

Identification of resistance to *Albugo candida* in Indian, Australian and Chinese *Brassica juncea* genotypes

LI Caixia¹, Krishnapillai Sivasithamparam², Graham Walton³, Allison Gurung⁴, Phil Salisbury⁴, Wayne Burton⁵, Surinder Banga⁶, Shashi Banga⁶, Chirantan Chattopadhyay⁷, Arvind Kumar⁷, Rajender Singh⁸, Singh Dhiraj⁸, Abha Agnohotri⁹, LIU Shengyi¹⁰, LI Yunchang¹⁰, FU Tingdong¹¹, Martin Barbetti¹

¹School of Plant Biology, Faculty of Natural and Agricultural Sciences, The University of Western Australia, 35 Stirling Highway, Crawley, W.A. 6009, Australia

²School of Earth and Geographical Sciences, Faculty of Natural and Agricultural Sciences, The University of Western Australia, 35 Stirling Highway, Crawley, W.A. 6009, Australia

³Department of Agriculture and Food Western Australia, Baron-Hay Court, South Perth, W.A. 6151, Australia

⁴School of Agriculture and Food Systems, The University of Melbourne, Victoria 3010 Australia

⁵Primary Industries Research Victoria, Natimuk Rd, Horsham, Victoria 3401, Australia

⁶Department of Plant Breeding, Genetics & Biotechnology, Punjab Agricultural University, Ludhiana 141004, India

⁷National Research Centre on Rapeseed-Mustard, Sewar, Bharatpur 321303, India

⁸Oilseeds Section, C.C.S. Haryana Agricultural University, Hisar 125004, India

⁹The Energy and Resources Institute, Lodhi Rd, New Delhi 110003, India

¹⁰Institute of Oil Crops Research, Chinese Academy of Agricultural Sciences, Wuhan 430062, P.R. China

¹¹The National Key Laboratory of Crop Genetics and Improvement, Huazhong Agricultural University, Wuhan 430070, P. R. China
Email: mbarbett@cylene.uwa.edu.au

Abstract

White rust (*Albugo candida*) is a highly destructive disease of oilseed Brassicas such as *Brassica juncea* and *B. rapa*. It is essential to identify useful sources of host resistance in *B. juncea* as breeding and/or selection for resistance is the most cost-effective method of delivering control for farmers. Experiments were undertaken under controlled environmental and field conditions to identify the best methods of characterizing host resistance and to identify sources of resistance in *B. juncea* germplasm from India, Australia and China. Forty-four *B. juncea* genotypes, viz. 22 from India, 12 from Australia and 10 from China, were used in these experiments. All genotypes were screened by artificial inoculation under controlled environmental conditions, while 22 genotypes from India and 12 from Australia were also screened under natural field conditions. Screening under the controlled environment conditions gave consistent and reliable results, but inconsistent results were obtained with field screening. Overall, four Chinese genotypes (CBJ-001, CBJ-002, CBJ-003, CBJ-004) and one Australian genotype (JR049) consistently showed a high level of resistance to *A. candida* throughout the different plant growth stages (viz. cotyledonary, seedling, or flowering) for a pathotype occurring in Australia. In contrast, the relative responses of the more susceptible genotypes sometimes varied according to the plant growth stage at inoculation. Our study demonstrates that controlled environmental conditions may be suitable for rapid identification of resistant genotypes and that genotypes with high levels of resistance can be identified at either the cotyledonary, seedling, or flowering stages.

Key words: *Albugo candida*, *Brassica juncea*, germplasm

Introduction

White rust, caused by *Albugo candida*, is a highly destructive disease of cruciferous vegetable (Williams and Pound 1963) and oilseed crops (Harper and Pittman 1974; Fan *et al.*, 1983; Edwards and Williams 1987). This disease is characterized by the formation of white to cream coloured zoosporangial pustules on cotyledons, leaves, stems and inflorescences. Staghead galls are formed as the result of inflorescence infection (Verma and Petrie 1980). Most commercial Indian mustard (*Brassica juncea*) varieties are highly susceptible to this pathogen (Mukherjee *et al.*, 2001). It has been estimated that combined infection of leaf and inflorescence causes yield losses up to 60% or more in India (Lakra and Saharan 1989), and losses of up to 20% in Australia (Barbetti 1981; Barbetti and Carter 1986). While a number of chemicals have been suggested for control this disease (Verma and Petrie 1979; Barbetti 1988a, b), as has cultural means (Barbetti 1981), the most efficient and cost effective way of protecting mustard plants from white rust is through the utilisation of genetic resistance. Identification of sources of host resistance is an important prerequisite to managing this disease.

