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Management of Foot and Root Rot Disease of Eggplant (*Solanum melongena* L.) Caused by *Sclerotium rolfsii* under *In Vivo* Condition

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Abstract

An experiment was conducted to evaluate the efficacy of fungicides, plant extracts, organic manure and biocontrol-agents against foot and root rot disease of eggplant caused by *Sclerotium rolfsii*. Five chemical fungicides, two plant extracts, organic amendment - poultry manure and biocontrol-agent *Trichoderma harzianum* were evaluated against the disease in field condition. Fungicides and plant extracts were sprayed at the base of each plant and adjacent soil at 40, 50 and 60 days after transplanting. Organic manure and biocontrol-agent were applied to the soil before transplanting. The lowest disease incidence (7.10 %) and no disease severity were observed in Bavistin 50 WP at 120 DAT followed by Topgan 50 WP and Ridomil Gold. Higher yield and plant growth like plant hight (88 cm), number of branch/plant (7.33) and number of leaf/branch (25.33) was also supported by Bavistin 50 WP . The highest benefit cost ratio was also calculated in Bavistin 50 WP followed by Topgan 50 WP and Ridomil Gold. Application of biocontrol-agent (*T. harzianum*) also showed promising effect against foot and root rot disease.

Keywords: Foot and root rot, *Sclerotium rolfsii*, fungicides, plant extract, poultry manure, biocontrol-agent and eggplant.

1. Introduction

Eggplant (*Solanum melongena* L.) is an important vegetable crop in Bangladesh (BBS, 2011). It is being cultivated in almost all districts and consumed as a cooked vegetable in various ways. It is a small short lived perennial herb belonging to the family Solanaceae of dicot angiosperm. More than ten diseases of eggplant have been reported in Bangladesh (Islam, 2005; Ahmmed, 2012) of which foot and root rot caused by *Sclerotium rolfsii* is an important one. Dasgupta *et al*. (2000) reported the highest intensity of foot and root rot and leaf rot of eggplant in Midnapore and Nadia district of India. Foot and root rot may cause up to 30-50 % loss in fruit yield in eggplant (Siddique *et al.*, 2016). The fungus *S. rolfsii* is a facultative saprophyte and can maintain continuity of its generation under adverse situation by formation of sclerotia (Ahmed, 1980).

The fungus *S. rolfsii* is soil borne and become pathogenic at favourable environment. It is very

difficult to control it even by the use of chemical fungicides. Some fungicides such as Bavistin 50 WP, Topgan 50 WP, Dithane M-45 and bordeaux mixture reported to be effective to control foot and root rot disease of eggplant caused by *Sclerotium rolfsii* (Patil *et al.*, 1986; Tiwari and Ashok, 2004; Dasgupta and Maiti, 2008 and Johnson and Reddy, 2008).

Biological control could be successful alternative to chemicals. Many species of fungi and bacteria are reported to be effective as bio-control agents against soil borne plant pathogens (Mukhopadhyay, 1994 and Bari M. A. 2000). *Trichoderma* spp are antagonists to many plant pathogenic fungi. They are potential bio-control agent against several soil borne plant pathogenic fungi (Biswas and Sen, 2000; Pranab Datta and Das, 2002 and Saralamrna and Vithal, 2003). Antifungul activities of garlic, neem and alamanda have been reported by many researchers (Rahman *et al*., 1994; Arun *et al.*, 1995; Mohanty *et al.*, 2000; Gurjar *et al.*, 2003 and Islam, 2005).

Therefore, the present study was undertaken to evaluate some fungicides, plant extracts, organic manure and bio-agent against controlling foot and root rot disease of eggplant caused by *S. rolfsii.*

2. Materials and Methods

The experiment was conducted in field condition during November 2013 to May 2014 at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Ten treatments including five fungicides viz. Bavistin 50 WP (Carbendazim) @ 0.2 % , Topgan 50 WP (Copper-oxychloride) @ 0.2 %, Ridomil gold MZ 68 WG (Metalaxyl) @ 0.4 %, Bordeaux mixture (Cu fungicide) @ 1:1:2 (w/v), and Dithane M-45 (Mancozeb) @ 0.2 %; two plant extracts viz. Neem (*Azadirachta indica*) @ 1:2 (w/v) and Allamanda (*Allamanda cathertica*) leaf extract @ 1:2 (w/v); organic poultry manure @ 25 g/plant and biocontrol-agent *Trichoderma harzianum* @ 1.35 x 10^9 spores/plant were tested against foot and root rot disease of eggplant (Variety "Singnath"). The experiment was carried out in Randomized Complete Block Design (RCBD) with three replications.

