International Journal of Agricultural Sciences
Volume **10** | Issue 2 | June, 2014 | 755-760
e ISSN-0976-5670 | Visit us | *www.researchjournal.co.in*

RESEARCH PAPER

Management of stem and root rot of sesame

C.S. CHOUDHARY*, ANJANA ARUN **AND** S.M. PRASAD[1]
Regional Research Station, Agwanpur, SAHARSA (BIHAR) INDIA (Email : csrau07@gmail.com)

Abstract : Out of 27 entries evaluated against stem and root rot caused by *Macrophomina phaseolina*, only three entries *viz*., IC–205477, IC–205506 and Krishna were identified as resistant. Dates of sowing trials revealed that early sowing favored Macrophomina stem and root rot. Multiple regression equation between disease index and weather variables exhibited strong relationship among the different components of epiphytotics during 2002-03 and 2003-04 crop seasons (R^2 =0.989 and 0.985). This disease appeared during second week of July in the field. Maximum apparent infection rate of 0.122 unit/day and 0.118 unit/day were calculated at July 25, during both years of experimentations, respectively. The mean temperature 26.86 to 28.93^{0}C, mean relative humidity 77.49 to 79.4 per cent, rainfall 5.54 mm and 13.24 mm and 12 and 14 number of rainy days were favorable for maximum disease development. Seed treatment with a mixture of carbendazim 50 WP (0.1%) and thiram 75 WP (0.15%) recorded minimum PDI of 11.15 per cent and 9.91 per cent and highest seed yield of 637 kg/ha and 646 kg/ha during above mentioned crop seasons. First spray of carbendazim 50 WP (0.05%) + second spray of *T. viride* (10^7 spore/g) were found to be most economical for the management of the disease.

Key Words : *Sesamum indicum*, Stem and root rot, *Macrophomina phaseolina*, Management

View Point Article : Choudhary, C.S., Arun, Anjana and Prasad, S.M. (2014). Management of stem and root rot of sesame. *Internat. J. agric. Sci.*, **10** (2): 755-760.

Article History : Received : 04.02.2014**; Revised :** 03.05.2014**; Accepted :** 15.05.2014

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important edible *Kharif* oilseed crop grown in hotter and drier areas and in recent years, regular occurrence of stem and root rot disease has been recorded from different districts of Jharkhand State with varying incidence per cent of 31.00 to 68.50. In India the disease was present in all sesamum growing areas. Although it has been recorded mainly from Madhya Pradesh (Pearl, 1923), Bihar (Mc Rae, 1930), and Madras (Sundararaman, 1931). Singh *et al*. (1991) surveyed sesame fields in Delhi, Haryana, Uttar Pradesh, Karnataka and Tamil Nadu for root rot incidence in fields varied from 6.0 to 71.5 % (av. 17.01 %) depending on the soil conditions and crop season. Choudhary *et al*. (2005) surveyed the major sesame growing areas of North Bihar and found that incidence of Stem and root rot caused by *M. phaseolina* (Tassi.) Goid. ranged from 22.5 to 38.5 per cent depending upon locality.

The disease is very destructive in nature and has been reported from many parts of the world. As the fungus is seed-borne in nature and survives on left over trashes in the field, it is difficult to manage the disease by any single approach. Trials were, therefore, conducted to evaluate different measures and the results have been reported in this paper.

MATERIAL AND METHODS

Twenty-five sesame germplasm lines collected from National Bureau of Plant Genetic Resources, New Delhi and two commercial varieties, Krishna and Kanke-Safed were screened under artificial epiphytotics against the disease. Seeds of these entries were sown in single rows of 3m length. All the agronomic recommendations for the crop were followed. Artificial field inoculations with mycelial-cum-spore

*** Author for correspondence**
[1]Department of Plant Pathology, Birsa Agricultural University, RANCHI (JHARKHAND) INDIA

suspension of the pathogen was carried out with the help of an atomizer during evening hours 30 and 45 days of sowing. Disease intensity was recorded 60 days after sowing (DAS). For disease scoring 0-5 rating scales recommended under ICAR All India Co-ordinated Research Project on sesame and niger was adopted (Anonymous, 1998).

