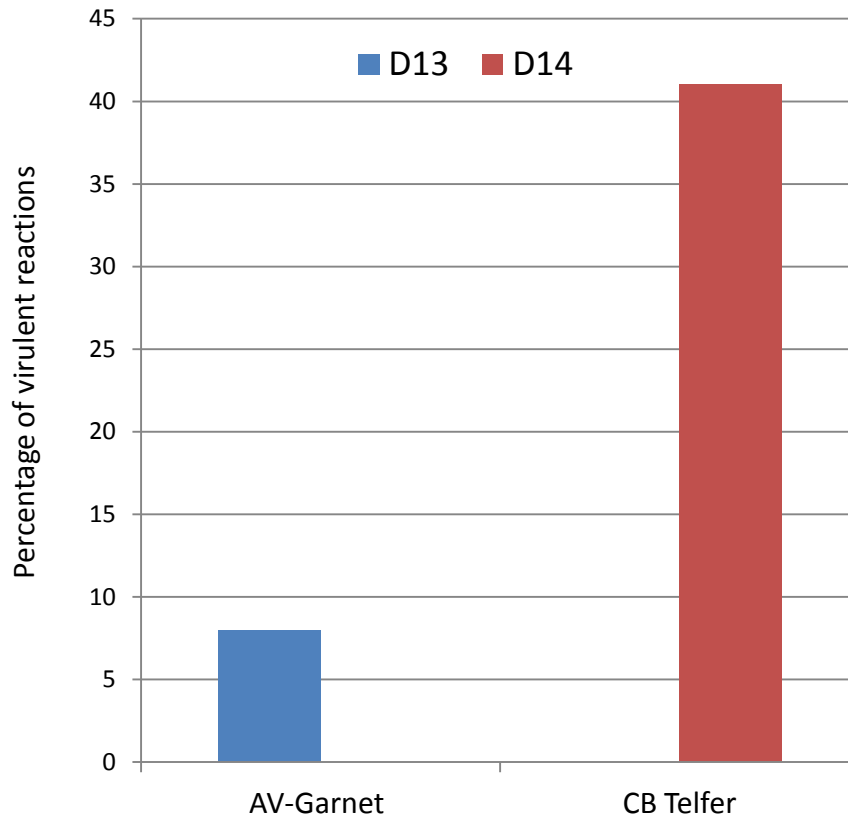
cv. CB Telfer
(*Rlm4*)



Leaf lesions only observed for the virulent isolate on the first 4 true leaves



Leaf lesions were observed for only the virulent isolate in all leaf stages tested



- All leaves from 5-10 leaf stages were inoculated with both isolates
- Low percentage of virulent reactions for both cultivars
 - AV-Garnet leaves very waxy
- No lesion development with avirulent isolate

Over 100 leaves across 12 plants tested for each cultivar



Pods were inoculated with each isolate in the glasshouse

- Pods of cv. CB-Telfer were inoculated with isolate D13 or D14
- Each isolate was inoculated onto 24 pods spread across three plants
- Lesion development was scored 17 dpi



Lesions on exterior of pod



Lesions on interior of pod



D13
(*AvrLm4*)

