Journal of Oilseed Brassica, 13 (2) : 100-104, July 2022

Identification of new source of resistance against white rust

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(Received: 19 January 2022; Revised: 20 March 2022; Accepted: 22 March 2022)

Abstract

Mustard is one of the most important oilseed crops in India in general and in the Rajasthan in particular. Low yield in mustard is attributed to many biotic and abiotic stresses. White rust, a serious foliar disease caused by *Albugo candida* is one of the major threats responsible for significant reduction in yield (17-55 %). Among various management approaches, use of resistant varieties is considered best, as it is cost-effective and environment friendly. However, till now only few resistant sources against this disease have been reported. Therefore, in the present investigation, 34 rapeseed-mustard germplasms were evaluated in natural field conditions during 2019-20 and 2020-21 to identify sources of resistance. Out of 34, only one accessions (IC422166) showed immune reaction (0) whereas other accessions showed variable reactions ranging from resistant (1-3) to highly susceptible (>6) against white rust. The identified accession remained stable for disease immunity under artificial inoculation with environment-controlled conditions against different isolates of *A. candida* from mustard growing regions. Therefore, identified accession may have potential of utilizing as resistant donor in the crop improvement programme for developing resistant cultivars having good agronomic traits and highly productive genetic potential and also for mapping and tagging resistant gene against white rust.

Keywords: *Germplasm, disease resistance, evaluation, mustard, white rust*

Introduction

India is one of the largest producers of edible oils in the world. Rapeseed-mustard is a major annual edible oilseed crops contributing to approximately 25% of the total oilseed production in India. It occupied 6.69 million hectares, with a production of 10.11 million tonnes and a productivity of 1511 kg/ha (MOA&FW, 2021). It ranks second in area, next to soybean and thus is an important oil-bearing crop for the country on account of its higher oil content (39-44 %). Rapeseed-mustard is an agriculturally important oilseed crop with a long history of cultivation in India, China and increasingly in Australia. Rapeseed-mustard is cultivated during *rabi* season and largely confined to Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, West Bengal, Assam, Jharkhand, Gujarat, North Eastern States and Bihar. These states account for 96% of the area and production of rapeseed-mustard. Despite having large area under oilseeds, India is the major importer of edible oil. The low productivity is attributed to yield stagnation in new varieties and increasing pressure of biotic and abiotic stresses. Rapeseed-mustard crops have been known to be affected by diseases such as downy mildew, white rust, alternaria blight and sclerotinia stem rot (Bisht *et al.*, 2015). White rust and downy mildew can occur separately or in association with each other and can cause 37-47 % loss in pod formation and 17-54.5 % reduction in seed yield (Mukherjee *et al*., 2001). Among various management approaches, use of resistant varieties is considered the best, as it is cost-effective and eco-friendly. The germplasm has been screened against white rust and varying levels of host resistance have been identified (Ahmad *et al.,* 2014; Dharavath *et al.,* 2017). However, the information on the sources of resistant donors from germplasm conserved in the National Gene Bank at ICAR-NBPGR is limited. Therefore, a large number of accessions were screened at hot spots under field and artificially inoculated conditions in laboratory with the objective to identify germplasm accession resistant to white rust disease.

Materials and Methods

During *Rabi* season 2019-20 and 2020-21, 34 accessions of indigenous mustard germplasm were grown at ICAR-NBPGR Regional Station, Jodhpur for screening against white rust resistance in augmented block design along

Table 1: Disease score, its severity percentage and corresponding reaction for white rust disease

Disease score	Disease severity (%) and symptoms	Disease reaction
0	No infection on either leaf surface	Immune (I)
1-2	Up to 5% leaf area covered with small pinpoint to larger brown necrotic flecks under inoculation point	Highly Resistant (HR)
3-4	> 5%-10% leaf area covered with very sparse sporulation, one to few pustules on lower surface and no of pustules on upper surface	Resistant (R)
5-6	11%-25% leaf area covered with few to many scattered pustules with good sporulation on lower surface and none to few pustules on upper surface	Moderately Resistant (MR)
7-8	26%-50% leaf area covered with many pustules with abundant sporulation on lower surface with none to few pustules on upper surface	Susceptible (S)
9	> 50% leaf area covered with many large coalescing pustules on lower surface with few to many pustules on upper surface of the cotyledon	Highly Susceptible (HS)

with susceptible check Pusa Jai Kisan using standard agronomic practices. Observations for white rust on leaves were recorded using 0-9 scale adopted by AICRP on Rapeseed-mustard (2011) to calculate plant disease index (PDI) at 20 days before the maturity of crop (Table 1).

