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Multiple disease resistance in different *Brassica* genotypes

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Abstract

Different genotypes of *Brassica juncea, B. carinata, B. napus* and *B. rapa* were evaluated under natural, and artificial inoculation field conditions against white rust, Alternaria blight and Sclerotinia rot diseases during 2004-05 to 2008-09. Nine germplasm lines including EC-414291, EC-414293, PT-303, GSL-1, BINOY (B-9), LES-39, NPJ-109, HNS-0004 and BIO-Q-108-2000 exhibited white rust intensity below 5% consistently under 3-4 years. *Brassica* germplasm PHR-2 and GSL-1 showed resistance against Alternaria blight consistently in 2 years of field testing. Ten *Brassica* germplasm including BIOYSR, PHR-2, JMT-04-03, RHO-304, NRCHB-04-06, NRCDR-705, PWR-2011, RRN-608, RRN-609 and EC-399301 exhibited Sclerotinia rot incidence below 5% consistently under 2 years of evaluation.

Key words: *Alternaria blight, Brassica genotypes, resistance, Sclerotinia rot, white rust*

Introduction

In India, mustard is grown in an area of 6.8 million ha with annual yield of 7.4 million tonnes and productivity of 1094 kg/ha (Anonymous, 2008). Rajasthan has the largest acreage (21.4 lakh ha) and production (27.4 lakh ton), which correspond to 39.8 and 44.2% of the total rapeseed mustard cropped area and production of the country (Kumar and Chauhan, 2005). Amongst the major constraints in realizing higher yields, fungal diseases are the foremost important constraints, deteriorating the quality and quantity of seed and oil content. Amongst them white rust (*Albugo candida*) is most wide spread, and destructive disease of India and Canada (Singh *et al.*, 2012). The other most important diseases are Alternaria blight caused by *Alternaria brassicae* (Berk) Sacc., which results in 35-45% yield losses (Saharan, 1992) and Sclerotinia rot (*Sclerotinia sclerotiorum*), which has been reported to take heavy toll of yield (30-60%) in severe cases (Shivpuri *et al*., 2000). However, growing awareness of residual and toxic problems of chemical application, and environmental pollution, cultivation of resistant varieties is an ecofriendly and practically feasible viable alternative. Keeping this in view, genotypes of rapeseed and mustard were evaluated against the major diseases and the sources with individual and multiple disease resistance have been reported. Resistant sources identified may be utilized for breeding resistant cultivars as an ecofriendly viable alternative to chemicals for the management of rapeseed-mustard diseases.

Materials and Methods

Genotypes of *Brassica juncea, B. carrinata, B. napus* and *B. rapa* were evaluated in 3 different trials viz. Advance Varietal Trial (AVT) I and II, National Disease Nursery for white rust, and single and double low oil seed *Brassica* lines of AICRP on rapeseed and mustard under field conditions against white rust, Alternaria blight and Sclerotinia rot at Agricultural Research Station (S.K.RAU), Sriganganagar from 2004-05 to 2008-09. All the test entries under 3 different trials were sown under randomized block design with two replications. Each entry was planted in 3 meter row length and row to row and plant to plant distance was kept at 30 and 10 cm respectively. Layout pattern and checks used in 3 trials were different. Under screening

trial of *Brassica* AVT I and II entries, the susceptible check was used after every 5th test row and resistant check after 20th test row during 2004-05 to 2006-07. However, during 2007-08 and 2008 –09, the susceptible check for white rust and Alternaria blight was planted after every 2 test rows and for Sclerotinia rot after every 6th test row. A resistant check for white rust was planted after every 10th test row. The susceptible check for white rust and Alternaria blight was Varuna and for Sclerotinia rot it was Rohini whereas cultivar JM-1 was used as resistant check for white rust. This trial was conducted under natural field conditions.

The screening trial of "National Disease Nursery (NDN)" for white rust resistance was conducted under artificial field inoculation conditions. In this trial each test entry was sown in paired row of 3 meter length between susceptible check. The screening trial comprising "Single and Double low oil seed *Brassica* lines" was conducted under natural field condition. After every 2 test rows, Varuna (*B. juncea*) and after every 6th test row GSL-1 (*B. napus*) was planted as check entry.

Inoculation technique: Inoculations for white rust in NDN trial were made at the time of flowering and initiation of pod formation stage during after noon (after 1500 hrs) (Anonymous, 2013).

Score of disease: The scoring of white rust and Alternaria blight disease was done using 0 –6 scale (Conn *et al.* 1990). Scoring was done at leaf stage (75 and 90 DAS) and at siliqua (15 DBH) phase and finally percent disease index (PDI) was calculated. Number of infected plants due to stag head and Sclerotinia rot were counted and per cent disease incidence was calculated.