To determine the effect of different dates of sowing on disease development, field trials were carried out in Randomized Block Design (RBD). Seeds of sesame variety, Kanke safed were sown in 6 m^2 plots, 30 cm x 10 cm spacings at 10 days intervals beginning from 5^{th} June to 4^{th} August during 2002 and 2003. Three replications were maintained for each date of sowing. Progress of disease in terms of intensity was recorded at 60 DAS. For recording disease intensity 100 leaves were selected randomly from each replication. Cumulative weather parameters like temperature, relative humidity, rainfall and number of rainy days up to 60 days corresponding to the disease observations were recorded from Meteorological Observatory of the University and correlated with disease development.

In order to determine the effect of weather variables, trials were conducted in Randomized Block Design with three replications. Seeds were sown on 25^{th} June during both the years. PDI was recorded at 10 days intervals beginning from initial appearance of disease. Stepwise multiple regression analysis (MRA) was calculated to determine the effect of individual as well as combined weather variables. Disease prediction analysis equation *viz.*, $Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6$ was derived. Significance of co-efficient of multiple determination (R^2) and partial regression co-efficient (b) value was followed at 5 per cent level of probability.

Disease development in term of apparent infection rate (unit/day) was calculated with the help of formula given by Vander plank (1963) as given below:

$$\mathbf{R} = \left\{ \frac{2.3}{t_2 - t_1} \log \frac{x_2}{1 - x_2} - \log \frac{x_1}{1 - x_1} \right\}$$

where, r = Apparent infection rate

t_1 and t_2 = time intervals

x_1 and x_2 = disease intensities.

Seed dressing fungicides and fungal antagonists were also evaluated against the disease. Antagonists were grown on soaked and sterilized sorghum grains for twenty days in sterilized bottles. After full growth and sporulation, the grains were taken out from the bottle, dried in shade and ground. The powder was sieved and used for seed treatment @ 4g/kg seed (18.8×10^{13} spores/g). Rice gruel was used as natural sticker/ nutrient. Treated seeds were kept in shade for 30 minutes and sown afterwards. Talc based formulation of the rhizobacterium, *Pseudomonas fluorescens* pf-1 (TNAU isolate) was used @ 1 per cent (2×10^8 cells/g).

Ten different treatments of fungitoxicants, fungal antagonists and their possible combinations (integrations) including controls were evaluated as foliar sprays against the disease.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Evaluation of germplasm/varieties :

Out of 27 entries tested against *Macrophomina phaseolina*, all the entries were found to be infected by the pathogen but differed in their susceptibility. The percentage incidence in different entries varied from 8.0 to 41.0 per cent and 4.0 to 31.0 per cent during *Kharif*, 2002 and *Kharif*, 2003 seasons, respectively. The entries, IC–205477, IC–205506 and Krishna showed resistant reaction during above mentioned crop seasons. The data are presented in Table 1.

Influence of dates of sowing :

The crop sown on August 4 (very late) recorded lowest PDI of 23.80 and 22.5 per cent during above mentioned crop seasons, respectively. A relatively higher PDI was recorded in the timely sown crop (June 25). As evident from the data, early and timely sown crop recorded higher disease intensity. The mean temperature (22.54 to 30.11^{0}C and 23.23 to 29.28^{0}C), mean relative humidity (71.60 to 89.92 and 72.17 to 88.43%), mean rainfall (8.94 and 11.75 mm) and 29 and 34 number of rainy days during above mentioned seasons favoured disease development. Maximum seed yield of 401.0 kg/ha and 413.0 kg/ha were recorded when crop was timely sown (June 25) during both crop seasons, respectively, indicating that manipulations in dates of sowing had no significant effect in maximizing seed yield (Table 2).

