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Full Research Article

Studies on Severity, Comparative Preponderance, Cultural and Morphological Variability of *Alternaria* Species Causing *Alternaria* Blight of Yellow Sarson (*Brassica campestris* L. var. Yellow Sarson Prain)

Sunil Kumar[1], R. B. Singh[2] and R. C. Shakywar[3*]

[1]AICRP on Soybean, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland (797 106), India
[2]Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh (224 229), India
[3]College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh (791 102), India

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Correspondence to

E-mail: rcshakywar@gmail.com

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Abstract

A field experiment was conducted during *rabi* of 2006-07 and 2007-08 to study the severity, comparative preponderance, cultural and morphological variability of *Alternaria* spp. causing *Alternaria* blight of yellow *sarson* (*Brassica campestris* L. var. yellow *sarson* Prain) in field as well as in laboratory of Plant Pathology (NDUAT, Kumarganj, Faizabad). *Alternaria* blight initiated earliest on second week of December during both the years in the cultivars NDYS 2 and NDYS 2018 attaining highest PDI of 69.90 and 69.95% during first year and 75.60 and 76.65% during second year, respectively in 20 October sown crop. Among the entries average maximum colony diameter of *A. brassicae* was noted in NDYS 2018 (35.67 mm) with range of 34-38 mm followed by NDYS 123 (34.67 mm) with range of 33-37 mm and NDYS 2 (34.33 mm) with range of 32-36 mm. Both the species i.e. *A. brassicae* and *Alternaria brassicicola* were isolated from infected leaf, stem and pods. Average maximum conidial width of *A. brassicae* and *A. brassicicola* was noted in case of leaves (20.57 µ and 12.60 µ) followed by pods (19.11 µ and 11.59 µ) and stem (14.74 µ and 10.93 µ), respectively. Frequency of occurrence of *Alternaria brassicae* was noted higher in case of affected leaves and pods, while *Alternaria brassicicola* was found higher in affected stem. *Alternaria brassicae* and *Alternaria brassicicola* isolates obtained from leaves, stem and pods showed variability in colony diameter, shape and size of conidiophores, conidia and septation in conidia.

1. Introduction

Rapeseed-mustard is the most important oilseed crops grown in north-eastern part of India. Among them yellow sarson is most important which have higher oil content. This crop is highly susceptible to *Alternaria* blight disease (Kolte et al., 1987). Among the various biotic diseases on this crop, *Alternaria* blight is caused by *Alternaria brassicae* (Berk.) Sacc and *Alternaria brassicicola* (Schwein) Wiltshire is most important and causes yield reduction up to 47% in Indian mustard (Chattopadhayay, 2008). There are number of workers have been reported on different aspects like cultural variability in *Alternaria* species in respect of mycelial growth and sporulation in different temperature, relative humidity and hydrogen ion concentration (Ansari et al., 1989), conidial length, width and septation in different region isolates (Khan et al., 2007) and conidial length and breadth, beak length and septation (transverse and longitudinal) (Goyal et al., 2011). Considering the importance of the crop, destructive nature of disease and unavailability of information the study was undertaken to investigate the severity of *Alternaria* blight, cultural and morphological variability and comparative preponderance of *Alternaria brassicae* and *Alternaria brassicicola* in different plant part isolates of ten yellow sarson entries.

2. Materials and Methods

The studies were conducted at the Student's Instructional Farm and Plant Pathology laboratory of the Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad, India during *rabi* of 2006-07 and 2007-08. A trial consisting of 10 yellow sarson entries namely YST 151, NDYS

2, NDYS 117, NDYS 123, NDYS 2018, NDYS 116-1, NDYS 107, NDYS 119, NDYS 115-1 and NDYS 132-2 were planted on 20 October, 30 October and 10 November during 2006-07 and 2007-08 to investigate the first initiation, maximum severity of *Alternaria* blight, comparative preponderance of *Alternaria brassicae* and *Alternaria brassicicola*, cultural and morphological variability. Ten plants in each plot were randomly selected and tagged. *Alternaria* blight severity was measured visually as per cent affected area on lower, middle and upper leaves following 0-5 scale (Conn et al., 1990). Reading were averaged to calculate the per cent disease intensity (PDI)=[Total numerical rating/Total number of observations taken×Highest disease score]×100 (Van der Plank, 1963).