The disease severity under natural epiphytotic conditions was calculated using the formula given below:

$$\text{Average severity score} = \frac{(N\text{-}1\times0) + (N\text{-}2\times1) + (N\text{-}3\times3) + (N\text{-}4\times5) + (N\text{-}5\times7) + (N\text{-}6\times9)}{\text{No. of leaf samples}}$$

Germplasm accession scored as resistant (PDI = 0) across the years was further validated under artificially inoculated conditions as per the method described by Yadav *et al.* (2018) for its resistance at National Phytotron Facility, ICAR-IARI, New Delhi against various isolates of *A. candida* collected from various mustard growing regions of the country (Ludhiana, SK Nagar, Bharatpur and Wellington). Highly susceptible variety Pusa Jai Kisan was used as a susceptible check. Observations were recorded after one week of inoculation at cotyledonary stage, whereas, disease severity was again recorded after disease development on true leaf stage as per the method described by Fox and Williams (1984).

Results and Discussion

Screening under natural condition revealed that germplasm accession IC 422166 showed 0% disease severity with no infection (rated as immune reaction) (Table 2 & Fig. 1). Rest of the accessions showed moderately resistant to susceptible reaction and disease severity was more than 10 %.

The identified germplasm accession, IC422166 was further validated for its resistance using artificial inoculation technique. The results showed that accession, IC422166 is absolutely free of infection against Ab-Ludhiana isolate at both the stages (Table 3 & Fig. 2). Further, this accession performed well against remaining three isolates also showing disease severity between 5-10 % only.

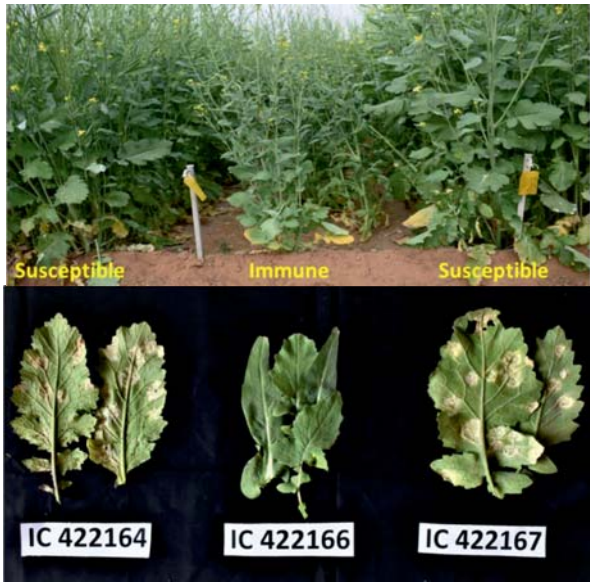

Fig. 1: Mustard germplasm, IC422166 showing immune response against white rust disease under field conditions

Donors for white rust resistance have been identified by various workers, for instance Bisht *et al.* (2015) while screening 240 germplasm accessions of Indian mustard found IC296685, IC399678 and IC401570 as immune having 0% disease severity and IC326253 and IC417020 resistant with 5-10% disease severity. Meena *et al.,* (2011) found PBC 9221 and EC 414299 as resistant to white rust. A number of germplasm lines, namely, EC414291, EC 414293, MCB1, DRMR 243, DRMR 261, DRMR 270, NRCDR 705,

Table 2: Phenotyping of mustard germplasm against white rust under natural conditions during *rabi* 2019-20 and 2020-21

Rating scale (0-9)			Disease severity and response		
PDI	Disease Response	No. of germplasm	Accession	Disease severity (%)	Response
0%	Immune (I)	01	IC422166	0.0	I
>5%	Highly Resistant (HR)	Nil	Nil	-	-
5-10%	Resistant (R)	Nil	Nil	-	-
11-25%	Moderately Resistant (MR)	03	IC422157	18.7	MR
			IC422161	19.8	MR
			IC422176	16.3	MR
26-50%	Susceptible (S)	15	IC422156	47.5	S
			IC422158	36.4	S
			IC422162	50.0	S
			IC422168	48.8	S
			IC422169	47.9	S
			IC422177	49.7	S
			IC422184	38.4	S
			IC422186	45.6	S
			IC422187	29.8	S
			IC422194	35.7	S
			IC422188	38.0	S
			IC422181	45.5	S
			IC422173	43.5	S
			IC422164	46.8	S
			IC422160	44.9	S
>50%	Highly Susceptible (HS)	15	IC422159	70.0	HS
			IC422163	68.7	HS
			IC422167	69.1	HS
			IC422170	73.8	HS
			IC422171	71.3	HS
			IC422174	69.5	HS
			IC422175	71.1	HS
			IC422178	67.1	HS
			IC422179	76.2	HS
			IC422180	67.1	HS
			IC422182	61.8	HS
			IC422183	59.5	HS
			IC422185	73.2	HS
			IC422189	66.7	HS
			IC398234	52.0	HS
			PJK	74.4	HS
SEm±				0.9	
CD (p=0.05)				2.5	
CV (%)				3.0	