Influence of weather factors :

Macrophomina stem/root rot appeared during second week of July in the field and its intensity increased gradually up to August 14 and after that disease development declined,

Table 1: Sources of resistance in sesame against macrophomina stem/root rot

Disease score	Disease response	Entries
2	Resistant (1-10%)	IC-205477, IC-205506, Krishna
3	Moderately susceptible (11-25%)	IC-283419, IC-205297, IC-205299, IC-205302, IC-205305, IC-205333, IC-205354, IC-205362, IC-205456, IC-205470, IC-205482, IC-205487, IC-205495, IC-205499, IC-205504, IC-205555, IC-205561, IC-205623, IC-205630, IC-205683, IC-205690, Kanke-Safed

Table 2: Influence of dates of sowing on the development of macrophomina stem/root rot of sesame and seed yield

Date of sowing	*Disease intensity (%)	*Yield (kg/ha)	**Mean temperature (°c)		**Mean relative humidity (%)		**Mean rainfall (mm)	**No. of rainy days
			Max^m	Min^m	Max^m	Min^m		
2002-03								
5th June	29.90 (33.14)	300.0	32.89	24.13	87.38	63.12	7.38	27
15th June	35.50 (36.56)	380.0	31.25	23.14	89.20	67.15	7.05	29
25th June	38.00 (38.05)	401.0	30.11	22.54	89.92	71.60	8.94	29
5th July	35.00 (36.26)	390.0	30.00	22.15	90.05	84.30	8.42	29
15th July	30.50 (33.50)	370.0	29.60	22.09	91.02	75.78	11.96	37
25th July	27.50 (31.61)	340.0	29.30	22.00	91.23	75.05	11.62	34
4th August	23.80 (28.93)	305.0	28.63	21.94	90.63	74.35	12.33	38
2003-04								
5th June	28.90 32.45)	320.0	31.93	23.42	84.53	62.66	9.96	30
15th June	32.70 (34.84)	360.0	29.99	23.26	86.92	67.37	10.05	31
25th June	34.45 (35.94)	413.0	29.28	23.23	88.43	72.17	11.75	34
5th July	32.65 (34.84)	401.0	29.53	23.12	87.57	73.50	12.12	37
15th July	29.50 (32.57)	390.0	28.99	23.03	89.88	75.22	12.46	40
25th July	25.00 (29.99)	365.0	28.87	22.97	91.75	76.20	10.52	43
4th August	22.50 (28.30)	340.0	29.14	22.83	90.33	75.08	7.81	40

	Disease incidence (%)		Yield (kg/ha)	
	2002-03	2003-04	2002-03	2003-04
SEm ±	0.21	0.21	2.80	2.10
C.D. (P=0.05)	0.67	0.60	9.00	5.80

* Average of three replications ** Average of 60 days

Figures in parentheses are transformed angular values

Table 3: Influence of weather factors on development of macrophomina stem/root rot of sesame

Date of observation	* Disease intensity (%)	Infection rate (Unit/ day)	Cumulative temperature (°C)			Cumulative relative humidity (%)			Cumulative rainfall (mm)	Cumulative number of rainy days
			Max^m	Min^m	Mean	Max^m	Min^m	Mean		
2002-03										
5th July	00 (0.00)	–	31.38	23.30	27.34	91.20	75.00	83.10	10.68	6
15th July	05.86 (13.97)	–	31.75	23.93	27.84	89.15	66.90	78.03	5.66	7
25th July	17.50 (24.69)	0.122	34.15	23.71	28.93	89.20	69.63	79.40	5.54	12
4th August	29.90 (33.14)	0.069	33.48	23.69	28.58	89.20	68.40	78.79	4.62	13
14th August	35.50 (36.56)	0.025	32.61	23.52	28.07	89.54	69.34	79.44	6.19	20
24th August	38.00 (38.05)	0.011	31.68	23.30	27.49	90.02	71.58	80.80	10.72	27
3rd September	39.65 (39.40)	0.006	31.14	23.17	27.15	90.30	72.21	81.26	8.73	34
13th September	41.50 (40.10)	0.007	30.64	22.99	26.83	90.55	73.29	81.92	10.38	43
SEm ±	0.47									
C.D. (P=0.05)	1.42									
2003-04										
5th July	00 (0.00)	–	30.36	23.57	26.97	86.20	64.00	75.71	14.27	6
15th July	05.65 (13.84)	–	30.45	23.41	26.93	86.60	67.20	76.90	11.05	11
25th July	16.35 (23.92)	0.118	30.37	23.35	26.86	87.37	67.60	77.49	13.24	14
4th August	28.50 (32.25)	0.071	29.87	23.23	26.55	87.95	70.60	79.28	13.90	21
14th August	32.70 (34.87)	0.019	29.84	23.20	26.52	88.28	70.80	79.54	11.54	26
24th August	34.45 (33.95)	0.008	29.76	23.20	26.48	88.47	71.85	80.16	12.44	34
3rd September	33.85 (36.36)	0.006	29.65	23.18	26.42	88.79	72.17	80.48	12.28	42
13th September	38.60 (38.40)	0.012	29.36	23.12	26.24	89.15	73.21	81.18	11.99	50
SEm ±	0.52									
C.D. (P=0.05)	1.41									