Arial part of yellow sarson plants showing typical blight symptoms on leaf, stem and pods were collected from experimental fields randomly at 75, 90 and 105 days after sowing. The samples were kept in rough dry paper envelops, especially meant for the purpose. The samples maintained for the purpose were taken up, separately for isolation. These were washed using sterilized water and cut into small pieces by sterilized scalpel and forceps. These pieces were surface sterilized with 0.1% H_gCl_2 solution and washed thoroughly three to four times with sterilized water. These were de-moisturized by placing them between folds of sterilized blotting papers and transferred aseptically to Petri dishes containing potato dextrose agar medium. On initiation of the mycelium growth around these pieces, the hyphal tips from the advancing mycelia were cut using cork borer and transferred into potato dextrose agar slants for further study. The pure culture of the isolates was obtained through single spore isolation technique.

A total of 30 mono-conidial isolates, each entry from leaf, stem and pods (10 from each part) were selected for the variability studies. Temporary slides were prepared, using lectophenol from 10 days old cultures. Slides were examined with the help of a binocular compound microscope under low and high magnification. Observations were recorded for colony diameter, length, width, size and number of septa in the conidiophores and conidia of individual isolates. To maintain uniformity, 50 counts were made and data averaged. For per cent frequency of isolation of individual species, a total of 300 isolates, 10 each from leaf, stem and pods of 10 yellow sarson entries were obtained and calculate the frequencies.

3. Results and Discussion

3.1. Effect of date of sowing

The initial symptoms of *Alternaria* blight was noted on 09 December and 11 December during 2006-07 and 2007-08 in the entry NDYS 2 attaining highest PDI of 69.90 and 75.40%, respectively in 20 October sown crop (Table 1). In 30 October sown crop the disease initiation was noted on 03 and 15 December during 2006-07 and 2007-08 on same entry. However, in 10th November sown crop the initiation of disease was noted on 18th December during 2006-07 in the entries YST 151, NDYS 2 and NDYS 115-1 attaining highest PDI of 64.80, 66.80 and 57.45%, respectively and during 2007-08 it appeared on 19 December in NDYS 107 attaining highest PDI of 63.00%. In general the initiation of *Alternaria* blight in 20 October sown crop was noted after 50 to 54 days and 52 to 56 days after sowing during 2006-07 and 2007-08 and duration to attain highest PDI was noted 52 to 56 days and 53 to 55 days of its initiation, respectively. In 30th October sown crop the initiation of disease was noted after 44 to 49 days and 46 to 50 days after sowing and highest PDI attained after 51 to 53 days and 51 to 54 days of its initiation during both the years, respectively, while the crop sown on 10 November the appearance of disease was noted after 38 to 42 days and 39 to 43 days after sowing and highest PDI attained after 48 to 51 days and 49 to 52 days from the initiation during both the years. Maximum disease intensity was noted in 30th October sown crop and minimum in 10 November during both the years of testing. Date of sowing had substantial effect on the intensity of *Alternaria* blight. In accordance with present findings Singh and Singh (2006) also reported the highest mean disease intensity in 30th October sown Indian mustard. Gupta et al. (2003) reported increasing blight intensity with delayed sowing in case of rapeseed and mustard. But as against subsequent decline in blight intensity after 20th December at Pantnagar, decline in our case in case of yellow sarson set in the 10th November sown crop itself.

3.2. Colony diameter

In general colony diameter of *A. brassicicola* was found higher in comparison to *A. brassicae* in case of each affected parts (Table 2). Part wise, the maximum average colony diameter of *A. brassicae* and *A. brassicicola* was found in case of leaves (30.70 mm with range of 25-38 mm and 33.40 mm with range of 27-42 mm) followed by pods (28.60 mm with range of 23-35 mm and 30.80 mm with range of 25-34 mm) and stem (26.80 mm with range of 20-34 mm and 28.40 mm with range of 23-36 mm), respectively (Table 2). Among the entries average maximum colony diameter of *A. brassicae* was noted in NDYS 2018 (35.67 mm) with range of 34-38 mm followed by NDYS 123 (34.67 mm) with range of 33-37 mm and NDYS 2 (34.33 mm) with range of 32-36 mm. Minimum colony diameter of 22.67 mm with range of 20-25 mm was noted in NDYS 132-2. Similar trend was recorded in case of *A. brassicicola*.