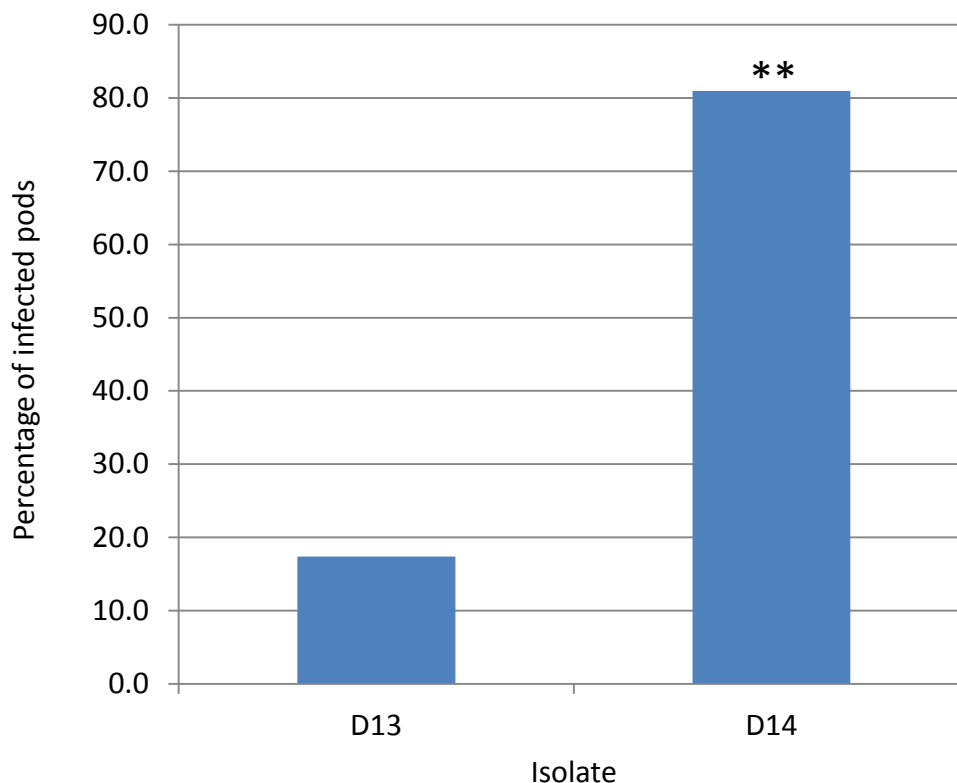


D14
(*avrLm4*)



cv. CB Telfer (*Rlm4*)

Lesions were observed on over 80% of pods inoculated with the virulent isolate



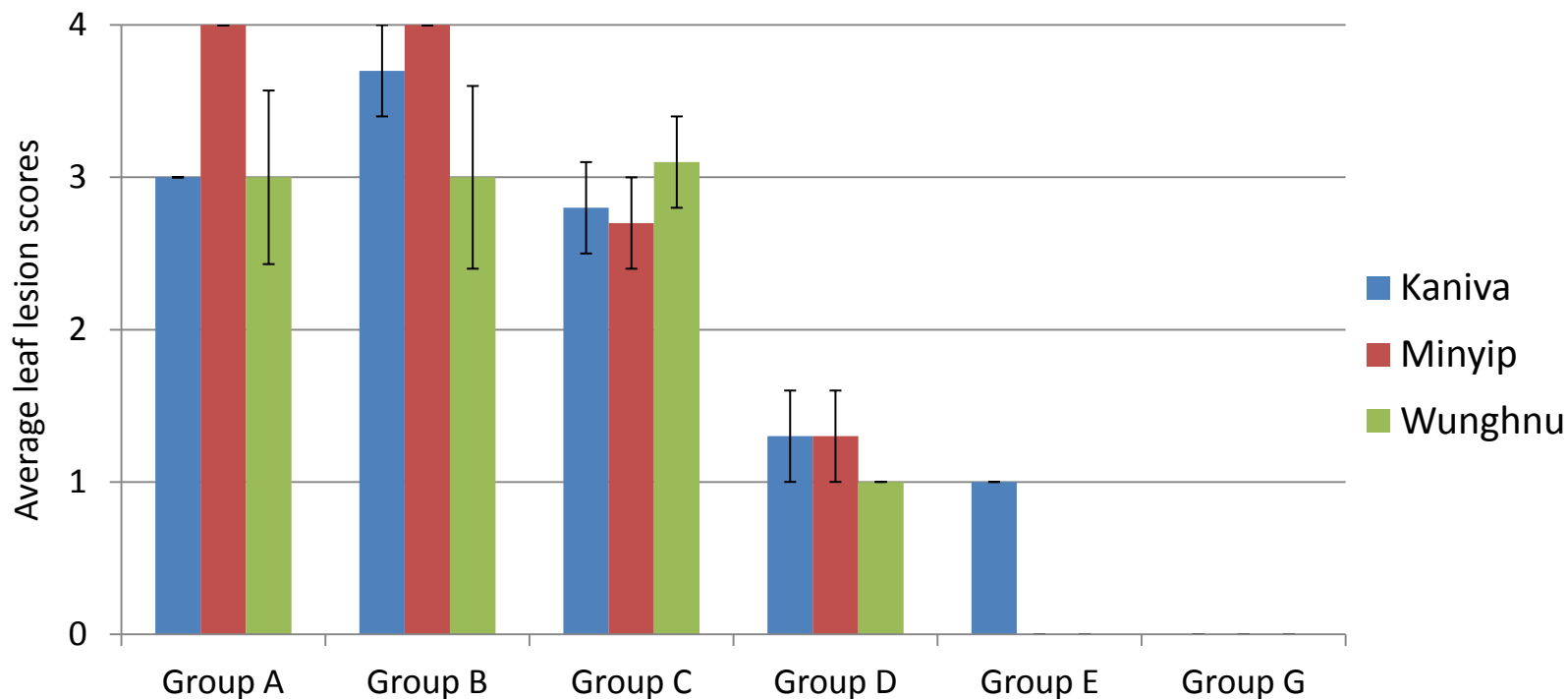
D14 (virulent isolate) caused significantly more lesions on pods than the avirulent isolate (D13) ($p < 0.001$)

