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Evaluation of different *Brassica* genotypes under field conditions against white rust disease (*Albugo candida*) of rapeseed-mustard for resistant sources

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Abstract
White rust or white blister disease caused by oomycete fungi, *Albugo candia* is one of the major devastating disease of rapeseed mustard. Continuous emergence of new races of the pathogen is responsible for breaking down of the resistance of already existing resistant cultivars. So there is need for the evaluation of existing resistant cultivars as well as new Brassica cultivars to find out stable resistance sources against the disease. In this context, 82 different Brassica genotypes, including 10 different Brassica species were evaluated in field, under natural conditions for the confirmation of resistance sources against *Albugo candida* in two successive years 2017-18 and 2018-19. Observations of percent disease severity and phenotypic disease reaction were taken at different time intervals of 70, 80 and 90 DAS. Infection rate and area under disease progress curve (AUDPC) were calculated for each genotype. Out of 82 Brassica genotypes evaluated, 26 were found free from the disease and 28 genotypes showed moderately resistant reaction while rest of the genotypes showed susceptible reaction at 90DAS. Minimum infection rate (0.0949) and AUDPC (69.44) was observed in DRMRJ 127 and SIVT-17-19 while maximum infection rate (0.1008) and AUDPC (588.0) was observed in 71 J0002 and RH 30, respectively at 90 DAS.

Keywords: *Albugo candida*, resistant, AUDPC, white rust, *Brassica* genotypes

1. Introduction
Oilseed Brassicas are important oilseed crops, grown as fodder, source of oil, condiments and vegetables around the world with global production of 584.3 million tonnes (mt) in 2019-20 (FAO, 2020). In India, oilseed crops comprise 26.20 mha, area with production of 35.35 mt and yield of 1328 kg/ha. Oilseed Brassica includes eight different species namely toria, yellow Sarson, Indian mustard, gobhi Sarson, Taramira, Brown Sarson and Karan Rai. Among them rapeseed-mustard attain prime position with total area of 6.64 mha, total production 8.1 mt and productivity 1980 kg/ha (Anonymous, 2020) [1]. Rapeseed-mustard is susceptible to a number of diseases eg. Alternaria blight, White rust, Sclerotinia stem rot and Downey mildew which limit its production. Among them, white rust disease caused by *Albugo candida* (Pers. ex Lev.) Kuntze, is wide spread and highly destructive disease in many agronomically important Brassica species as pathogen can spread systemically and cause severe malformation of the inflorescence through hypertrophy and hyperplasia resulting in staghead formation (Punjabi *et al*., 2010) [16]. The disease causes annual yield loss of 20-60 percent in rapeseed mustard crop (Saharan *et al*., 1984, Saharan and Verma, 1992, Bisht *et al*. 1994 and Kolte, 1996, Kalpana *et al*, 2017) [20, 17, 3, 8]. Protectant fungicides have been recommended for controlling white rust disease in rapeseed-mustard (Kolte and Tewari., 1980) [9] and Kolte and Awasthi, 1981, Kalpana *et al*, 2019) [10, 7]. But due to concern of environmental hazards, high cost of chemicals and problem of non-uniform spraying due to plant height, farmers are usually reluctant to use these fungicides for the management of the disease. At present best alternative method for management of this disease is identification of resistant cultivars which is also most eco-friendly and cost effective disease management strategy for this disease. Availability of resistant source has been reported by several workers and different criteria have been used by them to determine the relative resistance of various genotypes in oilseed Brassica

(Ashrufuzzaman, *et al*., 1996, Kumar and Kolte., 2001) [2, 11]. However, less work has been done to understand the various aspect of disease component in resistant and susceptible genotypes. In this view, it is very important to identify and confirm the resistant sources. So that some promising and potential genotypes could be identified and used as donor sources in resistant breeding programme. Due to variability and wide distribution of white rust pathogen, new races of *Albugo candida* pathogen emerge which challenge the resistance of existing cultivars. Hence, along with screening of new Brassica genotypes, continuous evaluation of already reported resistant cultivars is also needed for finding stable resistant sources against the pathogen. Considering the problems, the present investigation was undertaken for the confirmation of resistant sources in *Brassica* genotypes against *A. candida.*

2. Material and Method

Brassica genotypes (82 no.) including 10 different Brassica species were evaluated against *A. candida* pathogen in field under natural condition during the crop season 2017-18 and 2018-19 in Crop research centre, GBPUA&T, Pantnagar. Following Brassica genotypes (Table 1) were used for evaluation against white rust disease.