3.3. Conidiophore

In general the conidiophores of *A. brassicae* were found lengthiest in comparison to *A. brassicicola* in case of each

Table 1: Occurrence and intensity of Alternaria blight of yellow sarson entries sown at different dates

Entries	Date of initiation			Date of highest disease intensity			*DHDI from the date of initiation			Highest disease intensity (%)		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
					2006-07							
YST 151	11.12.06 (52)	13.12.06 (44)	18.12.06 (38)	02.02.07	03.02.07	06.02.07	53	52	50	67.72	72.80	64.80
NDYS 2	09.12.06 (50)	13.12.06 (44)	18.12.06 (38)	30.01.07	02.02.07	04.02.07	52	51	48	69.90	75.55	66.80
NDYS 117	14.12.06 (55)	16.12.06 (47)	22.12.06 (42)	05.02.07	05.02.07	09.02.07	53	51	49	59.95	67.35	60.52
NDYS 123	11.12.06 (52)	16.12.06 (47)	20.12.06 (40)	01.02.07	05.02.07	07.02.07	52	51	49	61.40	68.30	63.27
NDYS 2018	09.12.06 (50)	13.12.06 (44)	20.12.06 (40)	30.01.07	02.02.07	07.02.07	52	51	49	69.85	77.32	66.82
NDYS 116-1	13.12.06 (54)	17.12.06 (48)	21.12.06 (41)	04.02.07	07.02.07	09.02.07	53	52	50	56.90	62.32	59.25
NDYS 107	14.12.06 (55)	16.12.06 (47)	19.12.06 (39)	05.02.07	05.02.07	07.02.07	53	51	50	61.25	68.30	60.85
NDYS 119	14.12.06 (55)	19.12.06 (49)	22.12.06 (42)	07.02.07	10.02.07	11.02.07	55	53	51	51.35	57.95	53.70
NDYS 115-1	13.12.06 (54)	15.12.06 (46)	18.12.06 (38)	04.02.07	05.02.07	06.02.07	53	52	50	52.95	60.00	57.45
NDYS 132-2	13.12.06 (54)	16.12.06 (47)	19.12.06 (39)	05.02.07	07.02.07	07.02.07	54	53	50	56.30	64.37	58.35
					2007-08							
YST 151	12.12.07 (53)	15.12.07 (46)	20.12.07 (40)	04.02.08	06.02.08	08.02.08	54	53	50	70.80	74.93	65.85
NDYS 2	11.12.07 (52)	15.12.07 (46)	20.12.07 (40)	02.02.08	05.02.08	07.02.08	53	52	49	75.40	78.02	67.90
NDYS 117	12.12.07 (53)	16.12.07 (47)	22.12.07 (42)	05.02.08	07.02.08	10.02.08	55	53	50	68.80	72.37	62.65
NDYS 123	13.12.07 (54)	17.12.07 (48)	22.12.07 (42)	04.02.08	06.02.08	09.02.08	53	51	50	71.25	75.83	66.10
NDYS 2018	11.12.07 (52)	16.12.07 (47)	22.12.07 (42)	02.02.08	07.02.08	09.02.08	53	51	49	76.65	77.95	68.95
NDYS 116-1	12.12.07 (53)	17.12.07 (48)	22.12.07 (42)	04.02.08	08.02.08	10.02.08	54	53	50	67.80	71.36	61.79
NDYS 107	12.12.07 (53)	15.12.07 (46)	19.12.07 (39)	03.02.08	05.02.08	07.02.08	53	52	50	66.35	70.75	63.00
NDYS 119	15.12.07 (56)	19.12.07 (50)	23.12.07 (43)	08.02.08	11.02.08	13.02.08	55	54	52	59.05	64.25	56.85
NDYS 115-1	14.12.07 (55)	16.12.07 (47)	20.12.07 (40)	05.02.08	06.02.08	09.02.08	53	52	51	65.00	69.10	60.90
NDYS 132-2	13.12.07 (54)	16.12.07 (47)	21.12.07 (41)	04.02.08	07.02.08	11.02.08	53	53	52	67.72	70.35	63.85

Figure in parentheses are days after sowing; D_1: 20th Oct; D_2: 30 Oct; D_3: 10th Nov.; *DHDI: Days to highest disease intensity

