Indian Journal of Agricultural Sciences **80** (2): 155–9, February 2010

Field evaluation of indigenous and exotic *Brassica juncea* genotypes against *Alternaria* blight, white rust, downy mildew and powdery mildew diseases in India

RAJENDER SINGH[1], DHIRAJ SINGH[2], P SALISBURY[3] and M J BARBETTI[4]

CCS Haryana Agricultural University, Hisar 125 004

Received: 11 June 2009; Accepted: 2 December 2009

ABSTRACT

A study was conducted during 2007–08 to evaluate 71 genotypes of *Brassica. juncea* obtained from Australia, China and India against important diseases, *Alternaria blight*, white rust, powdery mildew and downy mildew occurring under the northern Indian field conditions. Two Australian genotypes, 'JM06014' and 'JM06015' expressed multiple field resistance to all 4 diseases. Australian genotypes 'JM018', 'JM06021'and 'JM06026' exhibited field resistance to *Alternaria* blight and white rust, while 'JR049' and 'JN033' showed resistance only against white rust, Chinese genotypes 'RK 2', 'Ringot', 'RH 13', 'AmoraIII', 'Quianxianjiecai', 'Yilihuang', 'Hatianyoucai', 'Jinshahuang', 'Manushuang', 'Brassica juncea I', 'Brassica-juncea 2' and 'Brassica juncea 3' showed resistance against white rust. Genotypes 'JM06009' and 'JM06012' from Australia were resistant to powdery mildew, while all Chinese and Indian genotypes tested were susceptible to powdery mildew. No Indian genotypes tested showed resistance against *Alternaria* blight or white rust but genotypes 'JM 3' and 'Kranti' showed resistance to both downy and powdery mildews.

Key words: *Alternaria* blight, *Brassica juncea*, Downy mildew, Powdery mildew, White rust

Oilseed brassicas play a pivotal role in agricultural economy of the world (Wang *et al.*2007). India has the third largest edible oil economy in the world after the USA and China. Even then, India is spending large amount of its foreign exchange to import additional oil to meet local consumption demand. In India, *Brassica juncea* is the predominant oilseed *Brassica* species, while it grown in only small areas (approximately 3, 000 ha) were in Australia (Li *et al.* 2007), there are increasing areas since the release of the first commercial canola quality *B. juncea* in 2006 (Salisbury *et al.*2006). *Alternaria* blight [*Alternaria brassicae* (Berk) Sacc.], downy mildew [*Hyaloperonospora parasitica* (per. Ex. Fr.)], white rust [*Albugo candida* (pers) Kuntze] and powdery mildew [*Erysiphe cruciferarum* opiz. Ex. Junell] are most important. Yield losses up to 35–45% from *Alternaria* blight have been reported (Saharan 1991). Most of commercial Indian mustard varieties of *B. juncea* are highly susceptible to both *Alternaria* blight and white rust. Combined infection of leaves and inflorescences from white rust causes losses up to 60% or more in India (Lakra and Saharan 1989) and up to 20% in Australia (Barbetti and Carter 1986). White rust and downy mildew mixed infections cause 23–55% yield losses in *B. juncea* (Saharan 1992) Chemical control of these diseases is expensive, labour-intensive, not ecofriendly, and generally at best is only partially effective. The most cost-effective way of protecting *B. juncea* from foliar diseases is through the use of host genetic resistance and the search for new host resistances is crucial if management of these foliar diseases is to be improved. This paper reports results of field evaluations to identify sources of host resistance to *Alternaria* blight, white rust, downy mildew and powdery mildew in *B. juncea* germplasm from Australia, China and India.

[1]Plant Pathologist (email: rsb1965 @gmail.com)

[2]Professor and Head (email: dhiraj542004@yahoo.co.in) Deparment of Plant Breeding

[3]Professor (email: p.salisbury@unimelb.edu.au) University of Melbourne, Australia; [4]Professor (email: mbarbett@cyllene.uwa.edu.au) University of Western Australia

MATERIALS AND METHODS

Seeds of *B. juncea* genotypes were obtained from Australia, China and India through an Australian Centre for International Agricultural Research (ACIAR) programme across these three countries. There were total 71 *B. juncea* genotypes (29 from Australia, 20 from China, 22 from India (Table 1). They were screened for their reaction against *Alternaria* blight, white rust, downy mildew and powdery mildew at the Chaudhary Charan Singh Haryana Agricultural University (CCS HAU) at Hisar, India, under natural epiphytotic conditions. Each genotype was sown in plots of 5 m × 2 m, each plot containing 6 rows on the 29 October in