* Average of three replications, Figures in parentheses are transformed angular values

but average total intensity of disease as recorded was maintained till harvest of the crop during both *Kharif,* 2002-03 and 2003-04. Maximum apparent infection rate of 0.122 unit/day and 0.118 unit/day were calculated at July 25, during both years of experimentations, respectively. The temperature 23.71 to 34.15^{0}C and 23.35 to 30.37^{0}C, relative humidity 69.63 to 89.20 per cent and 67.6 to 87.37 per cent, rainfall 5.54 mm and 13.24 mm and 12 and 14 number of rainy days favoured maximum disease development during June 25 to July 25, 2002-03 and 2003-04, respectively (Table 3).

PDI were significantly positively correlated with number of rainy days. Maximum temperature, minimum temperature and minimum relative humidity were negatively correlated and maximum relative humidity and rainfall were positively correlated and all these factors showed statistically non-significant effect during 2002-03.

Highly significant negative correlation was established between maximum and minimum temperature. Highly significant positive correlation was established between maximum relative humidity, minimum relative humidity and number of rainy days whereas only rainfall showed non-significant negative correlation during 2003-04 (Table 4).

Multiple regression equation between PDI and weather variables exhibited strong relationship among the different component of the epiphytotics during both the years of study and combined effect of different weather variables favoured disease development causing upto 98 per cent variation in disease index (Table 5).

Management through fungicides and antagonists :

Seed treatment with carbendazim 50 WP (0.15) + thiram (0.15%) recorded minimum PDI of Macrophomina stem/root rot with 11.15 per cent and 9.91 followed by carbendazim 50 WP (23.06% and 21.01%) and *Trichoderma viride* (23.61% and 21.75%), respectively, during above mentioned crop seasons. The highest PDI (38.69% and 36.53%) were recorded in control. Seed treatment with carbendazim 50 WP (0.1%) + Thiram (0.15%) recorded the maximum seed yield of 637 kg/ha and 646 kg/ha followed by carbendazim 50 WP (556.0 kg/ha and 573.0 kg/ha) (Table 6).

All the fungicides and their integration reduced the incidence of Macrophomina stem/root rot disease significantly over control. Two sprays of carbendazim (0.05%) recorded minimum PDI- 12.5% which was followed by 1st spraying of carbendazim + 2nd spraying of *T. viride* (PDI-15.1%). Control plot registered highest PDI of 41.5 per cent. Accordingly, highest seed yield of 671.0 kg/ha was obtained with two sprays of carbendazim (0.05%) which was followed by 1st spraying

Table 4 : Correlation co-efficient and regression equation between macrophomina stem/root rot disease index and weather parameters