affected parts. Average lengthiest conidiophores of *A. brassicae* and *A. brassicicola* was found in case of leaves (64.04 µ and 39.68 µ) followed by pod (62.11 µ and 37.46 µ) and stem (58.64 µ and 36.33 µ), respectively. Among the entries average maximum length of conidiophores of *A. brassicae* was noted in the isolates of NDYS 2018 (71.24 µ with range of 68.89-73.92 µ followed by NDYS 123 (67.65 µ) with range of 64.36-70.19 µ and NDYS 2 (65.71 µ) with range of 59.91-70.31 µ. Shortest conidiophore of 55.48 µ was found in NDYS 119. Lengthiest conidiophores of *A. brassicicola* was also noted in same entry i.e. NDYS 2018 (41.70 µ) followed by NDYS 2 (41.47 µ) and YST 151 (41.20 µµ). Shortest conidiophore of *A. brassicicola* was found in NDYS 132-2 (34.69 µµ). Conidiophores length of *A. brassicae* isolates obtained from leaves ranged between 56.67 µ (NDYS 119) to 73.92 µ (NDYS 2018), from stem between 53.79 µ (NDYS 119) to 68.89 µ (NDYS 2018) and from pods between 55.97 µ (NDYS 119) to 70.91 µ (NDYS 2018), respectively. Conidiophores length of *A. brassicicola* obtained from leaves ranged between 35.60 µ (NDYS 132-2) to 46.39 µ (YST 151), from stem between 33.69 µ (NDYS 132-2) to 40.69 µ (NDYS 2018) and from pods between 33.75 µ (NDYS 117) to 41.79 µ (NDYS 2018), respectively.

In general the conidiophores of *A. brassicae* were widest in comparison to *A. brassicicola* in case of each affected parts. Average widest conidiophores of *A. brassicae* and *A. brassicicola* was found in case of leaves (6.49 µ and 5.18 µ) followed by pod (5.77 µ and 4.69 µ) and stem (5.10 µ and 4.50 µ), respectively. In case of entries, average widest conidiophores of *A. brassicae* was noted in NDYS 2018 (7.71 µ) followed by NDYS 107 (6.91 µ) and NDYS 2 (5.94 µ). Narrowest conidiophore of 4.30 µ was noted in NDYS 132-2. Widest conidiophores of *A. brassicicola* was noted in NDYS 107(5.72 µ) followed by NDYS 2018 (5.60 µ) and NDYS 2 (5.14 µ). Narrowest conidiophore of *A. brassicicola* was noted in NDYS 132-2 (3.65 µ). Conidiophores width of *A. brassicae* isolates obtained from leaves ranged between 4.71 to 8.10 µ, from stem between 4.01 to 7.11 µ and from pods 4.19 to 7.91 µ in NDYS 132-2 and NDYS 2018, respectively. Conidiophores width of *A. brassicicola* obtained from leaves also ranged between 3.91 µ (NDYS 132-2) to 5.72 µ (NDYS 2), from stem between 3.41 µ (NDYS 132-2) to 6.29 µ (NDYS 107) and from pods between 3.64 µ (NDYS 132-2) to 5.91 µ (NDYS 2018).

More septation was recorded in conidia of *A. brassicae* isolates in comparison to *A. brassicicola* obtained from different affected parts. Average maximum septation was recorded in conidiophores of *A. brassicae* and *A. brassicicola* obtained from leaves (6.90 and 5.20) followed by pods (5.90 and 4.80) and stem (4.90 and 3.90), respectively. Among the entries mean maximum number of septa in *A. brassicae* was noted in the conidiophores of NDYS 2018 (7.00) followed by NDYS 123 (6.67) and YST 151 (6.00). Minimum septation of 4.33 was noted in conidiophores of NDYS 119. Similar trend was recorded in septation of conidiophores of *A. brassicicola* also in test entries. Number of septa in conidiophores of *A. brassicae* obtained from leaves ranged between 5 (NDYS 119) to 8 (NDYS 2018), from stem between 4 (NDYS 119) to 6 (NDYS 2018) and from pods between 4 (NDYS 119) to 7 (NDYS 2 and NDYS 2018). While in case of *A. brassicicola* septation in conidiophores of leaves ranged between 4 (NDYS 119) to 7 (NDYS 2018), in stem between 3 (YST 151, NDYS 2 and NDYS 119) to 5 (NDYS 2018 and NDYS 107) and in pods between 4 (NDYS 2, NDYS-119 and NDYS 115-1) to 5 (NDYS 2018 and NDYS 107).

