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Fungicidal management of foliar diseases of mustard in mid-eastern India

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ABSTRACT: Alternaria blight (AB), white rust (WR), and downy mildew (DM) of mustard caused by *Alternaria brassicae*, *A. brassicicola; Albugo candida* and *Peronospora parasitica*, respectively, occur severely across Uttar Pradesh, Bihar and Jharkhand. Seed treatment with Apron 35 SD @ 06g kg^{-1} gave only marginal, though significantly superior, disease control and yield gain over untreated check with cost-benefit ratio of 1: 8.8. Seed treatment combined with three foliar sprays of Mancozeb 75% WP (0.2%) at 15 days interval, beginning 45 days after sowing, resulted in lowest AB, highest seed yield and cost-benefit ratio of 1:5.2. It was followed by foliar sprays of Mancozeb 75% WP alone in all respects. Highest avoidable losses due to the combined effect of these diseases in seed yield, seed test weight and oil content were 34.7, 13.1 and 4.2%, respectively. NDR 8501 performed best under unprotected and Varuna under protected condition, former giving higher seed test weight.

Key words: *Brassica juncea,* Alternaria blight, white rust, downy mildew, yield loss, fungicidal management

The oilseed crops, especially *Brassica* spp., play a pivotal role in the agricultural economy of India. Rapeseed-mustard, among these, are important *rabi* crops of mid-eastern India, comprising Uttar Pradesh, Bihar and Jharkhand. Productivity of the crop, in the region, however, is reduced due to a number of foliar diseases, viz., Alternaria blight, white rust, downy mildew and powdery mildew. These diseases cause severe losses, both, qualitative and quantitative in north-western India (Kolte, 1985; Saharan *et al.*, 1997). Therefore, investigations were undertaken to study their occurrence, distribution, avoidable yield losses and management.

MATERIALS AND METHODS

Investigations were carried out at 4 locations during 1996-97 to 2000-01 following recommended agronomic practices with 80 N : 40 P : 40 K in kg ha^{-1}.

Survey trips were organized in the middle of November, December, January and February in Uttar Pradesh, Bihar and Jharkhand in 1997-98, 98-99 and 99-2000. Road survey was undertaken to Kanpur, Lucknow, Faizabad, Varanasi, Buxur, Patna, Gaya, Gomoh, Bokaro, Muri and Ranchi. Samples collected from farmers' fields and experimental plots were studied for symptomatology and etiology of the diseases. The causal fungi were isolated and their pathologenicity tested. *Brassica juncea* cv. Varuna was used as susceptible host. Suitable checks were also maintained. Disease incidence and severity were recorded on timely sown (15 to 20 October) crop across 60 locations. Disease severity was recorded following the scale of Conn *et al.* (1990) for Alternaria blight, Lakra and Saharan (1989) for white rust and Natti *et al.* (1967) for downy mildew. Per cent disease intensity (PDI) was calculated using formula PDI = [Total numerical rating/Total number of observations taken x Maximum disease score] x 100.

Trials were conducted in randomized block design with 4 replications, in the same field, during 1996-97 to 1998-99 crop seasons. Test variety Varuna was sown on November 02 with a spacing of 30 cm x 10 cm in plots of 05 m x 03 m size. Treatments included seed treatment (ST) with Apron 35 SD @ 06 g kg^{-1} alone, ST followed by three

foliar sprays (FS) of 0.2% Indofil M 45 (Mancozeb) @ 1000 ha^{-1}, ST followed by two FS of 0.25% Ridomil MZ 72 (Mancozeb + Metalaxyl), three FS of 0.2% Indofil M 45, two FS of 0.25% Ridomil MZ 72 and untreated check. Indofil M 45 spray was given at 45 days after sowing (DAS) and was repeated at 15 days intervals while Ridomil MZ 72 spray was given at 60 DAS followed by the second spray at 80 DAS. Efficacy of the treatments in managing individual diseases was assessed by comparing their PDI. Overall efficacy and economics of these treatments, in managing foliar diseases, was worked out by comparing their mean disease intensity, seed yield, additional net income and cost-benefit (CB) ratio.

Avoidable yield loss (AYL) due to combined effect of these foliar diseases was calculated using seed yield data from the fungicidal management trials following formula AYL = [(Yp-Yu) / Yp] x 100 where, Yp = Yield under protected condition and Yu = Yield under unprotected condition.

Another trial was conducted concurrently to assess losses in commercial varieties NDR 8501, Varuna, Kranti, Krishna, Rohini and Vardan using a split-plot design having three replications sown in plots of 05 m x 03 m with 30 cm x 10 cm spacing on 16 October. Treatment with Apron 35 SD followed by FS of Indofil M 45, and unprotected served as main plot and varieties as sub-plot. Thousand seed weight (g), seed yield (kg ha^{-1}) and oil content (%) were recorded to calculate respective yield losses.