Weather factors	Correlation co-efficient (r)	Co-efficient of multiple determination (R^2)	Regression equation
2002-03			
Maximum temperature	-0.162^{NS}	0.026	$Y = 95.615 – 2.169 X_1$
Minimum temperature	-0.536^{NS}	0.287	$Y = 670.972 – 27.503 X_2$
Maximum relative humidity	0.023^{NS}	0.001	$Y = 69.598 – 0.485 X_3$
Minimum relative humidity	-0.076^{NS}	0.006	$Y = -6.361 + 0.457 X_4$
Mean rainfall	0.162^{NS}	0.026	$Y = 18.052 + 1.016 X_5$
No. of rainy days	0.858**	0.736	$Y = 4.984 + 1.037 X_6$
2003-2004			
Maximum temperature	-0.923**	0.851*	$Y = 1046.059 – 34.125 X_1$
Minimum temperature	-0.979**	0.959**	$Y = 2244.958 – 95.402 X_2$
Maximum relative humidity	0.985**	0.969**	$Y = 1180.548 + 13.708 X_3$
Minimum relative humidity	0.974**	0.950**	$Y = -293.284 + 4.550 X_4$
Mean rainfall	-0.292_{NS}	0.086	$Y = 71.296 – 3.775 X_5$
No. of rainy days	0.894**	0.798*	$Y = 2.384 + 0.838 X_6$

* and ** indicate significance of values at P=0.05 and 0.01, respectively
NS = Non-significant, Y = Disease index, X_1 = Max. temp, X_2 = Min. temp, X_3= Max. RH, X_4 = Min. RH, X_5 = Mean Rainfall, X_6 = No. of rainy days

Table 5 : Multiple regression equation between weather parameters on macrophomina stem/root rot disease index during the year, 2002-03 and 2003-04

Disease index	Correlation co-efficient (r)	Co-efficient of multiple determination (R^2)	Regression equation
2002-03	0.995**	0.989**	$Y = 1935.212 + 11.928 X_1 – 123.561 X_2 + 19.444 X_3 – 16.442 X_4 + 2.764 X_5$
2003-04	0.993**	0.985**	$Y = 1356.267 – 2.944 X_1 – 71.684 X_2 + 5.281 X_3 – 0.758 X_4 + 1.082 X_5$

* and ** indicate significance of values at P=0.05 and 0.01, respectively
NS = Non-significant, Y = Disease index, X_1 = Max. temp, X_2 = Min. temp, X_3= Max. RH, X_4 = Min. RH, X_5 = Mean Rainfall, X_6 = No. of rainy days.

of carbendazim + 2nd spraying of *T. viride* (660 kg/ha). The least (401.0 kg/ha) yield was recorded in control. Considering cost: benefit ratio, 1st spraying of carbendazim + 2nd spraying of *T. viride* was found to be superior (1: 4.3) which was followed by two sprays of carbendazim (1: 4.1). Similar results were obtained during *Kharif*, 2003-04 crop seasons also. Two sprays of carbendazim (0.05%) recorded minimum PDI-11.5 per cent which was followed by 1st spraying of carbendazim + 2nd spraying of *T. viride* (PDI-13.9%). Control plots recorded highest PDI of 28.6 per cent. Two sprays of carbendazim (0.05%) recorded highest seed yield of 691.5 kg/ha which was followed by 1st spraying of carbendazim + 2nd spraying of *T. viride* (679.8 kg/ha). The minimum (413.0 kg/ha) seed yield was recorded in control plot. Considering cost benefit ratio, 1st spraying of carbendazim + 2nd spraying of *T. viride* was found to be superior (1: 4.4) which was closely followed by two sprays of carbendazim (1: 4.2) (Table 7).

Singh *et al*. (1989) evaluated a large number of sesame cultivars and germplasm lines for resistance against *M. phaseolina* under natural conditions and reported that out of 866 cultivars/lines, only 30 were found resistant. Cultivars, local, AT-9 and HT-16 were found to be most resistant out of 25 sesame genotypes evaluated for resistance to *M. phaseolina* (Gupta, 1995). Choudhary *et al*. (2005) reported

Table 6 : Effect of seed treatment with chemicals/bioagents on incidence of macrophomina stem/root rot blight and yield of sesame