3.4. Conidia

In general the conidial length of *A. brassicae* was found more in comparison to *A. brassicicola* in case of each affected parts. Average lengthiest conidia of *A. brassicae* and *A. brassicicola* was noted in case of leaves (169.29 µ and 52.19 µ) followed by pod (148.08 µ and 47.76 µ) and stem (127.76 µ and 44.95 µ) respectively. Among the entries average lengthiest conidia of *A. brassicae* was noted in NDYS 2018 (160.45 µ) followed by NDYS 2 (160.21 µ) and YST 151 (157.41 µ). Shortest conidia of *A. brassicae* (137.63 µ) was noted in NDYS 119. Lengthiest conidia of *A. brassicicola* was also noted in NDYS 2018 (50.73 µ) followed by NDYS 115-1 (49.55 µ) and NDYS 2 (49.46 µ). Shortest conidia of *A. brassicicola* was noted in NDYS 107 (45.57 µ). Length of *A. brassicae* conidia obtained from leaves ranged between 155.75 µ (NDYS 132-2) to 189.67 µ (NDYS 2018), from stem between 115.38 µ (NDYS 115-1) to 137.16 µ (NDYS 2) and from pods between 135.36 µ (NDYS 119) to 160.69 µ (NDYS 2018). Length of *A. brassicicola* conidia obtained from leaves ranged between 48.13 µ (NDYS 107) to 56.30 µ (NDYS 2018), from stem between 42.45 µ (NDYS 119) to 47.39 µ (NDYS 2) and from pods between 45.67 µ (NDYS 107) to 49.67 µ (NDYS 2), respectively (Table 2).

In general width of *Alternaria brassicae* was noted maximum in comparison to *A. brassicicola* in case of all affected plant parts. Average maximum conidial width of *A. brassicae* and *A. brassicicola* was noted in case of leaves (20.57 µ and 12.60 µ) followed by pods (19.11 µ and 11.59 µ) and stem (14.74 µ and 10.93 µ), respectively. Among the entries average widest conidia of *A. brassicae* was noted in NDYS 2018 (21.48 µ) followed by NDYS 115-1 (20.68 µ) and NDYS 132-2 (20.62 µ). Narrowest conidium was found in the NDYS 117 (16.90 µ). Widest conidia of *A. brassicicola* was found in NDYS 2018 (12.87 µ) followed by NDYS 2 (12.66 µ) and NDYS 123 (12.42 µ). Narrowest conidium of *A. brassicicola* was

Table 2: Cultural and morphological variation in conidiophores and conidia of *Alternaria spp.* isolates obtained from plant parts of different entries

Varieties Plant[-1] part	Isolates	Colony Diameter (mm)		Conidiophore						Conidia								Per cent frequency	
				Length		Width		Septation		Length		Width		Septation					
														Transverse		Longitudinal			
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
YST 151	*A. brasicae*	30.00	33-35	62.63	57.91-65.37	5.60	4.72-6.35	6.00	4-8	157.41	135.65-180.89	19.44	16.69-21.67	11.00	9-13	3.00	2-4	63.33	55-70
	A. brassicicola	35.67	33-38	41.20	37.71-46.39	4.68	4.11-5.63	4.67	3-6	49.01	46.69-52.67	11.38	10.49-12.19	7.00	4-6	1.00	0-2	36.67	30-45
NDYS 2	*A. brassicae*	34.33	32-36	65.71	59.91-70.31	5.94	5.11-6.81	6.00	4-7	160.21	137.16-185.79	19.94	17.21-22.91	13.00	12-14	3.67	2-5	56.67	40-70
	A. brassicicola	36.67	34-39	41.47	38.72-44.71	5.14	4.51-5.72	4.00	3-5	49.46	47.39-53.31	12.66	11.97-13.61	5.67	6-8	1.00	1	43.33	30-60
NDYS 117	*A. brassicae*	26.67	25-28	58.18	55.37-60.38	5.10	4.10-5.91	6.00	5-7	144.21	126.76-160.16	16.90	15.31-17.89	9.67	9-10	2.67	2-3	48.33	30-60
	A. brassicicola	28.33	26-31	35.01	33.75-36.41	4.63	4.00-4.99	4.67	4-5	45.86	43.20-48.91	11.38	10.49-11.91	4.67	4-5	1.00	1	51.67	40-70
NDYS 123	*A. brassicae*	34.67	33-37	67.65	64.36-70.19	5.81	4.39-7.12	6.67	6-8	156.01	130.91-186.49	20.07	17.61-22.67	11.33	9-14	3.67	2-5	55.00	45-70
	A. brassicicola	37.00	35-40	37.99	35.79-39.91	4.95	4.67-5.21	4.33	4-5	49.23	45.30-54.43	12.42	11.60-13.69	6.00	5-7	1.67	1-2	45.00	30-55
NDYS 2018	*A. brassicae*	35.67	34-38	71.24	68.89-73.92	7.71	7.11-8.10	7.00	6-8	160.45	130.99-189.67	21.48	18.63-25.67	14.00	13-15	4.00	3-5	51.67	35-60
	A. brassicicola	39.00	36-42	41.70	40.69-42.61	5.60	5.19-5.71	6.00	5-7	50.73	46.50-56.30	12.87	11.91-14.50	8.00	7-9	2.00	2	48.33	40-65
NDYS 116-1	*A. brassicae*	25.67	24-28	58.53	56.38-60.91	5.60	4.79-6.11	5.67	5-6	144.79	127.59-159.88	17.44	15.29-18.67	10.00	9-11	2.67	2-3	48.33	35-60
	A. brassicicola	27.67	26-30	36.53	35.36-37.45	4.73	4.31-4.91	4.67	4-5	46.94	44.35-49.79	12.16	11.60-12.91	4.33	4-5	1.00	1	51.67	40-65