Table 1: Brassica genotypes for evaluation against *A. candida* under field condition

Si. No.	Genotypes	*Species*	Si no.	Genotype	*Species*	Si no.	Genotype	*Species*
1	Varuna	*B. juncea*	29	NBPGR 407	-	57	DRMRIJ-12-06	*B. juncea*
2	Pusa Bold	*B. juncea*	30	NBPGR 410	-	58	NPJ 217	*B. juncea*
3	TL 15	*B. rapa var.toria*	31	NBPGR 426	-	59	EC 399301	*B. juncea*
4	Candle	*B. rapa var. Brown sarson*	32	NBPGR 427	-	60	RMM-09-05-01	*B. juncea*
5	BSH 1	*B. rapa var. Brown sarson*	33	NBPGR 428	-	61	DRMRJ 127	*B. juncea*
6	Kranti	*B. juncea*	34	NBPGR 429	-	62	RMWR-09-05-01	*B. juncea*
7	Ragini	*B. rapa*	35	NBPGR 433	-	63	RH.14.001	*B. juncea*
8	RL 1359	*B. juncea*	36	NBPGR 434	-	64	DRMR 2035	*B. juncea*
9	Pusa Kalyani	*B. rapa* var. *Brown sarson*	37	NBPGR 437	-	65	DRMR 2019	*B. juncea*
10	Torch	*B. rapa var. Brown sarson*	38	NBPGR 439	-	66	RLC-5	*B. juncea*
11	Tobin	*B. rapa var. Brown sarson*	39	PRD.14.16	-	67	DRMR 12.39	*B. juncea*
12	Bhawani	*B. rapa var.toria*	40	PRD.14.25	-	68	DRMRIJ 12.40	*B. juncea*
13	*Sinapis alba*	*S. alba*	41	PRD.34.20	-	69	RL-JEB-52	*B. juncea*
14	DLSC-1	*B. carinata*	42	PAB.14.57	-	70	NPJ 217	*B. juncea*
15	YSPB 24	*B. rapa* var. *yellow sarson*	43	IC 413293	-	71	DRMR-12-48	*B. juncea*
16	Wester	*B. napus*	44	IC 426528	-	72	RMM-09-6-1	*B. juncea*
17	Heera	*B. juncea*	45	IC 597932	-	73	PDZ 5	*B. juncea*
18	Cutlass	*B. juncea*	46	IC 3175280	-	74	ABS(3)-15	*B. juncea*
19	Sangam	*B. nigra*	47	IC 313378	-	75	RTM-10-9-1	*B. juncea*
20	RH 30	*B. juncea*	48	IC 313379	-	76	PDZ 3	*B. juncea*
21	NRCDR 515	*B. juncea*	49	IC 265495	-	77	DRMR 5206	*B. juncea*
22	*Eureca sativa*	*E. sativa*	50	IC 298024	-	78	71 J0002	*B. juncea*
23	Donskaja	*B. juncea*	51	IC 597932	-	79	RTM 16.24	*B. carinata*
24	EC 41329	*B. juncea*	52	RMWR-09-05	*B. juncea*	80	SIVT 17.108	*B. carinata*
25	NBPGR 1	-	53	DRMRIJ-12-65	*B. juncea*	81	SIVT 17.19	*B. juncea*
26	NBPGR 8	-	54	DRMRIJ-12-43	*B. juncea*	82	SBZ 13 30	*B. juncea*
27	NBPGR 15	-	55	DRMRIJ-12-02	*B. juncea*			
28	NBPGR 352	-	56	RH 1231	*B. juncea*			