Treatments	Dose (%)	2002-03		2003-04	
		*PDI	*Yield (kg/ha)	*PDI	*Yield (kg/ha)
Thiram 75 WP	0.30	31.05 (33.86)	464	29.51 (32.90)	476
Carbendazim 50 WP	0.2	23.06 (28.71)	556	21.01 (27.25)	573
Carbendazim 50 WP + thiram 75 WP	0.1+0.15	11.15 (19.50)	637	9.91 (18.31)	646
Ridomil MZ 72 WP	0.2	17.09 (24.42)	588	15.03 (22.85)	597
Mancozeb 75 WP	0.25	28.45 (32.26)	480	26.10 (30.70)	491
Trichoderma viride	0.4	23.61 (29.01)	562	21.75 (27.80)	567
Trichoderma harzianum	0.4	24.67 (29.82)	551	22.88 (28.55)	563
Pseudomonas fluorescens – pf 1	1.0	26.45 (30.95)	524	24.34 (29.51)	533
Neem oil	1.0	33.49 (35.38)	434	31.19 (33.94)	443
Control	–	38.69 (38.42)	381	36.53 (37.18)	392
SEm ±		0.24	8.02	0.95	2.58
C.D. (P=0.05)		0.32	23.14	2.99	7.53

* Mean of three replications
Values in parentheses are angular transformed values

Table 7: Efficacy and economics of fungicides and antagonists on macrophomina stem/root rot and grain yield of sesame

Treatments	Dose (%)	*PDI	*Kharif* 2002-03 *Yield (kg/ha)	C:B ratio	*PDI	*Kharif* 2002-03 *Yield(kg/ha)	C:B ratio
2 spraying of carbendazim	0.05	12.5(20.72)	671.4	1:4.1	11.5 (19.82)	691.5	1:4.2
2 spraying of hexaconazole	0.1	19.0(25.80)	627.0	1:1.4	17.5 (24.72)	645.8	1:1.5
2 spraying of mancozeb	0.2	29.6(32.94)	546.5	1:1.2	27.2 (31.42)	563.0	1:1.2
2 spraying of *Trichoderma viride*	10^7spores/g	25.3(30.18)	585.0	1:3.1	23.3 (28.84)	602.6	1:3.2
2 spraying of *Pseudomonas fluorescens*– pf 1	0.2	27.1(31.34)	570.0	1:2.1	24.9 (29.92)	587.1	1:2.2
2 spraying of achook	0.2	32.0(34.42)	525.0	1:0.8	29.4 (32.80)	540.8	1:0.9
1st spraying of carbendazim+2nd spraying of *T. viride*	0.05+ 10^7spores/g	15.1(22.85)	660.0	1:4.3	13.9 (21.86)	679.8	1:4.4
1st spraying of carbendazim+2nd spraying of achook	0.05+0.2	24.4(29.55)	594.0	1:2.2	22.7 (28.42)	611.8	1:2.3
1st spraying of carbendazim+2nd spraying of mancozeb	0.05+0.2	23.1(28.85)	601.0	1:2.3	21.5 (27.60)	619.0	1:2.4
Control	–	41.5(40.10)	401.0	–	28.6 (37.80)	413.0	1:4.2
SEm ±		0.19	1.28		0.15	1.45	
C.D. (P=0.05)		0.51	3.95		0.48	4.11	

* Mean of three replications , Values in parentheses are angular transformed values,
Cost of fungicides etc. (Rs. Kg^{-1}/ L^{-1}): Carbendazim-770/-, Hexaconazole-800/-, Mancozeb-260/-, *Trichoderma viride*-150/-, *Pseudomonas fluorescens*-200/-, Achook-270/- Cost of application – Rs. 150/- per spray, Cost of sesame seed- Rs. 20/- per Kg.

that out of 25 entries screened, none was found to be immune or most resistant. However, 5 entries *i.e.*, JLSC– 87, PKDS–4, RT–325, RT- 326 and Krishna showed resistant reaction against the pathogen, remaining 20 entries showed moderately susceptible to susceptible reaction.

Singh *et al.* (1993) reported that the severity of stem rot caused by *Rhizoctonia bataticola (M. phaseolina)* was reduced by sowing sesame between 10-20 July, resulting in increased yield as compared with crop sown on 1st July. Kushi (1977) reported 76 per cent RH to be most optimum for growth of *M. phaseolina.*

Choudhary *et al.* (2004) tested efficacy of some fungicides *viz.*, carbendazim, mancozeb, propineb and ridomil MZ alone and in possible combinations with dates of sowing against Macrophomina stem and root rot and recorded minimum disease incidence and intensity and highest seed yield in case of seed treatment with carbendazim @ 2 g/kg seed plus 2 sprays with carbendazim 0.05 per cent at 10 days intervals in all the three dates of sowing.