A: Average; R: Range

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Varieties Plant-1 part	Isolates	Colony Diameter (mm)		Conidiophore						Conidia								Per cent frequency	
				Length		Width		Septation		Length		Width		Septation					
														Transverse		Longitudinal			
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
NDYS 107	*A. brassicae*	24.33	23-26	60.79	58.89-62.79	6.91	6.21-7.61	6.33	5-7	142.13	125.90-157.60	17.88	17.50-18.23	10.00	9-11	2.67	2-3	46.67	25-60
	A. brassicicola	26.33	24-29	37.24	35.41-38.62	5.72	4.97-6.29	5.67	5-6	45.57	42.90-48.13	11.00	9.98-12.60	4.67	4-6	1.33	1-2	53.33	40-75
NDYS 119	*A. brassicae*	23.33	21-26	55.48	53.79-56.67	4.98	4.19-5.79	4.33	4-5	137.63	121.59-155.95	18.65	17.24-20.31	11.00	10-12	3.33	3-4	41.67	20-55
	A. brassicicola	26.00	24-28	35.63	34.69-36.49	4.16	3.79-4.39	3.67	3-4	47.16	42.45-51.39	11.13	10.19-11.60	5.67	5-6	0.67	0-1	58.33	45-80
NDYS 115-1	*A. brassicae*	26.33	25-28	58.21	55.36-60.91	5.92	5.69-6.39	4.67	5-6	138.48	115.38-160.70	20.68	19.65-21.60	11.33	10-13	3.67	2-5	55.00	35-70
	A. brassicicola	28.67	27-31	36.83	35.39-38.67	4.67	4.19-5.42	4.33	4-5	49.55	45.39-54.60	11.15	10.29-11.60	5.00	5	1.33	1-2	45.00	30-65
NDYS 132-2	*A. brassicae*	22.67	20-25	57.53	55.79-58.91	4.30	4.01-4.71	6.00	5-7	142.43	125.64-155.75	18.96	16.59-20.69	11.67	11.13	3.33	3-4	35.00	20-45
	A. brassicicola	25.00	23-27	34.69	33.69-35.60	3.65	3.41-3.91	4.67	4-5	48.86	45.40-52.39	10.91	10.39-15.35	5.67	5-6	1.33	1-2	65.00	55-80
Leaf	*A. brassicae*	30.70	25-38	64.04	56.67-73.92	6.49	4.71-8.10	6.90	5-8	169.29	155.75-189.67	20.57	17.24-25.67	12.60	10-15	4.10	3-5	60.00	45-70
	A. brassicicola	33.40	27-42	39.68	35.60-46.39	5.18	3.91-5.91	5.20	4-7	52.19	48.18-56.30	12.60	11.35-14.50	6.10	4-9	1.60	1-2	40.00	30-55
Stem	*A. brassicae*	26.80	20-34	58.64	53.79-68.89	5.10	4.01-7.11	4.90	4-6	127.76	115.38-137.16	14.74	15.29-20.69	10.20	9-13	2.30	2-3	35.00	20-70
	A. brassicicola	28.40	23-36	36.33	33.69-40.69	4.50	3.41-6.29	3.90	3-5	44.95	42.45-47.39	10.93	9.98-12.41	5.00	4-7	0.80	0-2	64.50	30-80
Pod	*A. brassicae*	28.60	23-35	62.11	55.97-70.91	5.77	4.19-7.91	5.90	4-7	148.08	135.36-160.69	19.11	15.59-20.79	11.10	10-14	3.40	3-4	55.00	40-60
	A. brassicicola	30.80	25-39	37.46	33.75-41.79	4.69	3.64-5.91	4.80	4-6	47.76	45.46-49.67	11.59	10.43-12.19	6.00	4-8	1.40	1-2	45.00	40-60