Table 3: Phenotyping of IC422166 against white rust under environment-controlled artificial inoculation with different isolates of *A. candida*

Isolate	Disease severity (%)			
	IC422166		PJK	
	CL	TL	CL	TL
Ab-Ludhiana	0.0	0.0	57.0	52.8
Ab-S K Nagar	5.0	5.0	45.0	50.7
Ab-Bharatpur	10.0	5.0	70.5	75.0
Ab-Wellington	5.0	5.0	65.5	72.5
SEm±	0.128	0.042	0.938	1.058
CD (p=0.05)	0.423	0.139	3.107	3.505
CV	4.426	1.932	2.731	2.922

CL= cotyledonary leaf stage; TL=true leaf stage

Fig. 2: Mustard germplasm, IC422166 showing response against different *A. candida* isolates under environment-controlled artificial inoculation conditions

JMWR 945-2-2-75 Kr, EC 399313, JYM 11 and NDWR 5-1 were identified as resistant (Anonymous, 2011). Pandey *et al.* (2013) also found that GSL-1, PBC-9221, NDCDR-515 were highly resistant. Awasthi *et al*. (2012) demonstrated that almost all the important varieties of *B. juncea* being grown in India are susceptible and Yadav *et al.* (1999) while screening 74 Indian mustard germplasm lines found that none of the genotype showed resistance to white rust.

Conclusion

With limited sources of white rust disease resistance available, above identified germplasm accession IC-422166 can be further used and evaluated for resistance breeding programs in India. This field promising accession would most certainly be useful in developing disease resistance cultivars having good agronomic traits and highly productive genetic potential. The identified accession can be utilized to develop mapping population to map genomic regions conferring resistance to white rust.

Acknowledgement

We are also thankful to the Director, ICAR-National bureau of Plant genetic Resources for providing facilities to carry out this study.

References

Ahmad HN, Perveen R, Chohan S, Yasmeen G, Mehmood MA and Hussain W. 2014. Screening of canola germplasm against *A. candida* and its epidemiological studies. *Pak J Phytopathol* **26:** 169-173.

AICRIP R&M. Proceeding. 2011. Revised rating scale of major diseases of rapeseed-mustard. Proceedings of 18th annual group meeting of AICRP rapeseed-mustard. Khanpur campus, AAU, Guwahati (Assam). p. 1

Anonymous. 2011. Report of All India co-ordinated research project on rapeseed-mustard. Sewar, Bharatpur, Rajasthan. pp. 1-10.

Awasthi RP, Nashaat NI, Kolte SJ, Tewari AK, Meena PD and Renu Bhatt. 2012. Screening of putative resistant sources against Indian and exotic isolates of *A. candida* inciting white rust in rapeseed-mustard. *J Oilseed Brassica* **3:** 27-37.

Bisht KS, Rana M, Gairola K, Sharma BC, Tewari AK and Awasthi RP. 2015. Screening of Brassica germplasm for resistance to major diseases of rapeseed-mustard. *The bioscan* **10:** 2111-2119.

Dharavath N, Mehera B, Nath S, Patra SS and Rout S. 2017. Effect of different sowing dates and application of pesticides on growth and yield of mustard crop (*B. juncea*). *Int J Pure App Biosci* **5:** 178-187.

Fox DT and Williams PH. 1984. Correlation of spore production by *A. candida* and a visual white rust rating scale. *Can J Plant Pathol* **6:** 175-178.

Meena PD, Awasthi RP, Godika S, Gupta JC, Kumar A, Sandhu PS, Sharma P, Rai PK, Singh YP, Rathi AS, Prasad R, Rai D and Kolte SJ. 2011. Eco-friendly approaches managing major diseases of Indian mustard. *World Appl Sci* **12:** 1192-1195.

MOA&FF. 2020. Statistics at a glance. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.

Mukherjee AK, Mohapatra T, Varshney A, Sharma R and Sharma RP. 2001. Molecular mapping of a locus controlling resistance to *A. candida* in Indian mustard. *Plant Breed* **120:** 483-487.

Pandey P, Tewari AK and Awasthi RP. 2013. Morphological and pathogenic variability of *A. candida* isolates causing white rust in rapeseed mustard. *The Bioscan* **3:** 835-838.

Yadav MS, Dhillon SS, Kaur S, Brar KS and Singh K. 1999. Screening of Indian mustard germplasm for resistance to alternaria blight and white rust. *Plant Dis Res* **14:** 70-72.

Yadav R, Prasad L, Nanjundan J, Tewari AK, Singh P, Sandhu PS, Pant U, Avtar R, Radhamani J, Kumar S, Rao M and Rana JC. 2018. Identification and evaluation of Indian mustard genotypes for white rust resistance and agronomic performance. *Indian J Genet* **78:** 81-89.