Sources of resistance to *Sclerotinia sclerotiorum* in *Brassica napus* and *B. juncea* germplasm for China and Australia

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Abstract

Sclerotinia stem rot (*Sclerotinia sclerotiorum*) is a serious disease of oilseed rape in China and becoming a problem in various areas of Australia. Selection for resistance has been an important approach for the management of this disease in China and a similar approach is now required for Australia. While no sources of complete resistance have yet been identified, partial resistance has been reported in the Chinese *B. napus* genotypes, such as cv. Zhongyou 821. As a first step towards identifying new sources of partial resistance, a field study undertaken in Western Australia to evaluate the reactions to Sclerotinia stem rot of 25 lines of *B. napus* and 12 lines of *B. juncea* from Australia and 17 lines of *B. napus* from China obtained through an Australian Centre for International Agricultural Research program. Based on stem lesion length, varying levels of resistance to Sclerotinia were differentiated within genotypes from both countries. In particular, some Chinese *B. napus* genotypes showed good field resistance, with 7 lines ranked in the overall top 15 lines in relation to resistance based on Sclerotinia stem lesion length. With the exception of Fan168, the rest of the Chinese genotypes provided for this study had some tolerance to Sclerotinia. Some Australian *B. napus* lines with partial resistance were also identified, such as RR002, Ag-Spectrum, Oscar and Lantern, highlighting the existence of useful sources of resistance in the Australian germplasm. Interestingly, we found that severity of stem lesions was at the lowest level when the stem diameter is around 10 mm. Smaller or greater stem diameters gave increased stem lesion length and stem diameter may be a useful parameter for breeders to indicate genotypes of oilseed rape and mustard that may potentially have resistance to Sclerotinia stem rot. A wider search for new sources of resistance is planned, and this will not only include evaluation of additional germplasm from China and Australia, but also germplam from India.

Key words: Sclerotinia sclerotiorum, *Brassica* napus, *Brassica* juncea, germplasm

Introduction

Sclerotinia sclerotiorum (Lib) de Bary, the causal agent of stem rot in oilseed rape (*Brassica napus* and *B. juncea*), has been recorded as a pathogen on more than 400 plant species, including many important crop species, such as common bean, sunflower, soybean, and peanut (Purdy, 1979; Boland and Hall, 1994). Sclerotinia stem rot is a serious disease in oilseed rape in China and becoming a problem in oilseed growing areas in Australia (Hind-Lanoiselet, 2004). Breeding and/or selection for resistance has become an important approach for the management of this disease.

Screening for Sclerotinia resistance in soybean, common bean and sunflower has been undertaken using various methods including detached leaf inoculation (Wegulo *et al*., 1998; Kim *et al*., 2000), cut or wounded stem inoculation (Chun *et al*. 1987; Nelson *et al*., 1991; Wegulo *et al*., 1998; Vuong *et al*., 2004), cut petiole inoculation (Hoffman *et al*., 2002; Chen and Wang, 2005) and/or oxalic acid assay (Kolkman and Kelly, 2000). Although various tests for Sclerotinia resistance in *B. napus* have been attempted (Zhao *et al*., 2004; Bradley *et al*. 2006), no sources of complete resistance have yet been identified. However, partial resistance has been reported in *B. napus* cv. Zhongyou 821 (Li *et al*., 1999). Certain other Chinese lines have also been reported to show useful levels of tolerance to Sclerotinia (Zhao *et al*., 2004). The aims of this intitial study were (a) to evaluate the reactions of germplasm from Australia and China to *Sclerotinia sclerotiorum* under Western Australian field conditions and (b) to determine if the severity of the disease was related to stem diameter and/or the percentage of the host plants dead.

Materials and Methods

Twenty five lines of *B. napus* and 12 lines of *B. juncea* from Australia and 17 lines of *B. napus* from China were tested as part of an Australian Centre for International Agricultural Research (ACIAR) programme. The experiment was carried out in a screen house at the University of Western Australia Shenton Park Field Station in 2005. All test lines were grown in single rows of 1 m length and with 0.6 m between rows. Rows of test lines were arranged in a randomized complete block design with three replications. A single isolate of *S. sclerotiorum* (MBRS1) was used. The methods of inoculum production and inoculation were based on those of Buchwaldt *et al*. (2005). The disease assessment parameters used, and the assessment of stem diameters used in this study were as described in Li *et al*. (2006).

Results

Results of work to date (Li *et al*., 2006) showed significant differences among genotypes in relation to the stem lesion length by 3 weeks after inoculation ($P \leqslant 0.001$). Based on stem lesion length 3 weeks after inoculation, the most resistant lines were *B. napus* Fan168, Fan 028, Zhougyou-za No.8 from China; and RR002, Ag-Spectrum, Oscar and Lantern from Australia. While most Australian *B. juncea* lines were very susceptible, some lines such as JN033, JM18, JR042 and JN032 performed significantly better than others (JM16, JR049, JN004 and JO006) (Table 1).

