JOURNAL OF AGROFORESTRY AND ENVIRONMENT
ISSN 1995 - 6983
journal homepage : www.jaebd.com

SUSCEPTIBILITY OF MANGO TO STEM-END ROT AND ANTHRACNOSE AND ITS CONTROL THROUGH CHEMICAL AND HOT WATER TREATMENT

K. Nahar, H. N. Naznin, M. B. Hossain and M. M. Hossain
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh-2202.

Abstract: Susceptibility of mango to stem-end rot and anthracnose respectively caused by *Botryodiplodia theobromae* and *Colletotrichum gloeosporioides* were tested on 9 varieties and its control through chemical and hot water treatment were also studied. Most of the varieties were found to be more or less susceptible to the both pathogens. Dithane M-45, Bavistin, Rovral, Cupravit and Tilt incorporated using poisoned food technique showed more or less effective in inhibiting mycelial growth these two pathogens. Among the test fungicides, Bavistin (1000 ppm) and Tilt (1000 ppm) gave the best inhibition of fungal growth of these pathogens. Hot water treatment at 53^0C showed the best performance over 45^0C, 50^0C and 55^0C against post harvest decay of mango fruits. Therefore, dipping of mango in the suspension of Bavistin and Tilt at 1000 ppm conc. Hot water treatment at 53^0 C may be used for controlling post harvest diseases of mango.
Keywords: Susceptibility, stem-end rot, Anthracnose, Control

Introduction

Mango (*Mangifera indica* L.) is one of the most important and popular fruit in the tropical and sub-tropical countries as well as in Bangladesh. In Bangladesh mango fruit suffers from many diseases. There are a number of fungi that attack mango fruits at maturity after removal from the tree and causes infection during storage. *C. gloeosporioides* and *B. theobromae* are the two major fungi that have been reported to cause damage to mango fruits. Anthracnose caused by *C. gloeosporioides* is the major pre and post harvest disease of mango in all mango producing areas of the world and is associated with high rainfall and humidity (Jeffies *et al.*, 1990; Dodd *et al.* 1992). The highest disease incidence has been observed in mango variety Aswina (37.165) and Gootee (37.8%) in Nawabgonj district (Anonymous, 1990). *C. gloeosporioides* forms quiescent infections on fruit which develop further upon ripening during the post harvest period (Dodd *et al.* 1992). Fruit rot is particularly a serious concern when mango fruit is desired to be stored for consumption or is required to be shipped to long distances. Among the microbial decay due to several pathogens, stem-end rot of mango caused by *B. theobromae* has been reported to be the most serious and damaging one under the hot (28-32°c) and humid (80-90% RH) conditions of Bangladesh affecting all the mango varieties (Meah and Khan, 1987). It is the most important post-harvest disease of ripe mango causing 4-6% fruit loss in every year in India (Pathak and Srivastava, 1967) and 3-5% in Malaysia (Mendoza and Wills, 1984). In Bangladesh this disease has been reported to occur with an average disease incidence of 13.6% (Meah and Khan, 1987) having a range from5.54 to 20.25% (Anonymous, 1990). The post harvest losses can be reduced considerably by applying improved technologies and disease control measures. But no real emphasis was given on prolonging post harvest life of mango by preventing these two major post harvest diseases. In fact, very little is known about varietal response of mango against post harvest stem-end rot and anthracnose. Considering this fact, the present study was designed to assess the varietal response of mango to post harvest diseases (stem-end rot and anthracnose) and to develop the appropriate control measure(s).

Materials and methods

Nine mango varieties *viz*. Fazli, Aswina, Gopalbhog, Langra, Khirsapat, Gootee, Raniprasand, Cbosa and Lakbanbbog were collected from Mymensingh town during May-August, 2002 and inoculated with previously isolated isolates of *B. theobromae* and *C. gloeosporioides* for susceptibility study. Hot water treatment consisted of 5 temperature treatments *viz*. 45^0C (T_1), 50^0C (T_2), 53^0C (T_3), 55^0C (T_4) and room temperature (T_0) as control. Mature, hard and healthy mangoes of variety 'Gootee' were dipped in hot water at 45°c, 50°c, 53° and 55°c for 5 minutes. Then mangoes were inoculated by placing mycelial blocks (6 mm in diameter) of *B. theobrontae* and *C. gloeosporioides*. The surface disinfected fruits receiving sterile wet cotton wool without inocula served as control. The fruits were then kept in moist (above 90% RH) chamber at 28± 2°c for 48-72 hrs for symptoms development. Observations were made for initiation of infection and disease development