The leaf extract were prepared by using the method of Ashrafuzzaman and Hossain (1992). *S. rolfsii* was isolated from the infected plants following tissue planting method. Pure culture of the pathogen was prepared following hyphal tip method and subsequently multiplied on potato dextrose agar (PDA) medium in test tubes and petri dishes (Mian, 1995). The infected portion along with the healthy portion of the plants were cut into small pieces and surface sterilized with 1% Clorox for 2-3 minutes, washed briefly in sterile distilled water and dried on sterile filter paper. The dried pieces were cut into smaller pieces, plated onto PDA and incubated at 25±1°C. Pure cultures of *Sclerotium rolfsi* were identified following the key outlined by Singh (1982) and shown in Figure 1.

Selected healthy seedlings were transplanted in the earthen pot. Manures and fertilizers were applied properly. Seven petri plates (9 cm) of pure culture of *S. rolfsii* were cultured on PDA medium. Mycelium of *S. rolfsii* were collected from pure culture with the help of camel hair brush and blended with the help of electric blender to make mycelia suspension. Then pure mycelia suspensions were inoculated to the soil in the base of each plant at two months after transplanting. The fungicides, plant extracts, organic manure and biocontrol-agent were applied at root zone of eggplants by hand sprayer at 10 days interval.

Data were taken randomly from selected five plants from each plot. Disease incidence, stem lesion area (cm) of eggplant were recorded at 90 and 120 days after transplanting (DAT) and yield (t/ha) and yield contributing characters of eggplant were recorded at 120 DAT. Data was analyzed statistically and the means were separated by least significant difference (LSD) following MSTAT-C software.

Percent disease incidence was calculated using number of diseased plant as percent of total plant observed, while disease severity and benefit cost ratio were calculated using the following formula:

$$\text{Percent Disease Incidence} = \frac{\text{Number of diseased plants}}{\text{Number of total plant observed}} \times 100$$

$$\text{Percent Disease Severity/Stem lesion area} = \frac{\text{Sum of all disease rating}}{\text{Total no. of rating} \times \text{maximum disease grade}} \times 100$$

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Net Income}}{\text{Total Cost of Production}}$$

3. Results and Discussion

The causal organism of foot and root rot disease of eggplant was isolated by tissue planting method and identified as *Sclerotium rolfsii* (Fig. 1).

Whitish fan shape mycelial growth was observed on PDA medium. In culture, the whole area of a petri plate is rapidly covered with mycelium, including aerial hyphae which covered the lid of the plate. The fungus' growth was so fast. Both in culture and in plant tissue, a fan-shaped mycelial expanse was observed growing outward and branching acutely. Sclerotia begin to develop after 4-7 days of mycelial growth, initially a fatty white appearance and quickly melanize to a dark brown coloration. *Sclerotium rolfsii* is a necrotrophic, soil borne fungal plant pathogen that can be very destructive to numerous vegetable and fruit crops, especially eggplant, tomato, pepper, melon, and watermelon. Signs of infection include the development of coarse white strands of mycelium growing in a fan-shaped pattern on stem at soil level (Fig. 4a).

Even under dry conditions, at least a trace of white mycelium is generally evident on the surface of the stem. In some cases, mycelium was found only underground. After 20 to 30 days, tan-to-brown, mustard-seed-sized sclerotia form on the mycelial mat (Fig. 4b).

Disease infection usually restricted to plant parts in contact with the soil. Early symptoms consist of water-soaked lesions on lower stem tissue. The disease usually was recognized by the yellowing and wilting of foliage, followed by a complete collapse of the plant (Fig. 2. a & b). Vascular bundles became brown in the infected stem (Fig. 3. a&b).

The effect of all treatments on disease incidence and size of stem lesion (cm^2) on eggplant was recorded at 90 and 120 days after transplanting and presented in Table 1 and 2.

In case of 90 DAT, Bavistin 50 WP produced no disease incidence (0.00 %) and no stem lesion area of eggplant. Topgan 50 WP although produced some disease (6.6% incidence) was statistically similar to Ridomil Gold MZ 68WG (6.67 %), Bordeaux mixture (13.33 %), Dithane M-45 (13.33 %), Neem leaf extract (13.33 %), Poultry manure (20.00 %) and biocontrol-agent *T. harzianum* (13.33 %). The highest disease incidence was recorded in the untreated control (33.33 %). While application of Topgan 50 WP (0.93 cm^2) and Ridomil Gold MZ 68WG produced (0.93 cm^2) diseased area showing similar effect.