2007 and on the 27 October in 2008. A randomized complete block design with 3 replications was utilized. Each furrow was also supplemented with ground hypertrophied inflorescence of *B. juncea* containing a random mixture of oospores of *A. candida* and H. *parasitica* and conidia of *A. brassicae* collected during previous year's crop season at the CCS HAU, Hisar and stored at room temperature. Infector rows of known highly disease-susceptible cultivars 'Varuna' were also sown on borders and at the edges of the experimental area of oilseed section. All recommended agronomic package of practices were followed, viz 30 cm spacing between rows, 15 cm spacing between individual plants in each row, 100 kg N/ha, 30 kg P_2O_5/ha, and 2 irrigations applied at 45 and 90 days after sowing. Soil type was sandy loam having *p*H 7.8 and electrical conductivity of 3.5 mMhos/cm. In addition to the ground *B. juncea* plant materials applied as disease inoculum at sowing were one spray inoculation of *A. brassicae* conidia (10^5 conidia/ml), *A. candida* zoosporangia (10^5 zoosporangia/ml) using the methodology of Li *et al*. (2007) and *H. parasitica* zoosporangia (2.5 × 10 zoosporangia/ml) [using the methodology of Nashaat and Rawlison (1994)] at 45 days after sowing. All conidial and zoosporangial concentrations were adjusted using a haemocytometer

Pure cultures of *A. brassicae* used were isolated from *B. juncea* and single-spored cultures made; zoosporangia of *A. candida* were produced as by Li *et al.* (2007) ; while zoosporangia of *H. parasitica* were produced as by Nashaat and Rawlison (1994). Inocula of these pathogens were stored and maintained at–80°C until utilized. For *E. cruciferarum*, only natural field infection was utilized/observed.

Data on diseases severity for all diseases on each genotype were assessed and recorded at 75, 90 and 110 days after sowing using the 0–5 (0 = no infection on leaves, 1 = 1–10% leaf surface area covered with *Alternaria* leaf spot lesions, 2 = 11–20%, 3 = 21–30%, 4 = 31–50%, 5 = >50% leaf surface area covered with *Alternaria* leaf spot lesions) disease assessment scale used by Conn *et al*. (1990) for *Alternaria* blight; the 0–9 (0 = no symptom or sign of infection; 1 = pinpoint necrotic fleck, no sporulation; 2= large necrotic flecks; 3 = sparse sporulation up to 5% leaf surface area covered with pustules; 4 = 6–10%, 5 = 11–20%; 6 =21–30%; 7 = 31–50%; 8 = 5–75%; 9 = >75% leaf surface area covered with pustules) disease assessment scale used by Singh *et al.* (1999) for white rust; 0–9 (0=no symptom or sign of infection, 1= very minute necrotic fleck, no sporulation, 3 = very sparse sporulation, necrotic flecking, 5 = sparse scattered sporulation on either side of leaves, 7 = abundant to heavy sporulation on lower side of leaves; light to scattered sporulation on upper surface; and tissues necrosis and chlorosis present, 9 = abundant sporulation, leaf collapsed) disease assessment scale used by Nashaat and Rawlison (1994) for downy mildew; and the 1–5 (1 = 10% leaf area covered with powdery mildew, 2 = 11–20%, 3 = 21–30, 4 = 31–40%, 5 = >50% leaf area covered with powdery mildew) disease assessment scale used for powdery mildew. Only the highest final disease severity score was utilized, and for each genotype × disease score, a per cent disease index (%DI) was calculated as Agrios (2005). The mean disease indices across the two years crop seasons are presented in Table 1. Per cent disease indices ≤10% were considered as showing resistance and per cent disease indices >10 were taken as susceptible (Li *et al*. 2008, Li *et al*.2007). Fisher's least significant difference (LSD) at the 95% significance level was used to test difference among genotypes in terms of expression of genotype resistance to different diseases (Li *et al*.2008, Li *et al*. 2007). On the test genotypes *Alternaria* blight symptoms first appeared at 55 days after sowing, followed by downy mildew at 58 days after sowing and white rust at 65 days after sowing. Powdery mildew appeared later at 90 days after sowing.