Table 1. Specification of the 5 fungicides used in the study

Commercial name	Chemical name	Group	Percentage of active ingredient
Dithane M-45 (Mancozeb)	Manganous ethylene bis dithiocarbamate plus zinc.	Dithiocarbamate	80 WP
Bavistin (Carbendazim)	1 H-benzimidazol-2-2yl- carbamic acid methyl ester	Benzimidazole	50 WP
Rovral WP (Iprodione)	1-Isopropyl carbamoyl-3-(3-5-di chlorophenyl) hydantoin	Dicarboximide	50 WP
Cupravit	Copper oxychloride + 50% Cu 3 Cu $(OH)_2$ $Cucl_2$	Copper	50 WP
Tilt (Propiconazole)	1-2 (2,4-Dichlorophenyl-4- Propyl-1-1-3 Di-O Oxalem EL Methyl- H 1, 2, 4- Tryozole)	Propiconazole	250 E.C.

Poisoned food technique (Nene and Thaphyal, 1979) was employed to evaluate the efficacy of five fungicides as specified in Table 1 on the mycelial growth of the test fungus in the laboratory. Fungicidal solutions were prepared with 5 concentrations (500, 750, 1000, 1500 and 2000 ppm) separately by taking required amount of each funigicide for each concentration in 100 ml distilled water in 250 ml Erlenmeyer flask. Then Potato Dextrose Agar (PDA) medium was prepared in double concentration. For this purpose, 300 ml PDA was prepared by the ingredients as required for 600 ml PDA. The prepared PDA @ 50 ml, in each of 6 Erlenmeyer flasks (100 ml) was taken. The flasks were plugged with cotton followed by wrapping with brown paper and sterilized in autoclave. Fungicidal solutions (50 ml for each concentration) prepared earlier were mixed thoroughly with melted PDA. Thus 100 ml poisoned PDA for each concentration was prepared (50 ml PDA + 50 ml fungicidal solution). The poisoned food was plated in petridishes @ 20 ml for 3 replicates for each concentration. At the center of each plate, mycelial blocks of 5 mm were individually placed in an inverted position. The plates were incubated for growth at room temperature (22 ± 2^0C) nd linear growth (mm) of the test pathogen in each concentration was measured at 24 hours interval up to 7 days. Growth inhibition in percentage was calculated by using the formula of Ashrafuzzaman, (1976) as follows:

$$I = \frac{C - t}{C} \times 100$$

where,

C = average growth (mm) in the control (without fungicide)

t = average growth (mm)

I = percentage of growth inhibition

Dithan M-45, Rovral, Tilt, Cupravit and Bavistin (2000, 1500, 1000, 750 and 500 ppm) were screened to determine their effectiveness (0.1% a.i.) in controlling the stem- end rot and anthracnose. In pre-inoculation hot solution dip method, mature, hard mangoes were dipped in fungicide solutions (1000 ppm) for 5 minutes. Each concentration was considered as a treatment and 3 replications were provided for each treatment. The fungal blocks were inoculated into the treated fruits with or without wound and inoculated fruits were observed for symptom development. Fruits dipped in blank hot water served as control. Infection was monitored at every 24 hours by measuring length of diseased area (LDA) and percent fruit area diseased (FAD). Percent Disease index (PDI) was also measured from percent fruit area diseased. Surface area of fruit diseased (SAD) was calculated on the basis of lesions (Spalding and Reeder, 1986). To evaluate the effectiveness of the chemicals, the severity of disease was measured by calculating the percent disease index (PDI) according to the formula of Singh (1984):

$$PDI = \frac{\text{Total sum of rating}}{\text{Total number of fruits graded x maximum rating value}} \times 100$$

Infected fruits were graded using the scale given below (modified after Horsfall and Barratt, 1945):

Grade	% Fruit area diseased
0	Disease free fruit (No infection)
1	0-5
2	5.1-12
3	12.1-25
4	25.1-50
5	Above 50

The experiment for chemical control was laid out in a Completely Randomized Design (CRD). Treatment means were compared following Duncan's New Multiple Range Test (DMRT) using MSTAT statistical package program.