2.1 Evaluation under natural field conditions

The *Brassica* genotypes were sown on Oct.15, 2017 in a Randomized Block Design. Two rows of each with 3 m length were sown with plant to plant distance of 5-10 cm with a susceptible check (Varuna) sown after each two rows. Thinning of plants was done after 15 days of germination and two irrigations were applied during entire crop growth. Recommended doses of $N_{80}P_{40}K_{40}$ sulphur$_{40}$ Kg/ha was applied in the field. Half dose of nitrozen in the form of Urea was applied as broadcast 5 days after first irrigation. Ten plants were randomly selected in each row of each genotype and tagged to record observations. The observation on disease severity of white rust disease was recorded at 70, 80 and 90 days after sowing (DAS) using 0-9 rating scale (Conn *et al*, 1990) [4].

Rating score	Leaf area covered ((%)	Disease reaction
0	No symptoms	Immune (I)
1	<5	Highly resistant (HR)
3	5 – 10	Resistant (R)
5	11 – 25	Moderately resistant (MR)
7	26 – 50	Susceptible (S)
9	>50	Highly susceptible (HS)

With disease observations at different time intervals, Area under disease progress curve (AUDPC) was calculated for each genotypes using formula given by (Wilcox son *et al.*, 1975) [22].

$$AUDPC = \sum_{t=1}^{k-1} \frac{1}{2}\left[(x_i) + (x_i + 1) \ldots (x_i + n)\right]$$

Where

x_i = initial disease index

$x_i + 1$= second disease index

The Apparent infection rate was calculated by using formula given by (Vander plank, 1963) [21]

$$r = \frac{2.3}{t_2 - t_1} \log_{10} \frac{x_2(1 - x_1)}{x_1(1 - x_2)}$$

Where

However, disease response (resistant/susceptible) in all the genotypes was determined at maximum disease pressure at 90 DAS.

2.2 Statistical Analysis: Data obtained from the experiment was analyzed by using OPSTAT software in RBD at 0.05% probability level.

3. Result and Discussion

3.1 Disease reaction on the basis of percent disease severity at 90 DAS

Among different Brassica genotypes evaluated at different time intervals, out of 82 genotypes, 26 genotypes *viz*. Donskaja, NRCRD 515, Wester, DLSC 1, NBPGR 8, NBPGR 352, NBPGR 407, NBPGR 410, NBPGR 426, NBPGR 427, NBPGR 428, NBPGR 429, NBPGR 433, NBPGR 434, NBPGR 437, NBPGR 439, IC 298024, IC 313379, IC 317528, IC 313378, IC 313379, IC 265495, IC 298024, IC 597942, SIVT 17.108, RTM 16.24, were found immune or free from disease with 0.0 percent disease severity index, while 28 genotypes *viz*. Candle (18.33), Cutlasss (20.00), *Sinapis alba* (16.67), *Eureca sativa* (11.33), NBPGR 1 (25.0), NBPGR 15 (25.0), IC 597932 (20.0), RMWR-09-05 (15.0), DRMRIJ-12-65 (23.3), DRMRIJ-12-06 (25.0), NPJ 217 (15.0), RMM-09-10 (11.67), DRMRIJ-127(21.4), RMWR-09-5-1(11.67), RH-14-001(15.0), DRMR 2035 (11.67), DRMR 2019 (15.0), RLC 5 15.0), DRMR 12.39 (25.0), RL-JEB-52 (15.0), RH 305 (15.0), DRMR-12-48 (11.67), PDZ-5 (11.67), ABS(3)-15 (15.0), RTM-10-9-1 (15.0), 71J0002 (15.0), SIVT 17.19 (11.67), SBZ 13-30 (15.0) were found moderately resistant at 90 DAS. Rest of the genotypes were found susceptible to highly susceptible (28.0–75.0 percent disease severity) against white rust disease at 90DAS (Table 2). Many earlier workers also evaluated different Brassica genotypes under field conditions and found some genotypes free from disease. Kalpana *et al.* (2017) [6] reported different Brassica species *viz*. turnip red (*Brassica napus*), *Sinapis alba*, PBC 9221 (*Brassica carinata*), PBN 9501 (*Brassica napus)* free from disease while Katili local, Ornamental Rai, *Eureca sativa* were found resistant against the disease. Based on field studies Saharan and Kaushik, 1988; Gupta *et al*., (1994) [18, 5] reported *Brasssica* genotypes *viz*. HC-1, PCC-1 (*B. carinata*), GSL-1501 (*B. napus*), EC-129126-1 and Shiva free from white rust disease.