Discussion

This initial study (Li *et al*., 2006) was successful in differentiating, under Western Australian field conditions, varying levels of resistance to Sclerotinia in germplasm from China and Australia. Some Chinese *B. napus* lines showed partial field resistance, with 6 Chinese *B. napus* lines ranked in the top 15 lines in relation to resistance based on stem lesion length. We were also able to identify some Australian *B. napus* lines with partial resistance, such as cultivars Ag-Spectrum, Oscar and Lantern. This is the first study to highlight the existence of useful resources of resistance in germplasm from Australia under Western Australian conditions. The *B. juncea* lines from Australia were generally more susceptible than most of the *B. napus* lines tested. It is essential to rapidly identify useful sources of resistance in *B. juncea* in disease prone areas and this will involve testing of additional germplasm from Australia and China, and the testing of germplasm from India recently obtained through the Australian Centre for International Agricultural Research program.

This initial study is believed to be the first to demonstrate for Sclerotinia in oilseed *Brassica*s the relationship between the stem lesion length and stem diameter. Previous studies on Sclerotinia resistance in soybean showed that while there is a correlation between stem diameter and stem lesion length, this relationship was variable among cultivars (Wegulo *et al*., 1998). Stem lesion length was lowest when the stem diameter is around 10 mm. Smaller or greater stem diameters gave increased stem lesion length. Mean stem diameter may be a useful parameter for breeders to identify genotypes of oilseed *Brassica*s that have potential resistance to Sclerotinia stem rot. However, before this parameter can be fully relied upon for selection for resistance to Sclerotina stem rot, a wider range of germplasm needs to be tested and to include germplasm from other countries such as India. In addition, further field trials need to be established to confirm the consistency of this relationship between stem diameter and lesion length under varying environments.

Conclusion

This initial study only evaluated germplasm from Australia and China. Clearly there is a need to evaluate additional germplasm from Australia and China and to test germplasm from other countries, especially India. The current study also assumed that physiological races are not an issue in such screening tests, but this aspect needs to be clarified for a wider range of strains of *S. sclerotiorum*, both in Australia and in the countries from which germplasn has been obtained, such as China and India. 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 Sclerotinia stem rot, warrants further investigation.

References

Boland GJ, Hall R (1994) Index of plant hosts of *Sclerotinia sclerotiorum*. *Canadian Journal of Plant Pathology* 16, 93-108.

Bradley CA, Henson RA, Porter PM, LeGare DG, del Rio LE, Khot SD (2006) Response of canola cultivars to *Sclerotinia sclerotiorum* in controlled and field environment. *Plant Disease* 90, 215-219.

Buchwaldt L, Li R, Hegedus DD, Rimmer SR (2005) Pathogenesis of *Sclerotinia sclerotiorum* in relation to screening for resistance. *In:* 'Proceedings of the 13th International Sclerotinia workshop'. Monterey, CA, USA p. 22

Chen Y, Wang D (2005) Two convenient methods to evaluate soybean for resistance to *Sclerotinia sclerotiorum*. *Plant Disease* 89, 1268-1272.

Chun D, Kao LB, Lockwood JL (1987) Laboratory and field assessment of resistance in soybean to stem rot caused by *Sclerotinia sclerotiorum*. *Plant Disease* 71, 811-815.

Hind-Lanoiselet TL (2004) Canola concepts: managing sclerotinia. *NSW Agriculture*.

Hoffman DD, Diers BW, Hartman GL, Nickell CD, Nelson RL, Pedersen WL, Cober ER, Graef GL, Steadman JR, Grau CR, Nelson BD, del Rio LE, Helms T, Anderson T, Poysa V, Rajcan I, Stienstra WC (2002) Selected soybean plant intructions with partial resistance to *Sclerotinia sclerotiorum*. *Plant Disease* 86, 971-980.

Kim HS, Hartman GL, Manandhar JB, Graef GL, Steadman JR, Diers BW (2000) Reaction of soybean cultivars to Sclerotinia stem rot in field, greenhouse, and laboratory evaluations. *Crop Science* 40, 665-669.

Kolkman JM, Kelly JD (2000) An indirect test using oxalate to determine physiological resistance to white mold in common bean. *Crop Science* 40, 281-285.

Li, CX., Sivasithamparam, K., Fu, TD., Li, YC., Liu, SY.and Barbetti, M.J. (2006). Expression of field resistance under Western Australian conditions to *Sclerotinia sclerotiorum* in Chinese and Australian *Brassica napus* and *Brassica juncea* germplasm and its relation with stem diameter. *Australian Journal of Agricultural Research* 57, 1131-1135.