Results and Discussion

Varietal susceptibility to stem-end rot and anthracnose of 9 mango vaieties showed maximum lesion size (cm) and percent fruit area diseased (% FAD) in Raniprasand as 7.17 cm and 42.13%, respectively at 3 days after inoculation, followed by Gopal bhog (5.85cm, 38.90%) and Fazli (4.58 cm, 25.47%) and the lowest lesion size and % FAD were found in Langra as 2.17cm and 11.42%. Per cent fruit area diseased was statistically similar to variety Gootee, Lakkhan bhog, Chosa, Aswina and Langra (Table 2). Fazli was found to be the most susceptible variety among the tested 9 varieties of mango. Average lesion size and percent fruit area diseased were found 3.91cm and 23.03%, at 3 days after inoculation, followed by Gootee (3.08cm, 18.13%) and Gopal bhog (2.75cm and 16.17%). The lowest lesion size and percent fruit area diseased were found "in variety Lakkhan bhog (1.67cm, 6.87%). The average lesion size and percent fruit area disease (%FAD) were found statistically similar to variety Langra (1.33 cm, 7.83%), and Khirsapat (1.67cm, 9.80%) (Table 2). At 5 days after inoculation (DAI), the maximum % FAD was found in Fazli (33.33), followed by Gopal bhog (22.53) and Khirsapat (17.63) and the minimum % FAD were found in Raniprasand (4.9) and Langra (4.8). The fungicidal effect on the growth of *B. theobromae* was measured in terms of growth inhibition. The greatest efficacy on *B. theobromae* was observed with Bavistin and Tilt (1000 ppm) as complete inhibition of mycelial growth, followed by Dithane M-45 (63.75%) and Cupravit (64.92%) (Table 3). At 500 ppm concentration, 92.11% inhibition was obtained with Tilt, followed by Bavistin (84.64%), Dithane M-45 (37.01%), Rovral (48.64%) and Cupravit (48.64%), respectively. The average results noticed that maximum inhibition was obtained with Bavistin and Tilt at 1000 ppm concentration. This result is supported by Gupta and Pathak (1990) who claimed that hot water treatment (50± 2^0C) for 10 minutes was very effective to control *C. gloeosporioides*..

Table 2. Stem-end rot and anthracnose incidence in 9 varieties of mango inoculated artificially in the laboratory at 3 Days after inoculation (DAI)

Varieties	Stem-end rot			Anthracnose		
	Average lesion size (cm)	Percent fruit area diseased (% FAD)	Percent disease Index % PDI)	Average lesion size (cm)	Percent fruit area diseased (% FAD)	Percent disease Index (PDI)
Gopal bhog	5.8 5 b	38.90 a	73.33	2.750 be	16.17 be	40.0
Gootee	2.93 d	19.50 c	93.33	3.083 b	18.13 b	40.0
Khirshapat	6.67 ab	39.22 a	73.33	1,667 ef	9.80 ef	26.66
Raniprasad	7.17 a	42.13 a	93.33	0.00 g	0.00 g	0.0
Lakhan bhog	2.08 d	12.27 d	33.33	1. 167 f	6.87 f	26.66
Chosa,	2.92 d	16.17 cd	40.0	2.250 cd	13.23 cd	40.0
Aswina,	3.0 d	15.80 cd	40.0	2.0 de	11,77 de	33.33
Fazli	4.58 c	25.47 b	53.33	3.917 a	23.03 a	46.66
Langra	2.17 d	11.42 d	33.33	1.33 f	7.833 f	26.66

Figures having common letter do not differ significantly

Table 3. Effect of fungicides on the linear growth of *B. theobromae* at 30^0 C temperatures.