Similarly, different *B. napus* genotypes *viz*. EC-338997, PBN-2001, EC-339000, PBN 2002 and DGS-1 and *B. carinata* cv. PBC 9221 were free from disease and *B. juncea* genotypes *viz*. CBJ 001, CBJ 003 and CBJ 004 (China), JM06011 (Australia) were found resistant to white rust disease (Kumar and Kalha, 2005; Li *et al.*, 2008.; Meena *et al*., 2011) [13, 14, 15]. In accordance to the present finding this study reveals that Brassica species *viz. Sinapis alba* and *Eureca sativa* which were found free from disease and resistant, respectively by Kalpana *et al*. (2017) [6] reduced their resistance level and found to be moderately resistant against *A. candida* pathogen. Similarly, NBPGR series and IC series which were reported to be immune (0% disease severity) under field conditions were again found free from disease except NBPGR 1, NBPGR 15, IC 597932 which were found moderately resistant with 25.0, 25.0 and 20.0 percent disease severity respectively. Hence continuous screening of resistant genotypes is required to obtain a stable resistant source against the pathogen for effective management (Table 2, figure 1.A & 1.B).

3.2 Infection rate and area under disease progress curve (AUDPC) in different Brassica genotypes

Disease severity in different Brassica genotypes at different time intervals (70, 80 & 90 DAS) clearly revealed gradual progression of disease over time up to 90 DAS. Minimum (0.0949) and maximum (0.1008) infection rate were observed in DRMRJ 127 and 71 J0002 respectively. However, AUDPC for different genotypes was clearly in synchronization with percent disease severity at maximum disease pressure (90 DAS) with minimum AUDPC in SIVT-17-19 (69.44) and maximum in RH 30 (588.0). (Table 2, fig. 1 A& 1 B)). Present finding are in accordance with Kalpana *et al* (2017) [6] who reported low infection rate and AUDPC in EC 399299 and *Raphanus sativus*. Kumar *et al* (2004) [12] also reported resistant genotypes *viz.* RC 781, RH 819, RC 1425, RH 781 and RH 8119 containing low infection rate and AUDPC in comparison to susceptible genotypes.

Table 2: Disease severity, disease reaction and AUDPC of *A. candida* on different Brassica species/genotypes under field conditions (Pooled data of 2017-18 and 2018-19)

S. No.	Brassica Genotype	% Disease severity									Infection Rate	AUDPC
		70DAS	Ang*	DR	80DAS	Ang*	DR	90DAS	Ang*	DR		
1	Varuna	40.33	39.41	S	53.33	46.89	HS	73.33	58.91	HS	0.0299	575.56
2	Pusa Bold	39.33	38.82	S	48.33	44.03	S	65.00	53.74	HS	0.0251	498.89
3	TL 15	15.33	23.00	MR	21.67	27.70	MR	33.00	35.05	S	0.0383	235.56
4	Candle	8.33	16.59	R	15.00	22.59	MR	18.33	25.18	MR	0.0394	138.89
5	BSH 1	16.00	23.56	MR	16.67	24.04	MR	31.67	34.22	S	0.0341	207.22
6	Kranti	42.33	40.57	S	51.67	45.94	HS	65.00	53.74	HS	0.0214	515.00
7	Ragini	20.00	26.55	MR	25.00	29.98	MR	32.00	34.43	S	0.0235	245.56
8	RL 1359	30.00	33.20	S	33.33	35.24	S	53.33	46.89	HS	0.0288	369.44
9	Pusa Kalyani	22.67	28.40	MR	21.67	27.70	MR	36.67	37.24	S	0.0241	254.44
10	Torch	16.33	23.81	MR	15.00	22.78	MR	30.00	33.15	S	0.0304	193.89
11	Tobin	14.00	21.96	MR	17.33	24.56	MR	28.00	29.91	MR	0.0290	187.22
12	Bhawani	22.00	27.93	MR	32.67	34.83	S	41.67	40.18	S	0.0319	315.00
13	*Sinapis alba*	3.33	8.61	HR	10.00	18.04	R	16.67	24.04	MR	0.0805	113.89
14	DLSC 1	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
15	YSPB 24	32.33	34.63	S	28.33	32.13	S	43.33	41.15	S	0.0146	315.00
16	Wester	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
17	Heera	33.33	35.24	S	30.00	33.20	S	43.33	41.15	S	0.0131	325.00
18	Cutlass	8.33	16.59	MR	16.67	23.73	MR	20.00	26.44	MR	0.0438	155.56
19	Sangam	14.33	22.23	MR	18.33	25.30	MR	28.00	29.91	S	0.0278	185.56