Li YC, Chen J, Bennett R, Kiddle G, Wallsgrove R, Huang YJ, He YH (1999) Breeding, inheritance, and biochemical studies on *Brassica napus* cv. Zhougyou 821: tolerance to *Sclerotinia sclerotiorum* (stem rot). *In:* 'Proceedings of the 10th International Rapeseed Congress'. Canberra, Australia. (Eds N Wratten and PA Salisbury) p. 61

Nelson BD, Helms TC, Olson MA (1991) Comparison of laboratory and field evaluations of resistance in osybean to *Sclerotinia sclerotiorum*. *Plant Disease* 75, 662-665.

Purdy LH (1979) *Sclerotinia sclerotiorum*: history, diseases and symptomatology, host range, geographic distribution and impact. *Phytopathology* 69, 875-880.

Vuong TD, Hoffman DD, Diers BW, Miller JF, Steadman JR, Hartman GL (2004) Evaluation of soybean, dry bean and sunflower for resistance to *Sclerotinia sclerotiorum*. *Crop Science* 44, 777-783.

Wegulo SN, Yang XB, Martinson CA (1998) Soybean cultivar responses to *Sclerotinia sclerotiorum* in field and controlled environment studies. *Plant Disease* 82, 1264-1270.

Zhao J, Peltier AJ, Meng J, Osborn TC, Grau CR (2004) Evaluation of Sclerotinia stem rot resistance in oilseed *Brassica napus* using a petiole inoculation technique under greenhouse conditions. *Plant Disease* 88, 1033-1039.

Table 1. Sclerotinia stem rot resistance of 42 *Brassica* napus and 12 *Brassica* juncea lines from Australia and China grown under field conditions, inoculated with mycelia of Sclerotinia sclerotiorum. The length of stem lesions were measured 3 weeks after inoculation onto stems.

Line / Name	Source	Type	Stem lesion length (cm)	Rank 1
Fan168	China	B. napus	3.15	1
RR002	Australia	B. napus	3.48	2
Ag-Spectrum	Australia	B. napus	3.65	3
Oscar	Australia	B. napus	4.1	4
Lantern	Australia	B. napus	4.12	5
Fan 028	China	B. napus	4.77	6
Zhongyou-za No.8	China	B. napus	4.79	7
BST7-02M2	Australia	B. napus	4.87	8
Zhongshu-ang N0.4	China	B. napus	5.07	9
Ding474	China	B. napus	5.25	10
Mystic	Australia	B. napus	5.53	11
RQ011	Australia	B. napus	5.78	12
Charlton	Australia	B. napus	5.8	13
RR013	Australia	B.napus	5.8	14
Ding110	China	B. napus	5.89	15
P617	China	B. napus	6	16
Ag-Outback	Australia	B. napus	6.02	17
Fan 023	China	B. napus	6.02	18
RR009	Australia	B. napus	6.15	19
P3083	China	B. napus	6.23	20
Yu 178	China	B. napus	6.23	21
Av-Sapphire	Australia	B. napus	6.62	22
Surpass 400	Australia	B. napus	6.65	23
Tranby	Australia	B. napus	6.8	24
Purler	Australia	B.napus	6.82	25
Qu1104	China	B. napus	6.93	26
Zhongshu-ang N0.4	China	B. napus	7.07	27
Skipton	Australia	B. napus	7.1	28
Trigold	Australia	B. napus	7.18	29
Rainbow	Australia	B. napus	7.2	30
03-p74-3	China	B. napus	7.28	31
RR001	Australia	B. napus	7.65	32
RR005	Australia	B. napus	7.75	33
Monty	Australia	B. napus	7.85	34
JN033	Australia	*B. juncea*	8.07	35
JM18	Australia	*B. juncea*	8.08	36
JR042	Australia	*B. juncea*	8.13	37
JN032	Australia	*B. juncea*	8.19	38
RQ001-02M2	Australia	B. napus	8.69	39
TQ055-02W2	Australia	B. napus	9.34	40
JN031	Australia	*B. juncea*	10	41
Rivette	Australia	B. napus	10.39	42
P624	China	B. napus	11.17	43
03-p74-6	China	B. napus	12.8	44
JN010	Australia	*B. juncea*	12.96	45
JN028	Australia	*B. juncea*	13.45	46
03-p74-4	China	B. napus	14.09	47
Trilogy	Australia	B. napus	14.23	48
JO009	Australia	*B. juncea*	16.07	49
03-p74-11	China	B. napus	17.17	50
JM16	Australia	*B. juncea*	17.4	51
JR049	Australia	*B. juncea*	18.93	52
JN004	Australia	*B. juncea*	20.83	53
JO006	Australia	*B. juncea*	21.3	54
Significance ($P \leqslant$)			0.001	
l.s.d ($P = 0.05$)			6.9	