Gene-for-gene interactions were also assessed in the field

- Leaf lesions were scored (0-4 scale) at blackleg monitoring sites in Victoria
- Plants at different sites were at different growth stages
 - Streatham: 5 - 6 leaf
 - Minyip: 4 - 6 leaf
 - Wunghnu: 8 leaf - bud

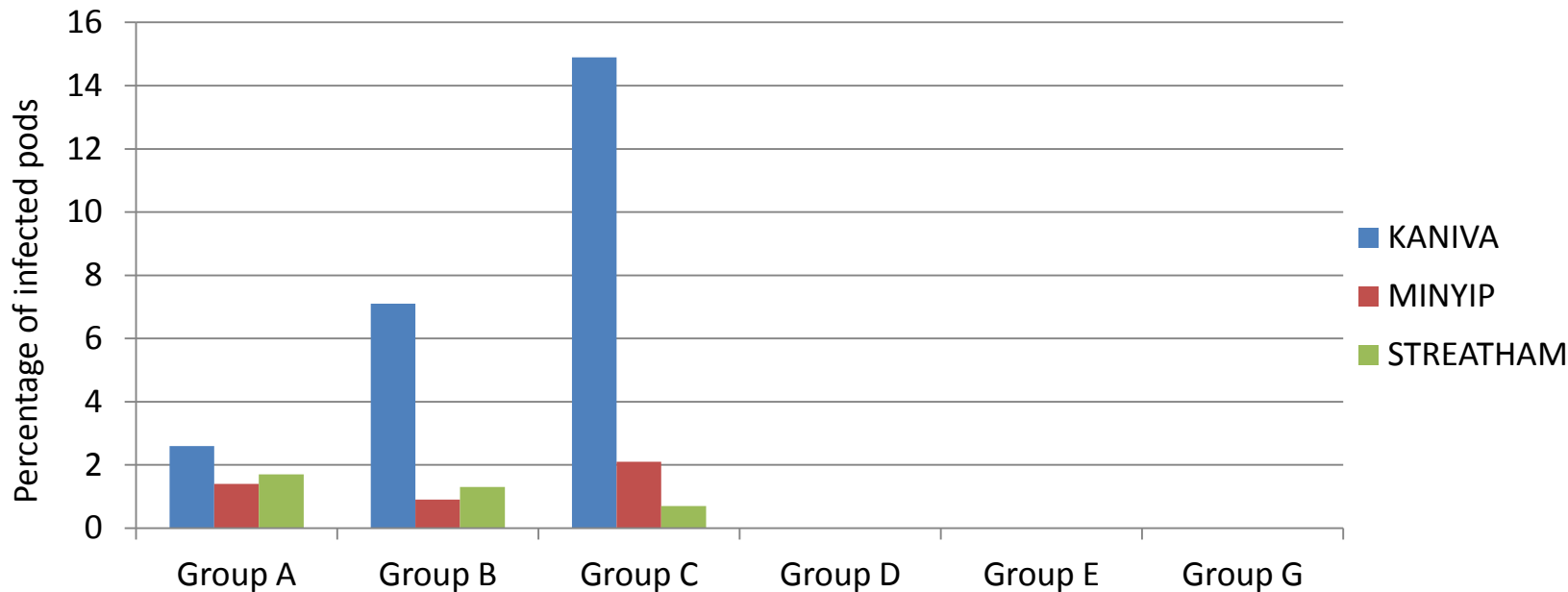