RESULTS AND DISCUSSION

There was significant difference among tested genotypes in terms of disease severity on all foliar diseases (Table 1). In relation to *Alternaria* blight, 'JM 06014', 'JM 06015', 'JM 06026' and 'JM 018' from Australia showed field resistance [≤10% disease severity (% DI)]. All Indian lines were susceptible to *Alternaria* blight (>10%DI).Similarly Australian genotypes'JM 06003', 'JM 06014', 'JM 06015', 'JM 06021', 'JM 06026', 'JM 018', 'JR 049'and 'JN 033'; Chinese genotypes 'RK 2' 'Ringot', 'RH 13', 'Amora III', 'Quianxianjiecai', 'Yilihuang', 'Hatinayoucai', 'Jinshahuang', 'Manushuang', 'Brassica juncea 1', 'Brassica juncea 2' and 'Brassica juncea 3' exhibited field resistance (≤10% per cent disease incidence). All Indian and Chinese lines were susceptible to white rust (>10% DI). Genotypes 'JM 06014' and 'JM 06015' from Australia also showed resistance against downy mildew and powdery mildew, while Australian genotypes 'JM 06009' and 'JM 06012' showed resistance against powdery mildew (≤10% DI). All Chinese genotypes were highly susceptible to powdery mildew. However, 'Kranti' and 'JM 3', both of Indian origin showed resistance against both powdery mildew and downy mildew. Genotypes 'JM 1', 'JM 2', 'GM 2', 'Maya', 'Narender Ageti', 'Urvashi'and 'Bio 902' from India showed resistance to powdery mildew (≤ 10% DI). In the present study, *B. juncea* genotypes with different field reactions to *Alternaria* blight, white rust, downy mildew, powdery mildew could be readily differentiated by screening germplasm exposed to artificial and/or natural field inocula. Australian genotypes 'JM 06014' and 'JM 06015' showed resistance to all four major foliar diseases screened against, viz *Alternaria* blight, white rust, downy mildew and powdery mildew, and this occurred across both crop seasons. Genotypes 'JM 06026' and 'JM 018' from Australia had resistance to *Alternaria* blight and white rust. Saharan (1992) had also earlier reported resistance in *B. juncea* against *Alternaria* blight, but he had

Table 1 Field response of *Brassica juncea* germplasm from Australia, China and India against *Alternaria* blight, white rust, powdery mildew and downy mildew, under North India field conditions, Hisar, India

Genotype	Country of origin	*Alternaria* blight (% DI)	White rust (% DI)	Powdery mildew (% DI)	Downy mildew (% DI)
'JM 06001'	Australia	28.5	56.6	28.1	23.1
'JM 06002'	Australia	22.2	20.0	43.3	12.2
'JM 06003'	Australia	22.2	10.0	14.5	11.1
'JM 06004'	Australia	26.6	19.5	24.8	18.4
'JM 06006'	Australia	16.6	48.2	18.1	21.1
'JM 06009'	Australia	23.3	26.6	9.6	18.8
'JM 06010'	Australia	36.1	58.2	18.3	23.3
'JM 06011'	Australia	28.3	26.6	16.2	29.5
'JM 06012'	Australia	14.2	26.6	7.1	27.3
'JM 06013'	Australia	22.5	41.1	28.5	31.7
'JM 06014'	Australia	9.3	8.2	9.5	8.1
'JM 06015'	Australia	9.5	8.3	9.6	8.1
'JM 06018'	Australia	16.6	18.6	11.1	28.5
'JM 06019'	Australia	12.5	16.6	18.0	19.3
'JM 06020'	Australia	14.2	28.3	11.1	12.5
'JM 06021'	Australia	16.6	8.3	14.2	22.2
'JM 06026'	Australia	6.3	9.1	12.5	20.0
'JN 004'	Australia	16.6	21.1	21.1	13.3
'JN 010'	Australia	41.1	16.6	16.6	31.1
'JN 028'	Australia	15.6	11.8	14.2	11.1
'JN 031'	Australia	26.6	21.8	28.5	14.2
'JN 032'	Australia	21.8	36.1	15.0	21.1
'JN 033'	Australia	41.5	4.3	15.0	11.1
'JM 016'	Australia	24.7	11.3	16.6	31.1
'JM 018'	Australia	8.3	4.0	18.3	14.2
'JO 006'	Australia	21.1	12.6	31.1	21.1
'JO 009'	Australia	11.5	32.0	33.3	13.3
'JR0 42'	Australia	32.6	31.1	18.3	16.6
'JR0 49'	Australia	29.3	4.0	46.6	21.1
'Loiret'	China	18.6	13.3	23.3	38.1
'Ekla'	China	15.8	28.2	44.2	19.3
'Montana'	China	14.5	20.0	22.5	27.1
'Berry'	China	26.6	26.6	30.0	11.1
'RH 13'	China	11.1	4.1	33.3	15.0
'Ringot'	China	11.1	6.6	16.6	11.1
'RK 2'	China	28.1	5.1	46.6	31.1
'Amora III'	China	36.6	8.3	46.6	23.3
'RL'	China	22.2	25.0	36.6	28.4
'Haoyou II'	China	14.5	25.0	43.3	28.4
'Tunliuhuangiie'	China	16.6	11.1	28.1	14.6
'Dutonghuangyoucai'	China	25.0	37.5	43.3	38.6
'Quianxianjieciai'	China	16.0	8.3	56.6	16.1
'Yilihuang'	China	25.0	6.1	56.6	19.5
'Hatianyoucai'	China	22.2	9.1	66.6	27.1
'Jinshahuang'	China	16.1	4.2	73.3	21.1
'Manushuang'	China	38.2	5.0	76.6	20.0
'Brassica juncea 1'	China	14.2	3.3	73.3	14.8
'Brassica juncea 2'	China	14.2	1.1	71.1	28.4
'Brassica juncea 3'	China	11.1	4.1	73.3	21.1
'Ashirwad'	India	26.6	56.6	11.1	16.6
'Aravali'	India	28.1	42.2	12.5	12.5
'Basanti'	India	28.6	22.2	13.3	18.6