RESULTS AND DISCUSSION

Alternaria blight, white rust and downy mildew were recorded on mustard crops grown along the route in Uttar Pradesh, Bihar and Jharkhand during 1997-98 to 1999-2000. Plants showed a variety of symptoms individually and in mixed infections, as reported earlier from north-western India (Kolte, 1985; Saharan *et al.*, 1997). Both blight and downy mildew appeared in mid-November and continued till February on all the varieties. The severity was more on the check variety Varuna. The white rust developed in mid-December and continued till February. Staghead production, though observed sporadically, was economically important only in diara land areas. Fungi isolated from diseased samples were pathogenic and produced typical Alternaria blight, white rust and downy mildew symptoms on vegetative and reproductive plant parts. *Alternaria brassicae* (Berk) Sacc. and *Alternaria brassicicola* (Schwein) Wiltshire, *Albugo candida* (Pers. Ex Lev.) Kuntze and *Peronospora parasitica* (Pers. Ex Fr.) Fr. were isolated as reported by other workers (Saharan *et al.*, 1997).

Fungicidal management

All the fungicidal treatments (Table 1), namely, ST with Apron 35 SD @ 06g kg^{-1}, ST + three FS of Indofil M 45 (0.2%) at 15 days interval, beginning 45 DAS, ST + 2 FS of Ridomil MZ 72 (0.25%) at a 20 days interval beginning 60 DAS and 3 FS of Indofil M 45 and 2 of Ridomil MZ 72, alone, using 1000 litre spray suspension per hectare, gave significantly ($P<0.05$) superior Alternaria blight, white rust and downy mildew control and seed yield. Seed treatment with Apron followed by FS of Indofil M 45 gave 24.0% leaf blight, 32.6% pod blight, 26.0% mean disease severity and 1828.2 kg seed yield / hectare. It was followed by FS of Indofil M 45 alone with 27.6% leaf blight, 37.8% pod blight, 30.5% mean disease intensity and 1726.3 kg seed yield ha^{-1}.

Seed treatment followed by 3 FS of Indofil M 45 gave an income of Rs. 8238.3 with a cost-benefit (C:B) ratio of 1: 5.3. Three FS of Indofil M 45 gave net income of Rs. 7096.3 and CB ratio of 1: 4.9.. Lowest disease reduction, increase in seed yield and highest CB ratio of 1: 8.6 was obtained with ST alone. Thus, based on cost-benefit ratio, ST with Apron 35 SD @ 06g kg^{-1} appears to be the most desirable practice for the management of foliar diseases of mustard in this region. However, to increase production, 3 FS of Indofil M 45 (0.2%), at 15 days interval, beginning 45 DAS should be followed. 0.25% spray of Ridomil MZ 72, either alone or in combination with ST, may be avoided as it gives lower returns.

Downy mildew appears first at the cotyledonary stage. The ST with Apron 35 SD manages the disease effectively and economically as reported earlier (Kolte, 1985, Saharan, 1992) also. Downy mildew was followed by Alternaria blight on leaf and pod with highest severity amongst all the three diseases. Therefore, FS of Indofil M 45, alone or in combination with ST, was most effective and economic. Tripathi *et al.* (1987) also noted the effectiveness of Indofil M 45 against Alternaria

Table 1. Effect of fungicidal treatments on percent disease intensity, seed yield and avoidable yield loss for 1996-97 to 1998-99 (Pooled data)

Treatment	Per cent disease intensity					Yield (kg ha^{-1})	Additional yield (kg ha^{-1})	Avoidable loss (%)	Additional income (Rs.)	Cost : benefit ratio
	Alternaria blight		White rust	Downy mildew	Mean					
	Leaf	Pod								
Seed treatment with Apron	73.7	78.4	55.3	42.5	62.5	1042.7	58.8	5.6	705.7	1:8.8
35 SD @ 6g kg^{-1} seed (ST)	(59.18)	(62.31)	(48.05)	(40.67)						
ST + Indofil M 45 (0.20%)	24.00	32.6	27.00	20.4	26.0	1828.2	844.3	46.2	10131.7	1:5.3
	(29.35)	(34.79)	(30.96)	(26.85)						
ST + Ridomil MZ 72 (0.25%)	41.7	51.5	15.4	10.7	29.8	1637.8	653.8	39.9	7845.7	1:1.0
	(40.24)	(45.84)	(23.05)	(19.07)						
Indofil M 45 (0.20%)	27.6	37.8	32.6	24.0	30.5	1726.3	742.3	43.0	8907.7	1:4.9
	(31.69)	(37.92)	(34.83)	(29.33)						
Ridomil MZ 72 (0.25%)	46.3	57.8	20.6	19.5	36.0	1559.0	575.1	36.9	6900.7	1:0.9
	(42.86)	(49.48)	(26.98)	(26.17)						
Untreated check	78.0	82.6	61.3	46.4	67.1	983.9	-	-	-	
	(62.04)	(65.37)	(51.51)	(42.93)						
SEm±	0.63	0.76	0.57	0.56		9.91				
C.D. (P <0.05)	1.55	1.87	1.40	1.37		24.38				