Figure 1. Pure culture of *Sclerotium rolfsii*

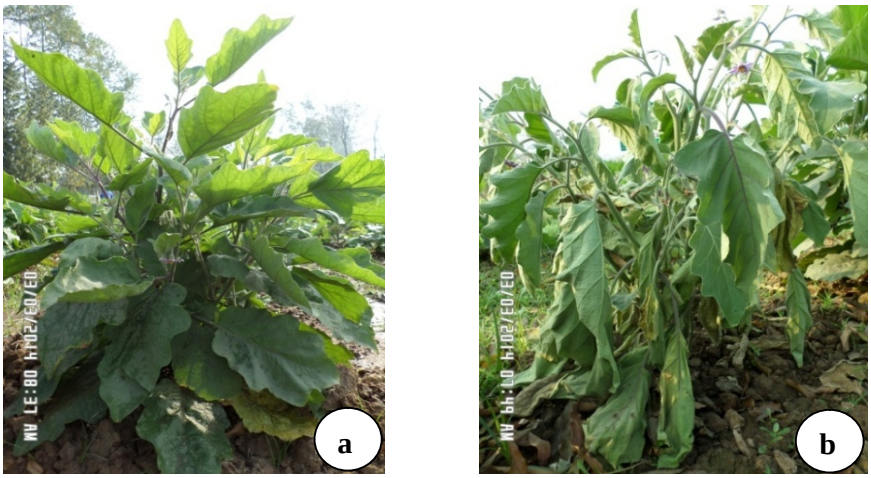

Figure 2. (a) Healthy eggplant, (b) Infected eggplant

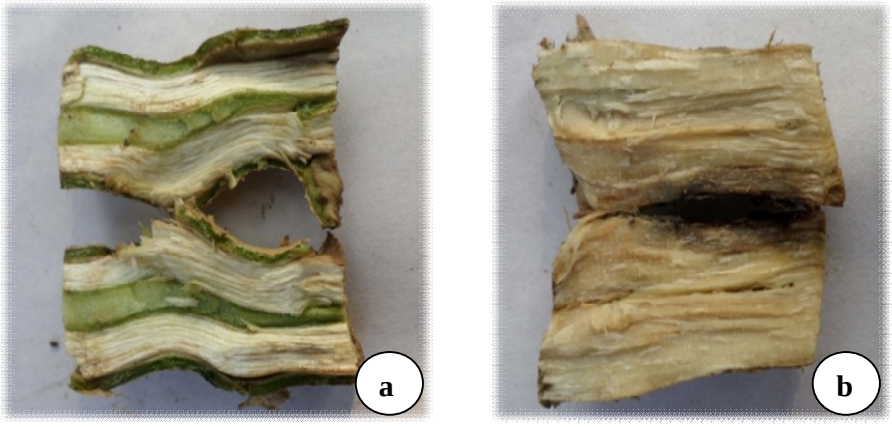

Figure 3. (a) Longitudinal section, healthy stem (b) Longitudinal section, infected stem

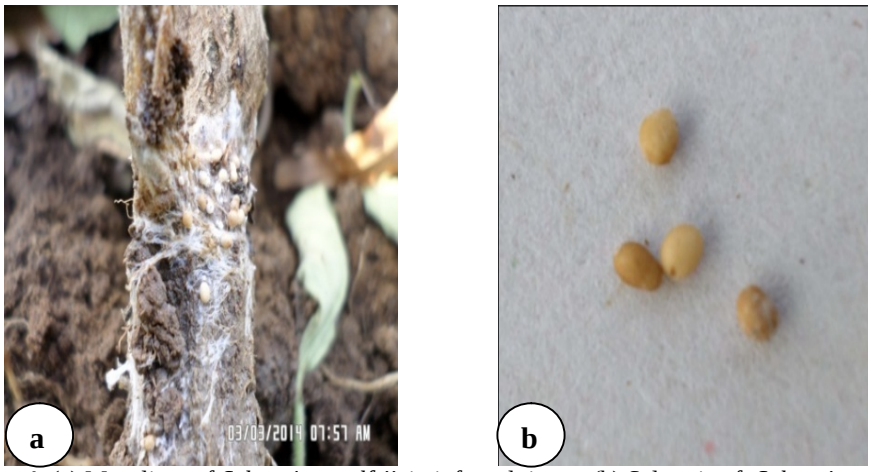

Figure 4. (a) Mycelium of *Sclerotium rolfsii*, in infected tissue; (b) Sclerotia of *Sclerotium rolfsii*

Table 1. Effect of different treatments on disease incidence and disease severity in eggplant under field condition at 90 days after transplanting

Treatment	% Disease Incidence*	% Incidence reduction over control	Disease Severity or Stem lesion area (cm^2)	% Severity reduction over control
T_1= Control	33.33 a	0.00	5.70 a	0.00
T_2= Bavistin 50 WP	0.00 c	100.00	0.00 e	100.00
T_3= Topgan 50 WP	6.67 bc	79.99	0.93 c-e	83.68
T_4= Ridomil Gold	6.67 bc	79.99	0.93 c-e	83.68
T_5= Bordeaux mixture	13.33 bc	60.00	1.97 b-e	65.44
T_6= Dithane M-45	13.33 bc	60.00	1.93 b-e	66.14
T_7= Neem leaf extract	13.33 bc	60.00	2.03 b-e	58.64
T_8= Alamanda leaf extract	26.67 ab	19.99	3.17 bc	44.39
T_9= Poultry manure	20.00 a-c	39.99	3.33 b	41.59
T_{10}= *Trichoderma harzianum*	13.33 bc	60.00	2.90 b-d	48.59
$LSD_{(0.05)}$	17.84		1.981	
CV (%)	70.91		50.42	

*Means followed by the same letter did not differ at 5% level of significance by LSD.