(Contd. . .)

(Table 1. Concluded)

Genotype	Country of origin	*Alternaria* blight (% DI)	White rust (% DI)	Powdery mildew (% DI)	Downy mildew (% DI)
'CS 52'	India	26.6	34.5	14.5	22.2
'CS 54'	India	27.1	41.1	23.3	11.1
'GM 2'	India	48.3	46.6	10.0	11.1
'Geeta'	India	22.5	43.3	12.5	21.1
'GM 3'	India	30.0	28.5	16.6	14.5
'Jagannath'	India	26.6	44.1	19.3	14.2
'JM 1'	India	24.3	28.5	10.0	18.6
'JM 2'	India	26.6	36.6	10.0	15.0
'JM3'	India	30.0	22.2	10.0	10.0
'Laxmi'	India	38.6	41.1	33.3	24.0
'Maya'	India	36.6	28.5	10.0	11.1
'Narender Ageti'	India	21.1	28.1	10.0	12.5
'Pusa Mahak'	India	24.0	35.5	14.2	24.5
'RGN13'	India	26.6	23.3	17.5	18.5
'Swaran Jyoti'	India	21.7	38.1	12.5	22.2
'Vasundra'	India	32.6	36.0	11.1	22.2
'Kranti'	India	26.2	23.3	10.0	10.0
'Urvashi'	India	22.2	36.6	10.0	18.3
'Bio 902'	India	26.6	42.2	10.0	20.0
LSD (P<0.05)		6.81	8.54	4.69	3.48

% DI, Per cnet discase index

screened genotypes of different genetic bases and origin, such as 'RC 781', 'PR 8805', 'PHRI', 'KRF Tall'. In the study, genotypes 'Kranti' and 'JM 3' from India showed resistance to downy and powdery mildews. Similarly Nashaat and Awasthi (1995) also observed genotypes with resistance to downy mildew, such as 'RESBJ 01', 'RESBJ 02', 'RESBJ 03' and 'Kranti', reinforcing the resistance was observed in 'Kranti'. Many genotypes, namely 'JM 06003', 'JM 06021', 'JR049', 'JN033', 'RK2', 'Ringot', 'Amora III', 'RH13', 'Quianxianjiecai', 'Yilihuang', 'Hatinayoucai', 'Jinshahuang', 'Manushuang', '*Brassica juncea* 1', '*Brassica juncea* 2', and '*Brassica juncea* 3' showed resistance to white rust. Li *et al*. (2007) also found resistance in *B. juncea* genotype 'JR 049'against white rust, which was confirmed in the present investigation. Mukherjee *et al*. (2001) showed that white rust resistant is governed by a single gene and hence should be easily incorporated into new varieties. These key findings corroborate the findings of Li *et al.* (2007) and Li *et al.* (2008) for tests conducted in Australia using an Australian isolate of *A. candida*. Genotypes 'JM 06009', 'JM 06012' 'JM 1', 'JM 2', 'GM 2', 'Maya', 'Narender Ageti', 'Urvashi' and 'Bio 902' from India showed resistance to powdery mildew. The late maturity of Chinese genotypes, and the longer association of the host in the presence of powdery mildew, may have been a reason for them to be categorized as more susceptible to powdery mildew. These resistant genotypes identified can be exploited and utilized in *B. juncea* breeding programme and, if they have suitable agronomic adaptation, could even be directly utilized as commercial varieties in India. As Indian genotypes were all susceptible to *Alternaria* blight and to white rust, there is a need to bring new resistances from Australia and/or China into Indian *B. juncea* programmes.

ACKNOWLEDGEMENT

The financial support of the Australian Centre for International Agricultural Research and the Australian Grains Research and Development Corporation is gratefully acknowledgement

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