Results and Discussion

A total of 1319 *Brassica* germplasm/cultivars/ entries feeded under 3 different trials (SBG, NDN, RMQ) were screened against Alternaria blight, white rust and Sclerotinia rot included, *B. napus* (99), *Eruca sativa* (6), *B. rapa* (197), *B. juncea* (1000), and *B. carrinata* (17).

Screening of Brassica breeding material (AVT-I & II entries) against different diseases

A total of 248 *Brassica* entries were screened, out of which 57 entries against white rust and 06 entries against Alternaria blight exhibited disease intensity below 5% and 45 entries showed below 5% Sclerotinia rot incidence. The yearly white rust severity on leaf in the trial ranged between 0-18.3 to 0-46.8%, stag head ranged between 0.1 – 6.4 to 0 – 26.9%, Alternaria blight intensity between 5.6 - 35.1 to 20.8 - 63.3%, and Sclerotinia rot incidence ranged between 4.8 – 15 to 2.4 - 98.3 per cent (Table 1).

Screening of germplasm entries under 'NDN' against white rust and major diseases

A total of 146 *Brassica* entries were screened against white rust under artificial inoculation conditions. Observations on Alternaria blight and Sclerotinia rot were also recorded. Amongst tested lot, 42 entries against white rust, and 03 entries against Alternaria blight exhibited below 5% disease intensity and 34 entries showed below 5% Sclerotinia rot intensity. The year wise prominent cultivars screened against white rust, Alternaria blight and Sclerotinia rot disease are presented in Table 2.

Screening of single and double low oilseed Brassica lines

A total of 80 *Brassica* entries were screened under natural conditions, out of which 28 entries against white rust, and 02 entries against Alternaria blight exhibited disease intensity below 5% and 10 entries showed below 5% Sclerotinia rot incidence. The white rust intensity on leaf in the trial ranged between 0-13.2 to 0-44.3%, stag head ranged between 0-4.0 to 0-29.6%, Alternaria blight intensity between 2.0-23.1 to 23.0-53.0%, and Sclerotinia rot incidence in the trial ranged between 0-17.0 to 0-43.0 per cent (Table 3).

Selection of disease resistant material

Five years data obtained from screening of different *Brassica* entries seeded under 3 different trials (SBG, NDN, RMQ) were analyzed to record consistent resistance in entries against white rust, Alternaria blight, and Sclerotinia rot.

Table 1: Disease range and prominent cultivars screened from *Brassica* germplasm and breeding material (SBG AVT-I & AVT-II entries) against different diseases under natural conditions

Year	Disease range (%)		Prominent cultivars screened against different diseases				
	White rust on leaf	Stag head	Alternaria blight	Sclerotinia rot	White rust	Alternaria blight	Sclerotinia rot
2004-05	0-18.3	0-23.2	0.1-44.2	-	NDYS-133-1, NDT-03-2, NDT-03-3, NDYS-2, NDYS-128, PYS-2001-1, PT-2002-25, PBN-2004-1, NPC-15, NPN-1	PBN-2004-01, PBC-2004-1, NPC-15	-
2005-06	0.1-23.3	0.1-6.4	5.6-35.1	2.4-98.3	HNS-004, ONK-1, NUDB-26-11, OCN-3, CAN-133, RTM-730, TMB-2008, TMB-2007, RTM-2002	PHR-2	EJ-15, LET-18, RK-04-02, PHR-2
2006-07	0-44.0	-	20.8-63.3	4.8-15.0	PAC-432, PBG-300, NRCDR-509, TL-2030, PT-303, RYSK-05-01, RYSK-05-02, NRCYS-05-02, YSH-04-01, BINOY (B-9)-(SC-Br), HNS-0301, ONK-1, GSL-1 (Bn), KIRAN (BC), KR-299, BIOYSR (RC-WR-BJ)	Nil	RK-05-02, RQN-152, NDR-05-1
2007-08	0-46.8	0-26.9	0-59.0	0-25.0	TL-2013, TK-06-1, PT-303, RYSK-05-02, YSH-401, *YSK-06-02, YST-151, BINOY (B-9), *MHO173, *GSL-1 * Showed below 5% stag head also.	PHR-2	JMT-04-03, TL-15, RH-0304, TL-2013, TK-06-1, PT-303, JD-6, MHO-173, GSL-1, NPJ-113, RGN-145, WUJM-05-01, RB-50, DMH-1, WRCHB-603, PAC-437, PHR-2, JM-1, BIOYSR
2008-09	0-28.4	0-19.2	0-48.0	0-33.0	TERI-WRBJ-24-3, *BIOYSR, EJ-19, *NPJ-112, NPJ-117, *TK-07-2, TL-2013, *TL-15, PT-303, *PYS-2006-1, *YST-151, BINOY * Showed below 5% stag head also.	PHR-2	RH-0216, TERI-HOJ-48, PBR-330, ELM-108, RB-55, LET-14-1, BIOYSR, NRCDR-601, JMM-07-2, JMM-07-1, RH-0506, EJ-17, RH-0270, RH-0304, JMT-4-3, TK-07-2, YST-151, PR-2005-24, BBM-07-01

