# Screening of *Brassica* Germplasms for Resistance to *Plasmodiophora brassicae* Pathotypes Prevalent in Canada

**Muhammad Jakir Hasan, Stephen E. Strelkov and M. Habibur Rahman**

Department of Agricultural, Food and Nutritional Science, University of Alberta, Agriculture-Forestry Centre, Edmonton, AB, Canada, T6G 2P5

## Introduction

*Plasmodiophora brassicae* causes clubroot disease in *Brassica* (Woronin 1878). In Canadian canola fields, this disease was reported for the first time in 2003 in Alberta (Tewari et al. 2005). It has also been reported to cause significant reduction in yield of this crop (Strelkov et al. 2007).

All Canadian canola (*Brassica napus*) cultivars are susceptible to this disease, except few cultivars recently developed by Pioneer Hi-Bred Intl. Inc. and Monsanto. However, breakdown of single gene resistance to this disease has been reported elsewhere in the world. Therefore, breeding of canola cultivars with durable resistance is needed, and this would require diversity in resistance.

## Objective

Evaluation of the *Brassica* germplasms for resistance to the Canadian *Plasmodiophora brassicae* pathotypes.

## Materials and Methods

### Germplasms

A total of 275 *Brassica* genotypes which includes 36 *B. rapa* (AA), 49 *B. oleracea* (CC); 77 *B. nigra* (BB), 41 *B. napus* (AACC), 48 *B. juncea* (AABB) and 24 *B. carinata* (BBCC) were evaluated.

### *Plasmodiophora brassicae*

Single-spore derived isolates of Canadian *P. brassicae* pathotypes 2, 3, 5, 6 and 8 (Xue et al. 2008) were used.

### Inoculation

Root-dip method was applied (Nieuwhof and Wiering 1961). For this, roots of seven days old seedlings were dipped in resting spore suspension with conc. of 1.0 × $10^7$ spore/mL for 10 seconds. Inoculated seedlings were grown in greenhouse at 21±1°C with 16/8 hours (day/night) photoperiod. Chinese cabbage cultivar 'Granaat' (ECD-5) was used as susceptible control.

### Scoring for resistance

Seedlings were scored at 42-45 days after inoculation and was rated on a 0 to 3 scale (Kuginuki et al. 1999) (Figure 1).

### Experiment 1

All 275 *Brassica* genotypes were inoculated with *P. brassicae* pathotypes 2, 3, 5, 6 and 8 in non-replicated experiment. Nine seedlings of each genotype was challenged against each pathotype.

### Experiment 2

Fifty-nine *Brassica* genotypes showing resistance to multiple pathotypes in Experiment 1 were evaluated against pathotypes 3 and 5 in three-replication experiment. Eighteen seedlings was used in each replication.

Index of Disease (ID) was calculated using the method described by Horiuchi and Hori (1980) and Modified by Strelkov et al. (2006)

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

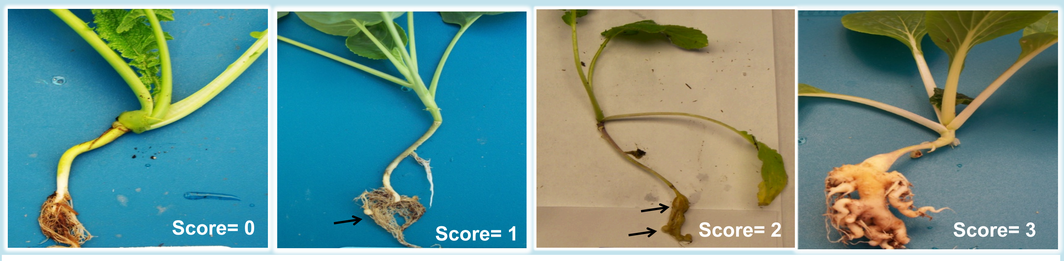


**Figure 1:** Severity classes for clubroot disease in *Brassica* genotypes based on gall development (**Score 0**= No gall; **Score 1**= One or few small galls on lateral roots; **Score 2**= Moderate galling on lateral roots; **Score 3**= Sever galling on lateral roots or in main root)

## Results

**Table 1**: Summary of resistance in *Brassica* genotypes to Canadian *Plasmodiophora brassicae* pathotypes (Experiment 1)

| Species | Total no. of genotype | No. of genotype showed resistance to *P. brassicae* pathotype | | | | |
|---|---|---|---|---|---|---|
| | | Path 2 | Path 3 | Path 5 | Path 6 | Path 8 |
| *Brassica rapa* var. *rapifera* | 5 | 5 | 5 | 5 | 5 | 5 |
| *B. rapa* var. *chinensis* | 8 | 1 | 1 | 2 | 1 | 1 |
| *B. rapa* var. *pekinensis* | 5 | 0 | 0 | 0 | 0 | 0 |
| *B. rapa* var. *oleifera* (Winter type) | 9 | 6 | 9 | 9 | 9 | 9 |
| *B. rapa* var. *oleifera* (Spring type) | 9 | 0 | 0 | 0 | 3 | 3 |
| *Brassica oleracea* var. *capitata* | 16 | 1 | 3 | 2 | 1 | 2 |
| *B. oleracea* var. *botrytis* | 14 | 0 | 0 | 0 | 0 | 0 |
| *B. oleracea* var. *italica* | 13 | 0 | 0 | 0 | 0 | 0 |
| *B. oleracea* var. *gemmifera* | 3 | 0 | 2 | 1 | 0 | 0 |
| *B. oleracea* var. *alboglabra* | 2 | 0 | 0 | 0 | 0 | 0 |
| *B. oleracea* var. *villosa* | 1 | 0 | 0 | 0 | 0 | 0 |
| *Brassica nigra* (different subsp.) | 77 | 67 | 70 | 67 | 68 | 70 |
| *B. napus* var. *napus* | 36 | 29 | 3 | 1 | 27 | 32 |
| *B. napus* var. *napobrassica* | 5 | 5 | 3 | 4 | 5 | 5 |
| *Brassica juncea* | 48 | 0 | 0 | 0 | 0 | 0 |
| *Brassica carinata* | 24 | 0 | 0 | 0 | 0 | 0 |

A total of 17 *B. rapa*, 13 *B. oleracea*, 21 *B. nigra* and 8 *B. napus* genotypes were selected for evaluation against pathotypes 3 and 5 in Experiment 2.