20	RH 30	40.00	39.22	S	58.33	49.78	HS	75.00	60.05	HS	0.0314	588.89
21	NRCDR 515	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
22	*Eureca sativa*	3.33	8.61	HR	6.67	14.75	R	11.33	16.59	MR	0.0803	91.41
23	Donskaja	0.00	0.00		0.00	0.00	I	0.00	0.00	I	0.00	0.00
24	EC 41329	36.67	37.24	HS	41.67	40.18	S	45.00	42.10	S	0.0102	391.67
25	NBPGR 1	4.33	11.93	HR	11.67	19.88	MR	25.00	29.91	MR	0.0876	140.56
26	NBPGR 8	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
27	NBPGR 15	12.33	20.49	MR	12.33	20.49	MR	25.00	29.91	MR	0.0353	157.22
28	NBPGR 352	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
29	NBPGR 407	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
30	NBPGR 410	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
31	NBPGR 426	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
32	NBPGR 427	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
33	NBPGR 428	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
34	NBPGR 429	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
35	NBPGR 433	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
36	NBPGR 434	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
37	NBPGR 437	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
38	NBPGR 439	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
39	PRD.14.16	42.00	40.38	S	53.33	46.89	HS	66.67	54.76	HS	0.0231	497.78
40	PRD.14.25	38.33	38.23	S	38.33	38.23	S	45.00	42.10	S	0.0080	372.22
41	PRD.34.20	51.67	45.94	HS	53.33	46.89	HS	66.67	54.76	HS	0.0127	530.56
42	PAB.14.57	40.00	39.20	S	41.67	40.18	S	45.00	42.10	S	0.0059	391.67
43	IC 313379	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
44	IC 298024	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
45	IC 597932	6.67	13.70	R	12.67	20.81	MR	20.00	27.22	MR	0.0240	126.06
46	IC 317528	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
47	IC 313378	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
48	IC 313379	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
49	IC 265495	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
50	IC 298024	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
51	IC 597942	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