Fungicides	Conc. (ppm)	Linear growth (mm) after						
		1 day	2 days	3 days	4 days	5 days	6 days	7 days
Dithane M-45	500	10.83	13.17	25.17 d	38.38	54.17 b	71.50	77.17 b
	750	5.67	9.0	19.50 e	27.17	41.16 e	62.17	69.0 c
	1000	0.0	0.0	17.17 f	25.16	31.17 fg	37.17	44.67 f
	1500	0.0	0.0	5.66 h	13.83	20.17i	25.16	30.17 j
	2000	0.0	0.0	0.0 j	7.33	16.16 j	25.17	31.83 l
Bavistin	500	0.0	0.0	5.33 h	8.67	13.17 k	15.0	20.17 k
	750	0.0	0.0	0.0 j	0.0	4.33n	6.33	7.33 o
	1000	0.0	0.0	0.0 j	0.0	0.0 o	0.0	0.0 p
	1500	0.0	0.0	0.0 j	0.0	0.0 o	0.0	0.0 p
	2000	0.0	0.0	0.0 j	0.0	0.0 o	0.0	0.0 p
Rovral	500	9.83	19.5	32.17 b	37.17	44.17 d	65.17	69.50 c
	750	4.33	13.17	26.17 d	28.25	32.16 f	41.17	55.17 e
	1000	0.0	0.0	4.67 h	7.33	9.0 l	13.16	20.50 k
	1500	0.0	0.0	0.0 j	3.33	5.67 m	8.0	13.17 n
	2000	0.0	0.0	0.0 j	0.0	0.0 o	0.0	0.0 p
Cupravit	500	9.17	18.42	28.17 c	35.83	44.17 d	52.83	64.17 d
	750	8.0	18.50	25.16 d	35.17	49.50 c	60.25	69.33 c
	1000	5.83	11.17	17.17 f	21.17	30.17 g	35.17	41.17 g
	1500	0.0	0.0	7.33 g	16.50	24.50 h	28.15	34.83 h
	2000	0.0	0.0	0.0 j	0.0	8.67 l	13.50	18.17 l
Tilt	500	0.0	0.0	3.33 i	5.33	8.50 l	13.50	18.17 l
	750	0.0	0.0	0.0 j	3.33	6.33 m	10.17	16.18 m
	1000	0.0	0.0	0.0 j	0.0	0.0 o	0.0	0.0 p
	1500	0.0	0.0	0.0 j	0.0	0.0 o	0.0	0.0 p
	2000	0.0	0.0	0.0 j	0.0	0.0 o	0.0	0.0 p
Control		17.17	45.33	80.17 a	85.42	-	-	-

Figures having common letter do not differ significantly

C. gloeosporioides showed a slower growth than *B. theobromae*. After 24 hours of inoculation the highest mycelial growth was observed in control Plate (7.5 mm). No growth was observed in Bavistin, Rovral, and Tilt treated plates at all concentrations. At 7 days after inoculation minimum growth was observed in Bavistin 1000 ppm 5.33 mm followed by other treatments (Table 4). The highest inhibition of mycelial growth was found in Bavistin and Tilt 1000 ppm (100%), followed by Dithane M-45 (43.44%), Rovral (82.76%) and Cupravit (78.27%) at 5 days after inoculation. The lowest inhibition of mycelial growth was observed in Dithane M-45 with (27.70%) and the highest inhibition was found in Tilt (90.27%), followed by Cupravit (89.50%), Rovral (7.91%), and Bavistin (85.77%). The results of poisoned food technique indicated that all the fungicides possessed more or less inhibitory effect on the growth of *B. theobromae* and *C. gloeosporioides*. Effect of hot water with fungicidal solutions against *B. theobromae* showed that T_2 (Bavistin) and T_5 (Tilt) did not allow any growth of the fungus. The mean % FAD (15.72) observed in T_4 (Cupravit) was followed by 17.11% in T_3 (Rovral) and 36.11% in T_0 (control). The maximum and minimum percent fruit index (PDI) were recorded in T_0 (93.33) and T_5 (26.27) treatments, respectively. No fruit infection was found in T_2 treatment. At 5 DAI, the minimum % FAD was observed in T_5 (12.94%), whereas the maximum infection was found in T_0 (74.05%). Treatment T_2 (Bavistin) completely inhibited the growth of the fungus, which was significantly different than other treatments. T_5 (Tilt) ranked next effective fungicides which allowed minimum infection compared to other fungicides. The lowest lesion was found in T_5 (Tilt) 2.33cm, followed by other treatments (Table 5).

Table 4. Effect of fungicides on the linear growth of *C. gloeosporioides* at 30^0 C temperatures.