Wuike *et al*. (1995) reported that *T. viride*, an antagonist to *Rhizoctonia bataticola* significantly reduced the incidence of root/stem rot in sesame when added in soil and was at par with seed treatment with bavistin. Sankar and Jeyarajan (1996) conducted field trials to manage root rot of sesame caused by *M. phaseolina* by seed treatment with antagonists. *T. harzianum* and *T. viride* significantly reduced root rot incidence to 10.1 and 12.8 per cent, respectively, as compared to 60 per cent incidence in control plots. *T. harzianum* significantly increased root length, shoot length, yield and oil content over the control.

REFERENCES

Anonymous (1998). All India Co-ordinated Research Project on Sesame & Niger. Tech. Prog. & Guidelines for Implementation. 36-68 pp. Project Co-ordinating unit (sesame & niger) J.N.K.V.V. Jabalpur (M.P.) INDIA.

Choudhary, C.S., Singh, S.N. and Prasad, S.M. (2004). *In vitro* effectiveness of chemicals to control *Macrophomina phaseolina* (Tassi.) Goid., causing stem and root rot of sesame. *J. Appl. Biol.*, **14**(1) : 46-47.

Choudhary, C.S., Prasad, S.M. and Singh S.N. (2004b). Effect of sowing dates and fungicidal spray on Macrophomina stem and root rot and yield of sesame. *J. Appl. Biol.*, **14**(2) : 43-45.

Choudhary, C.S., Singh, S.N. and Yadav, B.P. (2005). Occurrence of Macrophomina stem and root rot of sesame in Bihar and evaluation of genotypes for field resistance. *RAU J. Res.*, **15**(1) : 160-161.

Gupta, R.B.L. (1995). Evaluation of sesame genotypes for resistance to root rot and oozing. *Indian Phytopath.*, **48**(2) : 194-195.

Kushi, K.K. (1977). Studies on seed borne pathogens of sesamum (*Sesamum indicum* L.). M.Sc. (Ag). Thesis, Jawaharlal Nehru Agricultural University, Jabalpur, M.P. (INDIA).

Mc Rae, W. (1930). Report of the Imperial Mycologist, *Sci. Rep. Imp. Agric. Res. Inst*. Pusa, 1928-29 pp. 20-26.

Pearl, R.T. (1923). Report of the mycologist to the Government of the central provinces and Berar. Rept. Deptt. Agric. Central provinces and Berar, for the year ending 30th June, 1922: 19-20.

Sankar, P. and Jeyarajan, R. (1996). Biological control of sesamum root rot by seed treatment with *Trichoderma* sp. and *Bacillus subtilis*. *Indian J. Mycol. Pl. Pathol*., **26**(2) : 217-220.

Singh, Amar, Bhowmik, T.P., Chaudhury, B.S. and Singh, A. (1989). Evaluation of sesamum germplasm/ cultivars for resistance against Macrophomina root rot. *Indian Phytopath*., **42**(3) : 471-473.

Singh, Amar, Bhowmik, T.P. and Singh, A. (1991). Prevalence and severity of root rot of sesamum caused by *Macrophomina phaseolina*. *Indian Phytopath*., **44**(2) : 235-238.

Singh, Paramjit, Gupta, T.R. and Singh, P. (1993). Effect of sowing dates on the development of disease and seed yield in sesamum (*Sesamum indicum* L.). *Plant Dis. Res*., **8**(1) : 61-63.

Sundararaman, S. (1931). Administration report of the mycologist for the year 1929-30: 30 pp. (Deptt. Agric. Madras).

Vanderplank, J.E. (1963). Plant disease, epidemics and control. Acad. Press, New York, 349 pp.

Wuike, R.V., Nanoti, A.A., Bhoyate, S.G. and Kitkoru, R.D. (1995). Biocontrol of root/stem rot of sesame with the antagonist *Trichoderma viride*. *J. Soils & Crops*, **5**(2) : 145-147.