

Rating Clubroot Resistance

S.E. Strelkov

Plant Pathology Sub-Committee



Background

- A *clear, accurate & consistent* definition of clubroot resistance is needed to guide breeding efforts & evaluate claims
- Produced set of “clubroot resistance screening guidelines and protocols” for the WCC/RRC
 - General agreement, but questions still need to be answered
- *Focus of this talk:*
 - *Evaluating host reactions*
 - *Rationale for designations*
 - *Identifying gaps*

Evaluating Host Reactions

- Has proven problematic in the literature
 - Host genotypes are rarely completely immune
 - Wide range of host reactions often observed



General Approach

- **Assign disease ratings to individual plants**
- **Calculate a “disease index” or “index of disease” for group as a whole**
 - **Number of different rating scales have been proposed (0 to 9; 0 to 4; 0 to 3)**
 - **Several formulas for calculating ID also developed (fairly similar)**

Rating System in Canada

- **We adopted a 0-3 scale, based on Kuginuki et al. (1999)**
 - **Amongst most commonly used in literature**
 - **In the scales with many categories (0-9), most reactions tended to be grouped into just a few groups**
 - **Published extensively using this scale**
 - **Strelkov et al. 2006, 2007; Cao et al. 2007; Xue et al. 2008, etc.**

Clubroot Rating Scale

0 = no galling

1 = a few small galls (small galls on $<1/3$ of roots)

2 = moderate galling (small to medium galls on $1/3 - 2/3$ of roots)

3 = severe galling (medium to large galls on $> 2/3$ of roots)

**Based on Kuginuki et al. (1999) as modified
by Xue et al. (2008)**

Clubroot Rating Scale



0

1

2

3

Individual scores then used to obtain an Index of Disease for group of plants

Index of Disease (ID)

- **Individual scores used to calculate an ID according to formula of Horiuchi & Hori (1980) as modified by Strelkov et al. (2006):**

$$ID(\%) = \frac{\sum (n \times 0 + n \times 1 + n \times 2 + n \times 3)}{N \times 3} \times 100\%$$

Where: n is number of plants in a class; N is total number of plants; and 0, 1, 2 and 3 are the symptom severity classes

Index of Disease

- **Captures range of reactions:**
 - 0% (no disease) → 100% (completely susceptible)
- **What ID corresponds to resistance?**

Resistant vs. Susceptible

- Numerous methods have been used to differentiate resistant vs. susceptible reactions
 - ID $\leq 20\%$ resistant, $\geq 80\%$ susceptible, 20-80% indistinct
 - ID $< 50\%$ or $< 25\%$ is resistant
 - LSD
 - *Suggested multiple categories (R, MR, MS, S) to reflect range of reactions*

Classification of Host Reactions

- Initial recommendation to Plant Pathology Sub-Committee of WCC/RRC:

ID < 30% of check = Resistant (R)

ID 30-49% = Moderately Resistant (MR)

ID 50-69% = Moderately Susceptible (MS)

ID \geq 70% = Susceptible (S)

- Sub-Committee did not approve of MR & MS classifications in absence of yield loss data

Classification of Host Reactions

- In absence of yield loss data, recommended 3 classifications:

ID < 30% of check = Resistant (R)

ID 30-69% = Intermediate (I)

ID ≥ 70% = Susceptible (S)

Clubroot trials will be accepted when ID of susceptible check > 60%

Effect of Clubroot on Canola Yields

- **Pageau et al. (2006):**
 - **Severe infection resulted in yield losses > 80%**
- **Wallenhammar et al. (1999):**
 - **Infestations of 91% caused 50% yield loss, infestations of less than 20% caused 10% loss**
 - **Referred to incidence, not severity!**

Clubroot and Yield Loss

- **Need to establish the yield loss-clubroot severity relationship for canola in Canadian context**
 - Part of the “vision”
 - Pioneer Hi-Bred providing lines with differential reactions
- *Provide guidance when evaluating canola lines for resistance claims, more informative for growers and industry*

Conclusion

- **Well-developed system for assessing clubroot reactions**
- **Less clarity on what constitutes resistance, especially for variety evaluation**
- **Require a yield loss model for canola**