Field results are consistent with glasshouse results



Leaf lesions only observed in cultivars with 'ineffective' major gene resistance.

Pod infection data from the field is consistent with glasshouse results



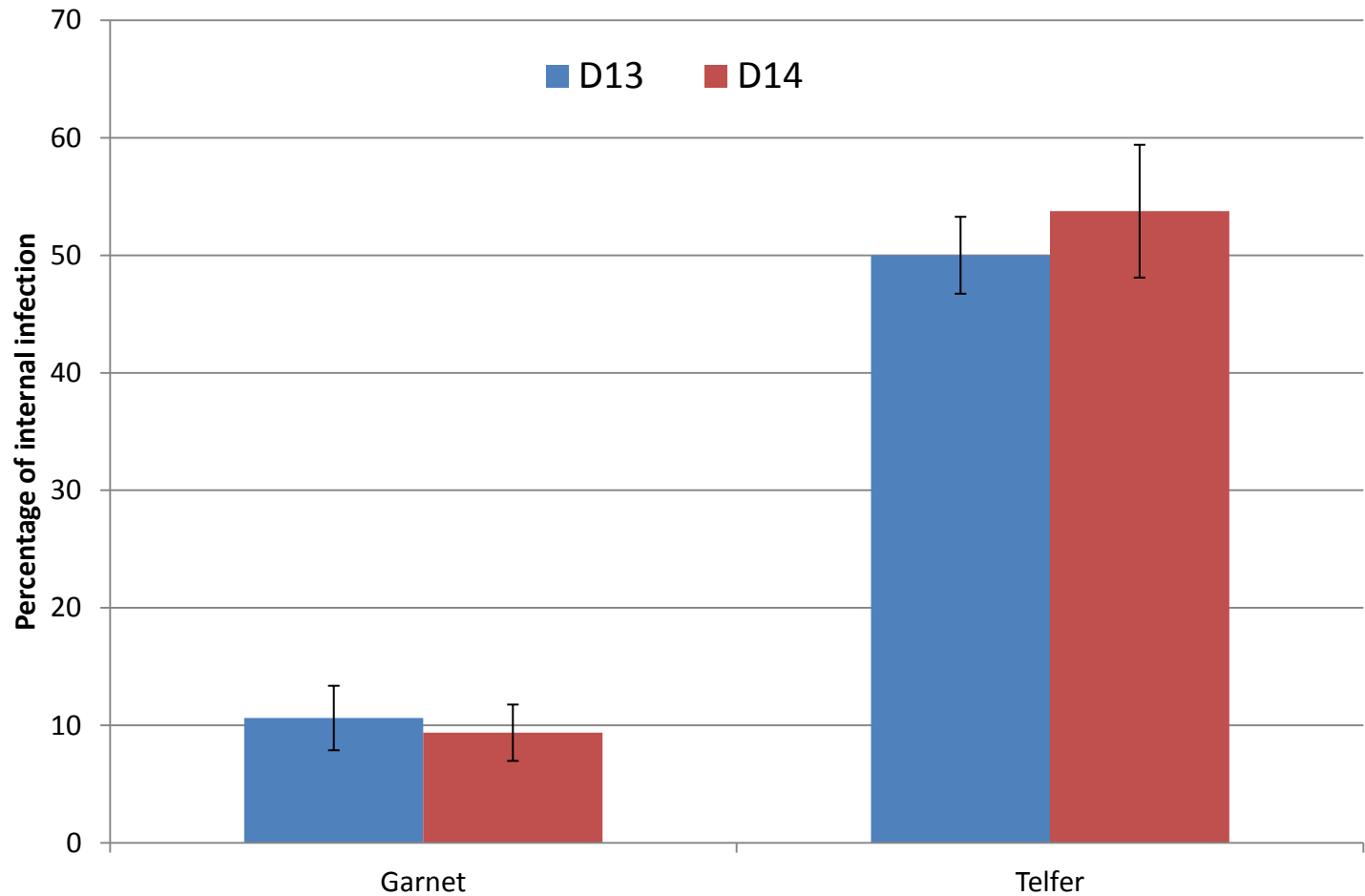
Pod infection was only observed on cultivars with ineffective major gene resistance.