obtained from NDYS 132-2 (10.91 µ). Width of conidia of *A. brassicae* obtained from leaves ranged between 17.24 µ (NDYS 119) to 25.67 µ (NDYS 2018), from stem between 15.29 µ (NDYS 116-1) to 19.65 µ (NDYS 115-1) and from pods between 16.59 µ (NDYS 132-2) to 20.79 µ (NDYS 115-1). Conidial width of *A. brassicicola* obtained from leaves ranged between 11.35 µ (NDYS 132-2) to 14.50 µ (NDYS 2018), from stem between 9.98 µ (NDYS 107) to 12.41 µ (NDYS 2) and from pods between 10.43 µ (NDYS 107) to 12.19 µ (NDYS 2018).

Number of transverse septa in the conidia of *A. brassicae* was found maximum in comparison to *A. brassicicola* in case of each affected plant parts. Average maximum number of septa in conidia of *A. brassicae* and *A. brassicicola* was noted in case of leaves (12.60 and 6.10) followed by pods (11.10 and 6.00) and stem (10.20 and 5.00), respectively. Among the entries average highest number of septa in *A. brassicae* was noted in NDYS 2018 (14.00) followed by NDYS 2 (13.00). The lowest number of septa was found in NDYS 117 (9.67). Highest number of septa in *A. brassicicola* was noted in NDYS 2018 (8.00) followed by YST 151 (7.00). Lowest number of septa in *A. brassicicola* was found in NDYS 116-1 (4.33). The number of septa in *A. brassicae* obtained from leaves range between 10 (NDYS 117) to 15 (NDYS 2018), from stem between 9 (YST 151) to 13 (NDYS 2018) and from pods between 10 (NDYS 117, NDYS 116-1, NDYS 107 and NDYS 119) to 14 (NDYS 2018). Likewise, the number of septa in *A. brassicicola* obtained from leaves ranged between 4 (NDYS 107) to 9 (NDYS 2018), from stem between 4 (YST 151, NDYS 117, NDYS 116-1 and NDYS 107) to 7 (NDYS 2018) and from pods ranged between 4 (NDYS 116-1) to 8 (NDYS 2018).

Longitudinal septation in conidia of *A. brassicae* was also found maximum in comparison to *A. brassicicola* in all the affected plant parts. Average maximum number of septa in *A. brassicae* and *A. brassicicola* was noted in case of leaves (4.10 and 1.60) followed by pods (3.40 and 1.40) and stem (2.30 and 0.80) respectively. Among the entries the average maximum number of septa in *A. brassicae* was noted in NDYS 2018 (4.00) followed by NDYS 123 (3.67). Minimum number of septa was found 2.67 in the entries NDYS 117, NDYS 116-1 and NDYS 107. The maximum number of septa in *A. brassicicola* was noted in NDYS 2018 (2.00) followed by NDYS 123 (1.67) and NDYS 107 (1.33). Minimum number of septa was found in NDYS 119 (0.67). Longitudinal septa of *A. brassicae* isolates obtained from leaves ranged between 3-5 from stem between 2-3 and from pods 3-4. The longitudinal septa of *A. brassicicola* obtained from leaves also ranged between 1 to 2, from stem 0 to 2 and from pods between 1 to 2, respectively (Table 2). Mehta et al. (2003) worked on the morphological and pathological variations in rapeseed-mustard isolates of *A. brassicae* collected from different agro climatic zone of India. They also reported variations in spore length and breadth and indicated the existence of variability in the pathogen. Singh et al. (2003) also reported the variation in colony growth, colour, size of conidia and conidiophores in case of *Alternaria* triticina causing leaf blight in wheat. Khan et al. (2007) isolated *Alternaria brassicae* with the samples collected from different places of Aligarh district and also reported variation in conidial length (112.0 to 185.6 µ), breadth (14.4 to 17.6 µ) and septation (5-16). The variation in colony colour, growth, colony size, length and breadth of conidiophore, length and breadth of conidia, vertical and horizontal septation in case of *A. brassicae* and *A. brassicicola* in present studies support the views of earlier workers. The studies therefore, also indicate the existence of variability among the isolates of *A. brassicae* and *A. brassicicola* obtained from yellow sarson, in eastern Uttar Pradesh.