52	RMWR-09-05	3.00	9.72	HR	5.00	12.92	HR	15.00	22.59	MR	0.0805	76.67
53	DRMRIJ-12-65	10.00	18.43	R	11.67	19.88	MR	23.33	28.65	MR	0.0424	144.44
54	DRMRIJ-12-43	20.00	26.55	MR	30.00	33.15	S	41.67	40.18	S	0.0367	300.00
55	DRMRIJ-12-02	18.33	25.30	MR	21.67	27.70	MR	36.67	37.19	S	0.0347	252.78
56	RH 1231	26.67	31.06	S	31.67	34.22	S	38.33	38.23	S	0.0181	313.89
57	DRMRIJ 12-06	12.33	20.49	MR	15.67	23.20	MR	25.00	29.91	MR	0.0353	170.56
58	NPJ 217	4.33	11.93	HR	6.67	14.75	R	15.00	22.59	MR	0.0621	82.78
59	EC 399301	26.67	31.06	S	35.00	36.22	S	50.00	44.98	S	0.0178	335.56
60	RMM-09-10	3.00	9.72	HR	6.67	14.75	R	11.67	19.88	MR	0.0679	72.22
61	DRMRJ 127	2.00	8.13	HR	10.00	18.04	R	13.33	21.14	MR	0.0949	87.22
62	RMWR-09-5-1	5.00	12.92	HR	6.67	14.75	R	11.67	19.88	MR	0.0424	74.44
63	RH.14.001	6.67	14.75	R	6.67	14.75	R	15.00	22.59	MR	0.0406	88.33
64	DRMR 2035	6.67	14.75	R	6.67	14.75	R	11.67	19.88	MR	0.0280	77.22
65	DRMR 2019	5.00	12.92	HR	7.33	15.59	R	15.00	22.59	MR	0.0549	87.78
66	RLC-5	4.00	11.32	HR	6.67	14.75	R	15.00	22.59	MR	0.0661	82.22
67	DRMR 12.39	8.33	16.59	R	13.00	21.10	MR	25.00	29.91	MR	0.0549	151.67
68	DRMRIJ 12.40	18.33	25.30	MR	26.67	31.06	S	45.33	42.30	S	0.0453	292.78
69	RL-JEB-52	5.00	12.92	HR	6.67	14.75	R	15.00	22.59	MR	0.0549	85.56
70	RH 305	4.00	11.32	HR	10.33	18.46	R	15.00	22.59	MR	0.0661	99.44
71	DRMR-12-48	5.00	12.92	HR	8.33	16.59	R	11.67	19.88	MR	0.0168	74.44
72	RMM-09-6-1	35.00	36.22	S	50.00	44.98	S	55.00	47.86	HS	0.0226	452.78
73	PDZ 5	6.67	14.75	R	10.00	18.04	R	11.67	19.88	MR	0.0280	85.56
74	ABS(3)-15	6.67	14.75	R	8.33	16.59	R	15.00	22.59	MR	0.0294	92.22
75	RTM-10-9-1	3.00	9.72	HR	8.33	16.59	R	15.00	22.59	MR	0.0805	91.11
76	PDZ 3	15.00	22.59	MR	23.33	28.84	MR	35.00	36.22	S	0.0424	241.11
77	DRMR 5206	16.67	24.04	MR	36.67	37.24	S	35.00	36.22	S	0.0371	305.56
78	71 J0002	2.00	8.13	HR	9.67	17.91	R	15.00	22.59	MR	0.1008	91.67
79	RTM 16.24	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
80	SIVT 17.108	0.00	0.00	I	0.00	0.00	I	0.00	0.00	I	0.00	0.00
81	SIVT 17.19	2.00	8.13	HR	6.67	14.75	R	11.67	19.88	MR	0.0882	69.44
82	SBZ 13 30	6.67	14.75	R	13.33	20.95	MR	15.00	22.59	MR	0.0406	107.78
CD 5%		3.49			3.68			4.37				
CV		11.18			10.31			9.76				