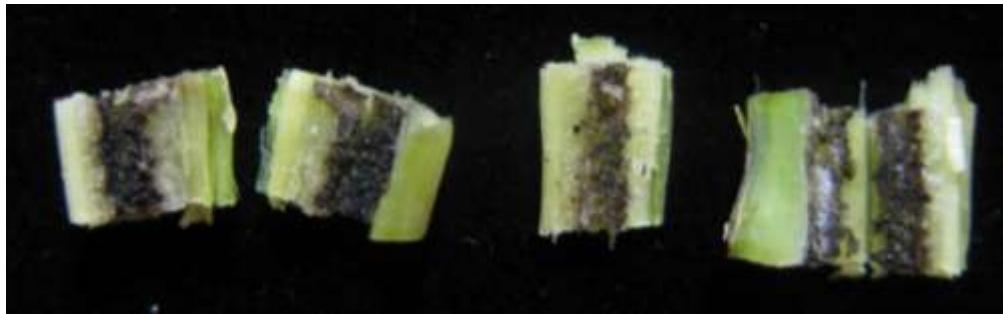
Expression of major gene resistance in stems?

- Stems of AV-Garnet and CB Telfer were inoculated at the axil of the oldest leaf with isolates D13 or D14
 - AV-Garnet = stem elongation
 - CB Telfer = setting pods
- 8 weeks post inoculation, stems cut at the inoculation site and crown and assessed for internal infection

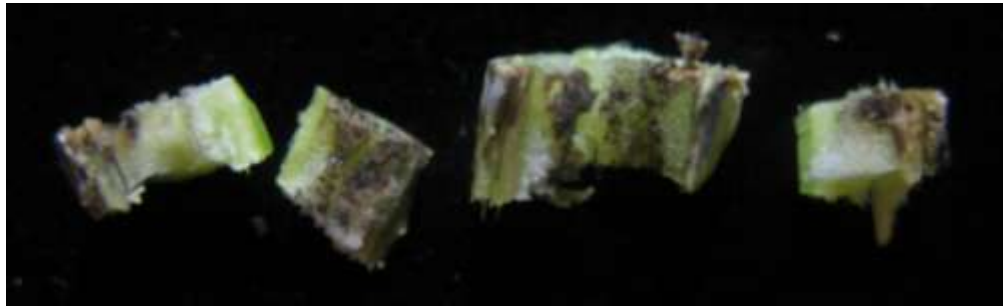


Major gene resistance not expressed in stems





D13 (*AvrLm4*)
cv. CB Telfer (*Rlm4*)



D14 (*avrLm4*)
cv. CB Telfer (*Rlm4*)



D13 (*avrLm1*)
cv. AV-Garnet (*Rlm1*)



D14 (*AvrLm1*)
cv. AV-Garnet (*Rlm1*)

Conclusions

- ‘Gene-for-gene’ interaction (major gene resistance) evident at cotyledon, all leaf stages and pods
 - Need to abolish term seedling resistance
- Gene-for-gene interaction appears to be lacking when stems are directly inoculated
 - Is major gene resistance not expressed in the stem or is it bypassed?
 - Can this method to assess minor gene resistance?