Table 2: Disease range and prominent cultivars screened from germplasm entries of 'National Disease Nursery' for white rust resistance under artificial inoculation conditions and other diseases under natural conditions

Year	Disease range (%)				Prominent cultivars screened against different diseases		
	White rust on leaf	Stag head	Alternaria blight	Sclerotinia rot	White rust	Alternaria blight	Sclerotinia rot
2004-05	3.4-13.4	0-10.9	13.1-34.7	-	EC-414293, LES-39, BIO-467-95	Nil	-
2005-06	0.1-21.9	0.1-10.1	11.7-20.9	0.1-10.1	NRCDR-513, NRCHB-03-12, NPJ-109, JMMWR-2-40, BIOYSR, EC-414291, EC-414293	Nil	RGN-42, PBR-210
2006-07	0-51.3	-	25.0-37.0	1.6-16.8	NRCDR-511, NRCDR-513, NRCHB-04-06, NPJ-109, LES-39, BIO-USR, EC-414291, EC-414293	Nil	LES-39, NDWR-2, PWR-2011, RRN-608, RRN-609, PBR-210
2007-08	0-37.6	0-23.9	25.0-53.6	0-21.0	*EC-414291, EC-414293, *NRCDR-705, NPJ-107, NPJ-109, *LES-39, *NPJ-121, *NDWR-05-1, *EC-399296, *EC-399299, *EC-399313, *BIOYSR * Showed below 5% stag head also.	Nil	NRCDR-513, NRCDR-705, NRCHB-04-6, NRCIJ-06-39, BPR-735-20, NPJ-121, EC-399301, EC-399299, EC-399313, JMWR-945-2-2-75Kr, RRN-608, RRN-609
2008-09	0-51.0	0-17.0	0-61.0	0-17.4	NPJ-120, NRCM-810, *NPJ-121, *JM-1, NRCDR-704, *NRCHB-04-6, NRCYS-08-3, *NRCYS-08-4, *MCB-1, NRCYS-08-5, *EC-414291, EC-414293 * Showed below 5% stag head also.	EC-399313, EC-399296, EC-399299	PWR-2012, NRCDR-705, TERI-WRBJ-24-3, NRCIJ-06-120, EC-399296, PWR-2011, EC-399301, NRCM-808, RH-0401, RH-0427, NRCIJ-06-112, NRCHB-04-6, EC-414291, MCB-1

Table 3: Disease range and prominent cultivars screened from single and double low oilseed *Brassica* lines (RMQ entries) against major diseases under natural conditions

Year	Disease range (%)				Prominent cultivars screened against different diseases		
	White rust on leaf	Stag head	Alternaria blight	Sclerotinia rot	White rust	Alternaria blight	Sclerotinia rot
2004-05	0-13.2	0-4.0	2.0-23.1	-	PT-303, GSL-1, HYOLA-402, OCN-3, HNS-0004, HNS-9605, CAN-78, CAN-39, TERI (00)-R 9903, TERI (OE)-R 03	GSL-1	-
2005-06	0.1-16.9	-	15.1-24.3	6.3-35.0	CAN-130, OCN-3	Nil	CAN-130
2006-07	0-33.9	-	18.0-41.5	4.1-21.1	BIO-Q-108-2000, HNS-0004, HNS-9605, QSL-1, PT-303	Nil	Rohini
2007-08	0-30.0	0-12.0	23.0-53.0	0-17.0	PT-303, *HNS-0004, *HNS-605, *GSL-1, *HYOLA-401, *BIOQ-108-2000, *PRQ-9701-46, *PRQ-2001 * Showed below 5% stag head also.	Nil	HNS-004, HNS-605, GSL-1, HYOLA-401, LET-14-1
2008-09	0-44.3	0-29.6	0-40.0	0-43.0	*BIO-Q-108-2000, GSL-1, *PT-303 * Showed below 5% stag head also.	GSL-1	LES-39, PRQ-2001, TERI LGM-06

White rust: Two entries each under NDN (EC-414291, EC-414293), and RMQ (PT-303, GSL-1) trial, exhibited white rust intensity below 5% consistently under 4 years of testing. Similarly, 2 entries each under SBG (PT-303, BINOY(B-9), NDN (LES-39, NPJ-109), and RMQ (HNS-0004, BIO-Q-108-2000) trials also exhibited white rust intensity below 5% under 3 years testing (Table 4). Five *Brassica* entries under SBG trial viz., RYSK-05-02, GSL-1, BIOYSR, TL-2013 and YST-151; four *Brassica* entries under NDN trial namely NRCDR-513, BIOYSR, NRCHB-04-06 and NPJ-121, and 2 *Brassica* entries viz., OCN-3 and HNS-9605 under RMQ trial were rated resistant consistently under 2 years of testing

