RESISTANCE TO WHITE RUST (ALBUGO CANDIDA) IN INDIAN MUSTARD

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INTRODUCTION

White rust caused by Albugo candida (Pers.ex.Lev) Kuntz, is an important disease of Indian mustard (Brassica juncea) and other crucifers. The disease is more damaging when it attacks the floral parts, causing deformities. It caused a loss of around 20 per cent in a large acreage of mustard in Rajasthan, a north-western state of India, when it appeared in an epiphytotic form (Verma and Bhowmik, 1989). Resistance to A. candida is more common in Brassica napus and Brassica carinata but it is less common in Brassica campestris and limited in B. juncea. According to Downey and Robbelen (1989), a number of yellow seeded oriental cultivars of B. juncea show resistance to race 2 of white rust. Although a number of cultivars of B. juncea have been reported as tolerant to white rust (Rai, 1989), information on the inheritance of its resistance is scanty. Although chemical control measures have been reported, these are not economically feasible on a commercial scale. Breeding of resistant varieties and their cultivation offers the most economical and lasting control. The present report deals with the isolation of resistance to white rust and its inheritance in Indian mustard.

MATERIALS AND METHODS

The material for the present investigation comprised of heterogeneous bulk of Dira-313, subjected to selection under heavy natural infection of Albugo candida during rabi 1988-89 (winter). Selected resistant/tolerant lines were further screened under natural epiphytotic conditions at two locations over 5 seasons i.e. Wellington Nilgiri Hills, Southern latitudes in 1989 and 1990 and New Delhi, Northern plains, during rabi seasons (winter) 1988-89, 1989-90 and 1990-91. Incidence of white rust during all the seasons was heavy except at Delhi in 1989-90 when it was of moderate intensity. Cultivars Pusa Bold and Varuna were used as susceptibile checks.

To study the Genetics of rust resistance, resistant isolate of Dira-313 namely Dira-313-6 was crossed with the susceptible parent Dira-335 in 1988-89 winter at Delhi. F_1, BC_1, BC_2, F_2 and F_3 generations were developed by utilizing the off season summer nursery facilities at Wellington, Nilgiri Hills in Southern India. Experimental material comprising of parents and different generations of the cross Dira-335 x Dira-313-6, was planted at New Delhi during the rabi (winter) 1990-91. This material was planted in the middle of November i.e. nearly a month later than the normal sowing time. The onset of winter was relatively earlier than usual and conditions were favourable for the development of the disease. During middle of December the crop was sprayed

with aqueous suspension of oospores collected from hypertrophied plant parts of mustard crop grown in the preceding seasons at New Delhi and Wellington in 1990. A spray of Zoospores, collected from the same field during the season, was given in the middle of January. Humidity in the experimental plot, was maintained by supplemental irrigations prior to spraying with the inoculum. Infection of white rust during the season in general, was adequate reaching very heavy in the experimental plots. Rust data were recorded on the plants during the peak period of infection. Plants showing no rust pustules were considered as resistant. Rust data recorded in different generations, were subjected to Chi-Square analysis to test the goodness of fit of segregation ratios.

RESULTS AND DISCUSSION

Data pertaining to the evaluation of Dira-313-6 in relation to susceptible Checks Pusa Bold and Varuna are presented in Table-1. It would be seen that Dira-313-6 which was isolated from a heterogenous mixture of Dira-313 bulk, has been found to be resistant to white rust during the last five seasons, whereas checks showed moderate to high level of susceptibility to white rust. Dira-313-6 has shown consistent performance for resistance over five seasons and two diverse locations extending from New Delhi in the North Western Plains to the higher southern latitude (around 6000 ft. a.m.s.l.) of Wellington in the Nilgiri hills. Wellington is also known to be hot spot for a number of diseases of crop plants including white rust (Albugo candida). Dira-313-6 therefore, can be said to be resistant to the prevalent race (s) of white rust. However, the information on the race flora in the region is lacking and needs attention of pathologists to study the pathogenic variability. In addition to resistance to white rust, Dira-313-6 has bold yellow seeds with high oil content.