Fungicides	Conc. (ppm)	Linear growth (mm) after						
		1 day	2 days	3 days	4 days	5 days	6 days	7 days
Dithane M-45	500	7.0	11.0	16.33 b	27.50	32.17 b	36.50	41.33 b
	750	5.5	9.67	15.00 c	24.50	29.83 c	31.83	36.17 c
	1000	7.0	4.17	9.83 d	21.0	25.17 d	27.58	31.17 d
	1500	4.33	0.0	5.67 f	13.5	16.17 e	19.33	24.16 e
	2000	0.0	0.0	4.0 h	7.0	8.0 gh	9.0	11.17 h
Bavistin	500	0.0	0.0	3.33 h	5.67	6.33 ijk	7.0	8.66 ij
	750	0.0	0.0	0.0 i	0.0	5.33klm	5.67	6.67 jkl
	1000	0.0	0.0	0.0 i	0.0	0.0 n	4.0	5.33 l
	1500	0.0	0.0	0.0 i	0.0	0.0 n	0.0	0.0 m
	2000	0.0	0.0	0.0 i	0.0	0.0 n	0.0	0.0 m
Rovral	500	0.0	3.31	5.33 f	7.67	9.83 f	10.50	11.33 gh
	750	0.0	5.67	6.0 f	6.33	9.0 fg	10.67	11.33 gh
	1000	0.0	3.33	3.33 h	5.67	6.67 ghi	7.67	8.33 ijk
	1500	0.0	0.0	0.0 i	5.33	6.0jkl	6.33	6.33 jkl
	2000	0.0	0.0	0.0 i	3.33	6.0 jkl	6.67	7.33 jk
Cupravit	500	3.33	4.20	5.0 f	5.33	5.67 ijk	6.33	6.67 jkl
	750	3.67	6.50	7.33 e	7.67	10.10 f	11.17	12.50fgh
	1000	0.0	4.67	5.0 f	6.0	9.67 f	10.17	14.17 f
	1500	0.0	0.0	4.33 gh	5.33	8.67 fg	11.0	13.50fg
	2000	0.0	0.0	0.0 i	4.33	0.0 n	5.33	6.33jkl
Tilt	500	0.0	0.0	0.0 i	0.0	4.33 m	5.67	8.67 ij
	750	0.0	0.0	0.0 i	0.0	4.67 lm	5.33	7.67 jkl
	1000	0.0	0.0	0.0 i	0.0	0.0 n	0.0	0.0 m
	1500	0.0	0.0	0.0 i	0.0	0.0 n	0.0	0.0 m
	2000	0.0	0.0	0.0 i	0.0	0.0 n	0.0	0.0 m
Control		7.5	13.0	21.17 a	37.0	44.50 a	60.83	70.17 a

Table 5. Effect of some fungicides against mango stem-end rot following dip method at 53^0C for 5 minutes (5 days after inoculation)

Treatments	No. of inoculation	No. of infection	Length of diseased area cm)	Percent fruit area diseased (% FAD)	Percent fruit index (PDI)
T_1	3	2	5.50c	30.55	53.33
T_2	3	0	0.00e	0.0	0.0
T_3	3	3	7.0b	38.89	60.0
T_4	3	2	4.75c	46.38	66.67
T_5	3	1	2.33d	12.94	26.27
T_0	3	3	11.33a	74.05	93.33

T_1 = Hot water treatment at 45^0C T_2 = Hot water treatment at 50^0C
T_3 = Hot water treatment at 53^0C T_4 = Hot water treatment at 55^0C
T_0 = Control (Untreated)

In vivo test against *C. gloeosporioides* showed that in the hot solution dipped method, the maximum 5.50cm and minimum 1.67cm lesion size were found in T_0 (Control), and T_4 (Cupravit), followed by T_1 (Dithane M-45) as 2.73cm and T_3 (Rovral) as 3.77cm. No lesion were found in T_2 (Bavistin) and T_5 (Tilt) at 3 DAI. Maximum % FAD (30.55%) was found in T_0 (control) and the minimum (9.27%) was for T_4 (Cupravit), followed by T_1, T_2 and T_5 treatments. Treatment T_5 (Tilt) completely inhibited the fungal infection. At 5 DAI, the minimum lesion size was found 1.67cm in T_2 (Bavistin) and maximum was 8.50 cm in T_0 (control), followed by T_1, (Dithane M-45) as 3.5cm, T_3 (Rovral) as 4.17cm and T_4 (Cupravit) as 2.33 cm. The minimum percent fruit index was found in T_5 (26.27), followed by T_1, T_2, T_3, T_4 and T_0

treatments. No percent disease index was recorded in T_2 treatment (Table 6).

The information on the use of these fungicides against stem-end rot of mango were available on the recent report by Shelar *et al*. (1997) who found that Carbendazim (Bavistin 0. 1%), Mancozeb (Dithane M-45 0.25%) were highly effective against *B. theobromae*, which was proved by other researchers like Banik *et al.*, 1998 and Gajbhiye *et al*., 2000.