*Angular transformed value

I: Immune, HR: Highly resistant, MR: Moderately resistant, R: Resistant,

S: Susceptible, HS: Highly susceptible

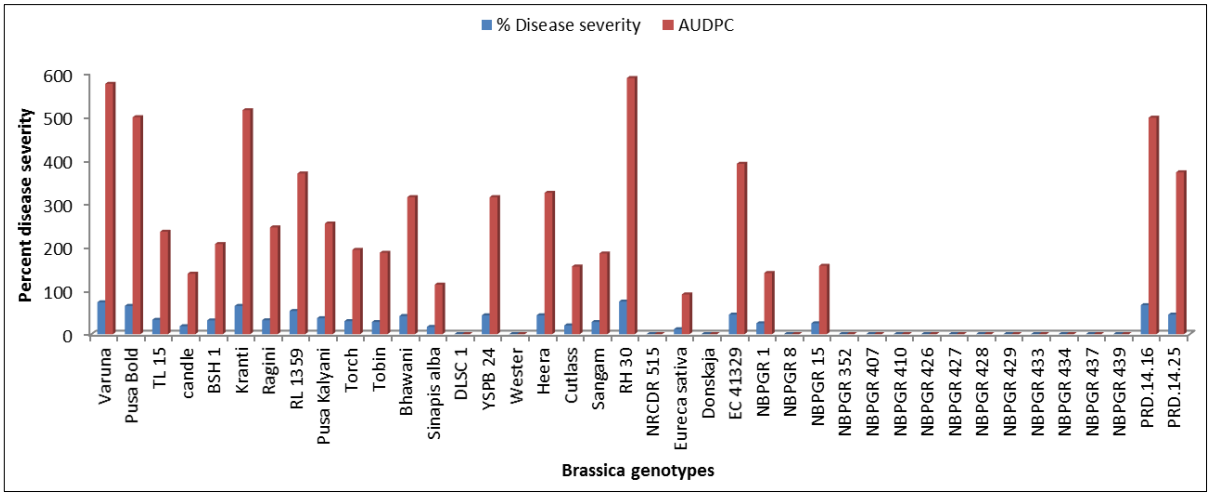

Fig 1(A): Percent disease severity (90DAS) and AUDPC of *A. candida* on different Brassica species under field conditions

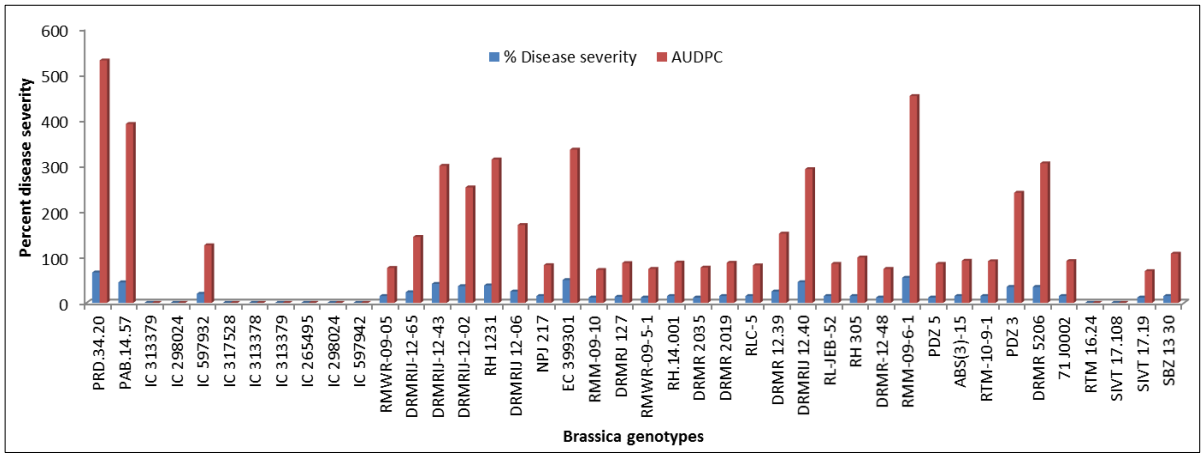

Fig 1(B): Percent disease severity (90DAS) and AUDPC of *A. candida* on different Brassica genotypes under field conditions

4. Conclusion

The present investigation on evaluation of different Brassica genotypes under natural field conditions against white rust disease revealed that continuous evaluation of new genotypes as well as existing resistant genotypes is needed as evolution and emergence of new pathogenic races, may cause break down of existing resistant sources. However, for the final confirmation of resistance, the genotypes which have been found free from disease or resistant under field conditions need to be evaluated in glasshouse also under artificial epiphytotic conditions to assure if absence of disease in field condition is due to true resistance in that genotype or an escape from disease due to unfavorable environmental conditions for disease development. The Brassica species which are free from disease or highly resistant against *A. candida* pathogen can not only be used as resistant sources against the disease but also as potential sources for selection of differential hosts for finding out *A. candida* pathotypes/races.

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