Alternaria blight: *Brassica* entry PHR-2 feeded under SBG group and GSL-1 evaluated under RMQ group were rated resistant consistently under 2 years of testing (Table 4)

Sclerotinia rot: Four *Brassica* entries viz., BIOYSR, PHR-2, JMT-04-03, and RHO-304 under SBG group and 6 *Brassica* entries namely NRCHB-04-06, NRCDR-705, PWR-2011, RRN-608, RRN-609, and EC-399301 under NDN group exhibited below 5% disease level consistently under 2 years of testing (Table 4).

Multiple disease resistance: Screening data obtained under 5 years of testing (2004-05 to 2008-09) were analysed for consistent multiple disease resistance against white rust, Alternaria blight, and Sclerotinia rot. None of the *Brassica* entries feeded under SBG, NDN, and RMQ group exhibited multiple disease resistance consistently under 5 years, 4 years and 3 years of testing. However, under SBG group *Brassica* entry, BIOYSR showed combined resistance against white rust and Sclerotinia rot and PHR-2 showed multiple diseases resistance against Alternaria blight and Sclerotinia rot consistently is 2 years of testing. Similarly, lone entry NRCHB-04-06 under NDN group and GSL-1 entry under RMQ group showed multiple diseases resistance against white rust and Sclerotinia rot and white rust and Alternaria blight respectively, consistently in 2 years of testing (Table 4). Present findings are in conformity with those of earlier workers who established the resistance in *Brassica* germplasm lines *viz*, BIOYSR, HNS 4, GSL-1 and other genotypes against white rust disease (Saharan *et al.,* 1995; Gupta *et al.,* 2002; Li *et al.,* 2008).

Similar to present findings, Yadav *et al.* (2008) also observed least number of Alternaria blight induced lesions in PHR-2 and GSL-1 genotypes. Resistance in *Brassica* species against the attack of *A. brassicae* might be also due to outcome of complex biochemical changes operated in host genotypes (Mathpal *et al.,* 2011). The resistant nature of some *Brassica* genotypes against Sclerotinia rot have also been reported earlier (Zhao *et al.,* 2004). The heritability of Sclerotinia rot resistance controlled by nuclear genes and unlinked to low erucic acid trait. Likewise, Anonymous (1992) and Saharan and Krishnia (2001) have proved multiple disease resistance (white rust and Alternaria blight) in *Brassica* germplasm viz., BIOYSR, GSL-1 and some other genotypes.

On the basis of present investigation it can be concluded that only four *Brassica* entries namely, BIOYSR and PHR-2 (SBG), NRCHB-04-06 (NDN) and GSL-1 (RMQ) exhibited multiple disease resistance consistently for 2 years. Screening of these genotypes against the diseases will give us clue about quality of resistance genes which in turn can be utilized for breeding resistant cultivars, analysis of components of resistance and will also be helpful in determining nature of resistance in varieties.

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Table 4: Prominent *Brassica* entries against different diseases under three different trials (SBG, NDN, RMQ) tested during 2004-05 to 2008-09

Trial	Consistently below 5% white rust intensity				Consistently below 5% Alternaria blight intensity				Consistently below 5% Sclerotinia rot incidence				Consistently below 5% disease level against white rust, Alternaria blight and Sclerotinia rot (multiple disease resistance)			
	5 yrs	4 yrs	3 yrs	2 yrs	5 yrs	4 yrs	3 yrs	2 yrs	5 yrs	4 yrs	3 yrs	2 yrs	5 yrs	4 yrs	3 yrs	2 yrs
SBG	Nil	Nil	PT-303, BINOY (B-9)	RYSK-05-02, GSL-1, BIOYSR, TL-2013, YST-151	Nil	Nil	Nil	PHR-2	Nil	Nil	Nil	BIOYSR, PHR-2, JMT-04-03, RHO-304	Nil	Nil	Nil	BIOYSR (white rust + Sclerotinia rot), PHR-2 (Alternaria blight + Sclerotinia rot)
NDN	Nil	EC-414293, EC-414291	LES-39, NPT-109	NRCDR-513, BIOYSR, NRCHB-04-06, NPJ-121	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NRCHB-04-06, NRCDR-705, PWR-2011, RRN-608, RRN-609, EC-399301	Nil	Nil	Nil	NRCHB-04-06 (white rust + Sclerotinia rot)
RMQ	Nil	PT-303, GSL-1	HNS-0004, BIO-Q-108-2000	OCN-3, HNS-9605	Nil	Nil	Nil	GSL-1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	GSL-1 (white rust + Alternaria blight

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