In vitro trials have indicated that post-harvest treatments with some chemicals are effective in controlling fruit rots. However, the residual effects of the chemicals and their commercial use have not been determined. Therefore hot water treatment still remains as an option. However, further studies are required to determine the residual effects of the tested fungicides. For the control of post harvest spoilage of mango and to develop an integrated disease management a detailed study is needed.

Table 6. Effect of some fungicides against mango anthracnose following dip method at 53^{0}C for 5 minutes (5 days after inoculation)

Treatments	No. of inoculation	No. of infection	Length of diseased area (LDA cm)	Percent fruit area diseased (% FAD)	Percent fruit index (PDI)
T_1	3	2	3.5 c	19.44	40.0
T_2	3	0	1.67 d	6.5	19.0
T_3	3	2	4.17 b	23,16	66.0
T_4	3	3	2.33d	12.94	33.33
T_5	3	1	0.85 e	3.72	13.13
T_0	3	3	8.50 a	47.22	66.67
LSD (P> 0.05)	-		1.129		

Figures having common letter do not differ significantly at P= 0.05

T_1 = Hot water treatment at 45^{0}C T_2 = Hot water treatment at 50^{0}C
T_3 = Hot water treatment at 53^{0}C T_4 = Hot water treatment at 55^{0}C
T_0 = Control (Untreated)

References

Annonymnous. 1990. Plant Pathology. Survey and monitoring of different diseases of mango. Annual Report, Division of Plant Pathology, BARI (Bangladesh Agricultural Research Institute), Joydebpur, Gazipur, Bangladesh. 73 p.

Ashrafuzzaman, H. 1976. Laboratory Manual of Plant Pathology. First Edition. Department of Plant Pathology, BAU, Mymensingh. 94 p.

Banik, A.K., Kaiser, S.A.K.M. and Dhua, R.S. 1998. Evaluation of some systemic and non- systemic fungicides against *Collelotrichum gloeosporioides* and *Diplodia natalensis* causing post harvest fruit rot of mango. Journal of Soils and Crops. 8(2): 119-122.

Dodd, J. C., Estrada, A.B. and Jeger, M.J. 1992. Epidemiology of *Colletotrichum gloeosporibides* in the tropics. In: Bailey, J. A. and Jeger, M. J. (eds) Colletotrichum : Biology, Pathology and Control. CAB International Wallingford. 308-325 pp.

Gajbhiye, V.T., Singh, R.H., Kumar, R. and Singh, C.P. 2000. Efficacy of post harvest treatment of carbendazim agaist stem-end rot / anthracnose disease and its persistence in mango fruits. Annals of Plant Protection Sciences. 8 (2): 230-232.

Gupta, A. K. and Pathak, V.N. 1990. Epidemiology and management of papaya fruit rots. Index to thesis accepted for higher degrees in the University of Great Britain and Ireland. 3 7 (3): 13 13.

Jeffies, P., Dodd, J.C., Jeger, M.J. and Plumbley, R.A. 1990. The biology and control of *Colletotrichum*. species on tropical fiuit crops. Plant Pathology. 39: 343-366.

Meah, M. B. and Khan, A.A. 1987. Survey of diseases of some important fruits and vegetables of Bangladesh. Annual Progress Report for 1986-87. Department of Plant Pathology Bangladesh Agricultural University. Mymensingh. 1-28 pp.

Mendoza, JR. D.B. and Wills, R.B.H. 1984. Changes in mango during growth and maturation, 'Mango' 21-27 pp. ASEAN Food Handling Bureau, Kuala lumpur, Malaysia.

Nene, Y. L. and Thaplyal, P.N. 1979. Fungicides in plant disease control. Second Edition. Mohan Primlani. Oxford and lBH publishing Co. 66. Janpath, New Delhi. 507 p.

Pathak, V. N. and Srivastava, D.N. 1967. Mango losses due to Diplodia stem-end rot Tropical Agriculturist 123 (1-2): 75-77.

Shelar, S. A., Padule, D.N., Sawant, D.M. and Konde, B.K. 1997. *In vitro* evaluation of fungicides against *Botryodiplodia theobromae* pat, the cause of die-back disease of mango. Indian Journal of Plant Protection. 25 (2): 118- 120.

Singh, R. S. 1984. Introduction of Principles of Plant Pathology. Third Edition Oxford & 11311 publishing Co. 66 J. Path, New Delhi 110001. 328 p.

Spalding, D. H. and W. F. Reeder. 1986. Controlling marker diseases of mangoes with heated benomyl. Proceedings of the Florida State Horticulture Society. USA.