3.5. Per cent frequency of A. brassicae and A. brassicicola obtained from leaves, stems and pods

On mean basis frequency of occurrence of *A. brassicae* was found maximum in case of leaves isolates followed by pods and stems. But in case of YST 151 frequency of *A. brassicae* was found more in stem followed by leaf and pod, while in NDYS 119 it was higher in pod followed by leaf and stem. Among the entries average maximum frequency of *A. brassicae* was noted in YST 151 (63.33%) followed by NDYS 2 (56.67%) and NDYS 123 (55.00%). Minimum frequency of this pathogen was found in NDYS 132-2 (35.00 %). Maximum mean per cent frequency of *A. brassicicola* was found in NDYS 132-2 (65.00%) followed by NDYS 119 (58.33%) and NDYS 107 (53.33%) and minimum in YST 151 (36.67%). Frequency of occurrence of *A. brassicae* obtained from leaves isolates ranged between 45% (NDYS 132-2) to 70% (NDYS 2, NDYS 123 and NDYS 151-1), from stem between 20% (NDYS 119 and NDYS 132-2) to 70% (YST 151) and from pods between 40% (NDYS 132-2) to 60% (NDYS 2, NDYS 107, NDYS 117 and NDYS 115-1) respectively, while the frequency of *A. brassicicola* was recorded 30% (NDYS 2, NDYS 123 and NDYS 115-1) to 55% (NDYS 132-2) from leaves isolates, 30% (YST 151) to 80% (NDYS 119 and NDYS 132-2) from stem isolates and 40% (NDYS 2, NDYS 117, NDYS 107, NDYS 115-1 and NDYS 2018) to 60% (NDYS 132-2) from pod isolates, respectively.

4. Conclusion

NDYS 119 showed lowest disease severity during both the

years which proved the least susceptibility. The frequency of occurrence of *A. brassicae* was found maximum in case of leaves isolates followed by pods and stems. However, the frequency of *A. brassicicola* was found maximum in case of isolates stem isolates followed by leaves and pods. Among the entries average maximum frequency of *A. brassicae* was noted in YST 151 followed by NDYS 2.

5. References

Ansari, N.A., Khan, M.W., Muheet, A., 1989. Effect of some factors on growth and sporulation of *Alternaria brassicae* causing *Alternaria* blight of rapeseed and mustard. Acta Botanika Indica 17(1), 49–53.

Chattopadhyay, C., 2008. Management of diseases of rapeseed-mustard with special reference to Indian conditions. In: Kumar, A., Chauhan, J.S., Chattopadhyay, C. (Eds.), Sustainable Production of Oilseeds: Rapeseed-Mustard Tchnology. Agrotech Publishing Academy, Udaipur, 364–88.

Conn, K.L., Tewari, J.P., Awasthi, R.P., 1990. A disease assessment key far Alternaria black spot in rapeseed and mustard. Canadian Plant Disease Survey 70, 19–22.

Goyal, P., Chahar, M., Mathur, A.P., Kumar, A., Chattopadhyay, C., 2011. Morphological and cultural variation in different oilseed *Brassica* isolates of *Alternaria brassicae* from different geographical regions of India. Indian Journal of Agricultural Science 81(11), 1053–1058.

Gupta, R., Awasthi, R.P., Kolte, S.J., 2003. Influence of sowing dates and weather factors on development of *Alternaria* blight on rapeseed-mustard. Indian Phytopath 56(4), 398–402.

Khan, M.M., Khan, R.U., Mohiddin, F.A., 2007. Variation in occurrence and morphology of *Alternaria brassicae* (Berk.) Sacc. causing blight in rapeseed and mustard. Annals of plant protection science 15(2), 414–417.

Kolte, S.J., Awasthi, R.P., Vishwanath, 1987. Assessment of yield losses due to *Alternaria* blight in rapeseed and mustard. Indian Phytipath 40, 209–211.

Mehta, N., Sangwan, M.S., Srivastava, M.P., 2003. Morphological and pathological variation in rapeseed and mustard isolates of *Alternaria brassicae*. Indian Phytopath 56(2), 188–190.

Singh, R.B., Singh, R.N., 2006. Spray schedule for the management of *Alternaria* blight and white rust of Indian mustard (*Brassica juncea*) under different dates of sowing. Indian Journal of Agrilcultural Science 76(9), 575–579.

Singh, R.P., Singh, A.K., Singh, R.N., 2003. Pathogenic variability in *Alternaria triticina* causing leaf blight of wheat. Annals of plant protection science 11(2), 309–311.

Van der Plank, J.E., 1963. Plant Disease: Epidamics and control. Academic Press, New York, London, 349.