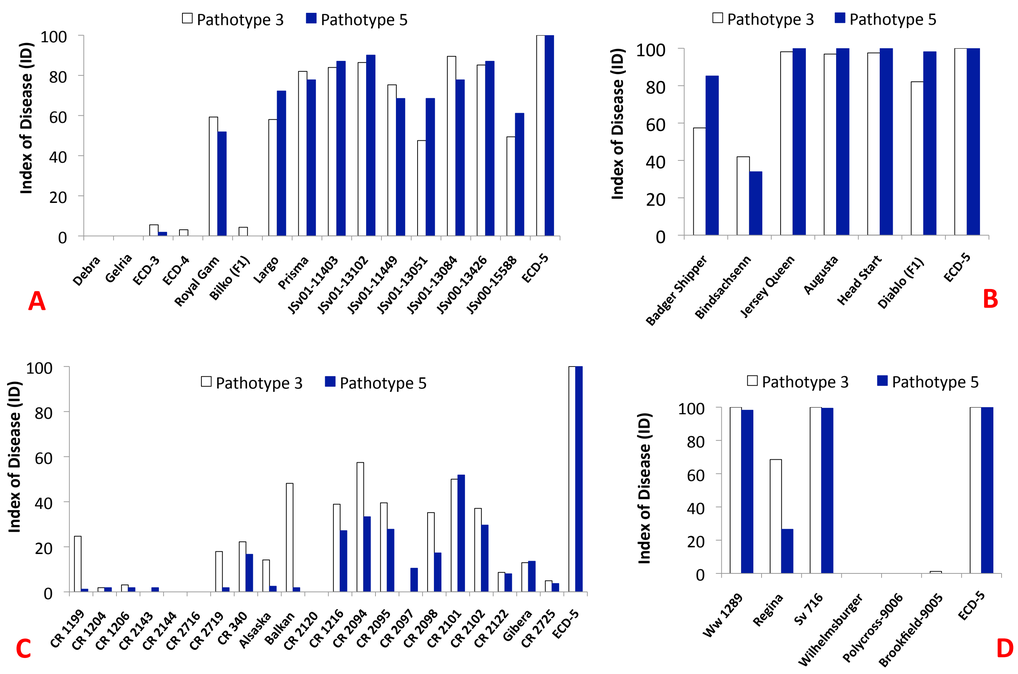


**Figure 2**: Resistance reaction of *Brassica* genotypes to single-spore isolates of *Plasmodiophora brassicae* pathotype 3 and pathotype 5; A= *B. rapa*; B= *B. oleracea*; C= *B. nigra*; D= *B. napus* (Experiment 2).

- *Brassica napus* var. *napobrassica* genotypes 'Wilhelmsburger', 'Brookfield-9005' and 'Polycross-9006' showed broad-spectrum resistance to all *P. brassicae* pathotypes and were homogeneous for resistance.
- *B. rapa* var. *rapifera* genotypes 'Debra', 'Gelria', 'ECD-3', 'ECD-4' and *B. rapa* var. *chinensis* cv. 'Bilko ($F_1$)' were also homogeneous for resistance to all pathotypes.
- Resistance in *B. oleracea* genotypes was low.
- Most *B. nigra* genotypes possess broad-spectrum resistance to the *P. brassicae* pathotypes.

## Conclusion

Among the six *Brassica* species, good resistance was found in the diploid *B. rapa* and in *B. nigra*, whereas rutabaga form of *B. napus* was the only amphidiploid found to carry broad-spectrum resistance to all pathotypes.

## Literature cited

Horiuchi, S and Hori, M. 1980. *Bull. Chugoku Natl. Agric. Expt. Stan.* 17: 33-55.
Kuginuki et al. 1999. *Eur. J. Plant Path.* 105: 327-332.
Nieuwhof, M and Wiering, D. 1961. *Euphytica* 10: 191-200.
Strelkov et al. 2007. *J. Phytopathol.* 155: 706-712.
Strelkov et al. 2006. *Can. J. Plant Pathol.* 28: 467-474.
Tewari et al. 2005. *Can. J. Plant Pathol.* 27: 143-144.
Woronin, M. 1878. *Jahrb Wissenschaftl Bot*. 11: 548-574.
Xue et al. 2008. *Plant Dis*. 92: 456-462

## Acknowledgements

**For Germplasms**

- Bangladesh Agricultural University (BAU), Bangladesh
- Bangladesh Agricultural Research Institute (BARI), Bangladesh
- Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh
- Dr. Dean Spaner, Professor, University of Alberta
- Dr. Ronald J. Howard, Alberta Agriculture, Food & Rural Development
- Green Gene International, United Kingdom
- Leibniz Institute of Plant Genetics and Crop Plant Research, Germany
- United States Department of Agriculture (USDA)

**For Fund**

Alberta Canola Producers Commission (ACPC)

Alberta Crop Industry Development Fund (ACIDF)