In India, *B. juncea* is the predominant oilseed *Brassica* species sown while in China and Australia *B. napus* predominates and only smaller areas (approximately 3,000 ha) of *B. juncea* are grown. However, *B. juncea* is a more drought-hardy species than *B. napus* in Canada (Downey 1971; Woods *et al.*, 1991), India and China (Oram *et al.*, 2005). Hence, canola-quality *B. juncea* is being developed to extend oilseed *Brassica* production into the lower rainfall areas, particularly in Australia (Burton *et al.*, 2003). Commercial *B. juncea* cultivars of canola quality are planned for release in Australia in 2006 (Salisbury *et al.*,

2004). It is essential to rapidly identify useful sources of resistance in *B. juncea*. There is need in Australia for a rapid and reliable technique for screening of germplasm for resistance to this disease. Hence, studies were undertaken (Li *et al.*, 2007 *in press*) to determine the differential responses of *B. juncea* germplasm from India, Australia and China, to identify sources of host resistance at the cotyledonary, seedling and flowering stages.

Materials and Methods

Seed was obtained from India, Australia and China through the Australian Centre for International Agricultural Research (ACIAR) programme. Forty-four genotypes of *B. juncea*, including 22 from India, 12 from Australia and 10 from China, were screened in a controlled environment room at different growing stages. A single isolate of *Albugo candida* (D1) provided by Dr. A. Gurung of the University of Melbourne, Victoria, Australia, was used as the inoculum. For all controlled environment studies, a zoosporangial suspension was used. Disease assessment details are as given in Singh *et al.* (1999) and Li *et al.* (2007 *in press*). Field trials involved testing 12 *B. juncea* lines from Australia and 22 *B. juncea* lines from India for white rust resistance at two field sites at Mt Barker and Wongan Hills in Western Australia.

Results

The controlled environment experiments showed significant differences among genotypes in relation to the disease severity on cotyledons, on leaves at the seedling stage and the disease incidence and the disease severity at the flowering stage. Based on disease scoring on all three stages, the most resistant genotypes were CBJ-001, CBJ-002, CBJ-003, CBJ-004 from China and JR049 from Australia. The most susceptible genotypes varied according to plant growth stage. There were no significant differences among genotypes in relation to the number of stagheads at the flowering stage. Disease incidence in the field was low and random and there was no significant difference among tested lines at either Mount Barker or Wongan Hills field sites.

Discussion

This study showed that the *B. juncea* genotypes with best potential resistance to *A. candida* could be readily identified from screening germplasm under controlled environmental conditions at all three different growth stages. In particular, the results confirm that genotype responses at the early growth stages, such as cotyledon or young seedling stages, could reliably be used as a rapid assay of *B. juncea* for resistance to *A. candida*.

A wide range in response was found within the 44 tested genotypes, ranging from complete resistance through to highly susceptible. Four Chinese genotypes CBJ-001, CBJ-002, CBJ-003 and CBJ-004 and one Australian line JR049 consistently showed the high levels of resistance to *A. candida* at all growth stages studied. To our knowledge, these are new sources of resistance that could be used in *B. juncea* breeding programs in Australia to develop cultivars that are more resistant to white rust.

Results from two separate field trials in Western Australia did not show significant differences among the tested genotypes at either Mt Barker (725 mm annual rainfall) or Wongan Hills (350 mm annual rainfall), probably because the levels of white rust leaf infection at both these field sites appeared to vary randomly across the trial area. This may have been because conditions other than rainfall also determined the conduciveness of the environment for this disease at both sites. Compared with this field testing, screening under controlled environmental conditions appears to be more reliable. However, these resistances identified under controlled environment conditions still need to be confirmed under conducive field conditions. Considering *B. juncea* is an emerging crop in Australia and that the first signs of white rust inoculum build-up in the field are now evident (M.J. Barbetti, unpublished data), it is possible that, in the future, field trials under conditions conducive for the disease may be needed to confirm resistance identified among genotypes to *A. candida*.

Conclusion

Clearly there is a need to evaluate additional germplasm from Australia, China and India. The current studies assumed that physiological races are currently not an issue in such screening tests. However, this aspect needs to be clarified for a wider range of strains of *A. candida*, both in Australia and in the countries from which germplasm has been obtained, such as China and India. It is possible that with expansion of the *B. juncea* cropping area in Australia that new strains could develop which may affect the genotypes differentially to the responses we obtained in our studies. Finally, the value of such resistances in terms of yield advantage, especially under varying environmental conditions (*e.g.*, humidity, temperature, etc) which could affect the level of damage caused by white rust, warrants further investigation.

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