Data pertaining to inheritance of white rust resistance to Dira-313-6(P2) in its cross with susceptible parent Dira-335(P1) in different generations namely F_1, BC_1, BC_2, F_2 and F_3, is presented in Table-2. All F_1 plants showed resistant reaction, suggesting dominance of resistance. F_2 and F_3 generations data confirmed to monogenic dominant behaviour of resistance. Back cross to the susceptible parent Dira-335 revealed 1R:1S segregation whereas that with resistant parent, gave all resistant plants. Therefore, the pattern of segregation for white rust resistance indicated monogenic dominant nature of its inheritance. There are limited reports on the inheritance of resistance to white rust in B. juncea. Thakral and Singh (1986), in an analysis of gene action for white rust resistance through generation means, in two crosses namely EC 12749 x Parkash (R x S) and EC 12749 X Varuna (R x S) found the importance of additive, dominance and epistatic effects.

There are reports of resistance to Albugo candida in other related crucifers. Williams and Pound (1963) reported monogenic dominant control of resistance to white rust race 1 in two cultivars CRW and RBS of Radish (Raphdnus sativus).

Resistance in CRW was manifested as a hypersensitive reaction, which could be modified by minor genes. Ebrahimi *et al.* (1976) reported resistance of *Brassica juncea*, *B. campestris* and *B. carinata* against race 2 of *Albugo candida*; Fan *et al.* (1983) reported inheritance of resistance to race 7 in a Canadian cultivar 'Regent' of *Brassica napus* in crosses with two susceptible lines. Resistance was found to be governed by independent dominant genes at three loci and 'Regent' population being heterozygous at one of the three loci for white rust resistance. Varma and Bhowmik (1989) studied the inheritance of resistance to *Brassica juncea* pathotype of *A. candida* in *Brassica napus* (BN-Sel). Resistance was conditioned by dominant duplicate genes. Results of the present study on the inheritance of white rust resistance in *B. juncea* are similar to those of Williams and Pound (1963) but differ from those of Varma and Bhowmik (1989). On the basis of available information, the nature of resistance to white rust in *Brassica* species and some related genera, appears to be under the control of major dominant gene(s). There are reports, that indicate the prevalence of race 2 of *A. candida* in *B. juncea* in Canada (Pound and Williams, 1963). Downey and Robbelen (1987) have reported that many oriental (yellow seeded) *B. juncea* cultivars are resistant to race 2 of *A. candida*. Dira-313-6 the resistant source reported here is also a yellow seeded *B. juncea* and it is likely that it confers resistance against race 2 of *Albugo candida*. However, this needs further confirmation.

CONCLUSIONS

Studies conducted during the continuous five seasons which include a hot spot location (Wellington, Nilgiri Hills of Southern India) indicate Dira 313-6 (with yellow bold seeds) to be resistant to the race/races of white rust prevalent under field conditions, though the detailed information on the race flora is lacking. Study of inheritance of resistance to white rust in different generations of the cross involving two parents Dira 335(P1) and Dira 313-6 (P2), indicated towards monogenic dominant behaviour of inheritance. Considering the fact that race 2 of *Albugo candida* has been reported on *Brassica juncea* and that number of yellow seeded oriental cultivars of *B. juncea* have been reported resistant to race 2 of white rust (Downey and Robbelen, 1989) it is probable that yellow seeded Dira 313-6 found resistant against prevalent races of white rust over seasons and geographically and agroclimatically diverse locations may also include resistance against race-2.

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Table-1. Resistance of Dira 313-6 in relation to Checks Pusa Bold and Varuna

Source	Wellington (Summer)		New Delhi (Winter, rabi)		
	1989	1990	1988-89	1989-90	1990-91
Dira 313-6	R	R	R	R	R
Checks					
Pusa Bold	S	HS	HS	MS	HS
Varuna	HS	MS	HS	MS	HS

R= Resistant; S= Susceptible; HS= Highly susceptible; MS = Moderately susceptible.

Table-2. Inheritance of white rust resistance in a *Brassica juncea* cross, Dira-335 x Dira-313-6

Source Cross/Parents	GEN(1)	NP/F(2)			Total	X^2	P	MS(3)
		R	Seg (3:1)	S				
Dira-335(S)	P1	-	-	25	25			
Dira 313-6(R)	P2	20	-	-	20			
(Dira 335 x Dira 313-6)	F_1	15	-	-	15			
	F_2	60	-	19	79	0.038	0.80-0.90	3:1
	F_3	13	26	4	43	5.650	0.05-0.10	1:2:1
(Dira 335 x Dira 313-6) x Dira 335	BC-1	18	-	12	30	1.200	0.20-0.30	1:1
(Dira 335 x Dira 313-6) x Dira 313-6	BC-2	38	-	-	38			

R= Resistant, S= Susceptible; Seg= Segregation

(1) Generation

(2) Number of Plants/Families

(3) Mode of Segregation