Table 2. Percent avoidable loss in seed yield, 1000-seed weight and percent oil content in different commercial varieties of mustard due to Alternaria blight, white rust and downy mildew for 1996-97 to 1998-99 (Pooled data)

Variety	Yield (kg ha^{-1})				1000 seed weight (g)				Oil content (%)			
	UP	P	Mean	% loss	UP	P	Mean	% loss	UP	P	Mean	% loss
NDR 8501	1080.0	1688.9	1384.4	36.0	4.9	5.7	5.3	13.6	39.6	41.0	40.3	3.3
Varuna	966.7	1733.3	1350.0	44.2	4.1	4.9	4.5	14.9	39.4	41.6	40.5	5.1
Kranti	1031.1	1528.9	1280.0	32.6	4.1	4.6	4.3	11.3	38.6	39.9	39.2	3.3
Krishna	973.3	1466.7	1220.0	36.1	4.1	4.8	4.5	14.2	38.0	39.8	38.9	4.7
Rohini	973.9	1413.3	1193.6	33.6	4.0	4.7	4.3	13.3	39.0	40.6	39.8	4.0
Vardan	960.0	1301.3	1130.6	26.0	4.0	4.6	4.3	11.6	37.4	39.2	38.3	4.6
Mean	997.5	1522.1		34.7	4.2	4.9		13.1	38.7	40.3		4.2
SEm±												
Main plot (Treatment)		38.67				0.02				0.06		
Sub plot (Variety)		66.93				0.04				0.11		
Treatment x Variety		94.67				0.05				0.15		
C.D. ($P < 0.05$)												
Main plot (Treatment)		111.99				0.06				0.18		
Sub plot (Variety)		193.33				0.11				0.32		
Treatment x Variety		275.99				0.16				0.45		

UP = Unprotected P = Protected

blight at Hissar. Seed treatment combined with FS of Indofil M 45 has also been found highly effective and economic in managing white rust (Bhargava *et al.*, 1997) and white rust-downy mildew complex (Mehta *et al.,* 1996). Puzari and Saikia (1997) noted that ST followed by FS of Ridomil MZ 72 (0.25%) was most effective in controlling downy mildew of rapeseed but less economic as compared to ST followed by FS of Indofil M 45. Most desirable characteristic of metalaxyl (a constituent of Ridomil MZ 72) sprays is its unique efficacy in reducing staghead formation (Mehta *et al.*, 1996), a disease phase virtually absent under our studies, thus making its application uneconomic.

Avoidable yield loss

A comparison of seed yield obtained from Varuna under protection, using ST followed by 3 FS of Indofil M 45, with that of unprotected (Table 1) revealed a yield loss of 46.2%. Other treatments avoided only lower level of yield losses. Comparison of commercial varieties for avoidable yield losses, amongst themselves, showed variable performance (Table 2). On varietal average basis, avoidable losses were around 34.7, 13.1 and 4.2%, respectively, for seed yield, 1000-seed weight and per cent oil content. Loss in seed yield is compounded by reduction in per cent oil content. Highest avoidable losses of 44.2, 14.9 and 5.1%, in seed yield, 1000-seed weight and per cent oil content, respectively, were observed in the case of Varuna, followed by Krishna (36.1, 14.2 and 4.7%). Lowest avoidable loss of 26.0% in seed yield was noted in Vardan and that in 1000-seed weight (11.3%) and per cent oil content (3.3%) in Kranti. NDR 8501 and Varuna gave the highest seed yield, 1000-seed weight and oil content under unprotected and protected conditions, respectively.

Severe yield losses ranging from 35 to 46% due to Alternaria blight (Kolte *et al.*, 1987), 89% due to staghead and 27% due to leaf phase of white rust (Lakra and Saharan, 1989) and 17-32% due to mixed infection of white rust and downy mildew (Bains and Jhooty, 1979) were reported from north-western India. Yield loss estimates for above diseases, singly or jointly, from mid-eastern India had been lacking. Overall, the yield losses under field conditions are lower here than the sum total of losses reported for individual diseases from north-western India. The main factor contributing to the lower level of losses is infrequent occurrence of staghead phase of white rust mixed with downy mildew infections. Reduction in seed quality due to reduced seed size and per cent oil content has also been reported from north-western India (Kaushik *et al.*, 1984).

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