Similarly, in case of 120 DAT, Bavistin 50 WP produced the lowest disease incidence (7.1 %) which was statistically similar to Topgan 50 WP (19.6 %) Ridomil Gold MZ 68WG (19.6 %), Bordeaux mixture (32.17%), Dithane M-45 (32.17%), Neem leaf extract (35.27%) and biocontrol-agent *T. harzianum* (38.43%). No stem lesion area of eggplant was also found in Bavistin 50 WP (0.00 cm^2) applied plant followed by Topgan 50 WP (1.004 cm^2). Here also the highest lesion area was recorded in the untreated control (6.36 cm^2). The highest percent reduction of stem lesion area (88.83 %) was obtained from Bavistin 50 WP treated plots.

Table 2. Effect of different treatments on disease incidence and disease severity in eggplant under field condition at 120 days after transplanting

Treatment	% Disease Incidence*	% Incidence reduction over control	Disease Severity or Stem lesion area (cm^2)	% Severity reduction over control
T_1= Control	62.50 a	0	6.36 a	0
T_2= Bavistin 50 WP	7.10 c	88.64	0.00 d	100.00
T_3= Topgan 50 WP	19.63 bc	68.59	1.00 cd	84.27
T_4= Ridomil Gold	19.63 bc	68.59	1.03 cd	83.80
T_5= Bordeaux mixture	32.17 a-c	48.52	2.20 b-d	65.40
T_6= Dithane M-45	32.17 a-c	48.52	2.13 b-d	66.50
T_7= Neem leaf extract	35.27 a-c	43.56	2.63 bc	58.64
T_8= Alamanda leaf extract	50.87 ab	18.60	4.13 bc	35.06
T_9= Poultry manure	50.90 ab	18.56	4.30 ab	32.38
T_{10}= *Trichoderma harzianum*	38.43 a-c	38.51	3.60 b	43.39
$LSD_{(0.05)}$	29.58		2.259	
CV (%)	49.45		48.06	

*Means followed by the same letter did not differ at 5% level of significance by LSD.

The effect of fungicides, plant extracts, organic manure and biocontrol-agent on plant hight, number of branch/plant, number of leaf/ branch and yield of eggplant was determined and presented in Table 3. The highest yield (25.17 t/ha) was recorded in plot treated with Bavistin 50 WP followed by Topgan 50 WP (22.87 t/ha) and Ridomil gold MZ 68WG (22.23 t/ha). However, the lowest yield (8.70 t/ha) was recorded in control plot. All the treatments have effect to increasing the plant hight, number of branch/plant and number of leaf/ branch. The highest plant hight (88 cm), number of branch/plant (7.33) and number of leaf/branch (25.33) was found in Bavistin 50 WP treated plot. The lowest plant hight (61 cm), number of branch/plant (4.33) and number of leaf/branch (12) was found in untreated control condition.

The effect of all treatments on benefit cost ratio of eggplant production was determined and presented in Table 4. The highest BCR (1.89) was recorded in plot treated with Bavistin 50 WP foot and root rot of eggplant (Islam, 2005). followed by Topgan 50 WP (1.72) and Ridomil gold MZ 68WG (1.67). However, the lowest BCR (0.65) was recorded in control plot. Neem leaf extract (1.35) and *Trichoderma harzianum* (1.34) was also effective to increasing the benefit cost ratio (BCR) of eggplant production.

From the results of the experiments it is revealed that the chemical fungicides, plant extracts, organic manure and biocontrol-agent are effective against *Sclerotium rolfsii* causing foot and root rot disease of eggplant. Bavistin 50 WP was the best among the options in reducing the incidence of foot and root rot disease and increasing fruit yield in eggplant. Similar findings were reported on foot and root rot of other crop (Mishra and Bais, 1987; Vanitha and Suresh, 2002 and Sheoraj *et al*., 2005). Neem leaf extract was reported promising against the *Sclerotium rolfsii* causing foot and root rot of eggplant (Dayaram and Tewari, 1994). *Trichoderma harzianum* was also effective in controlling *Sclerotium rolfsii*, the causal agent of

Table 3. Effect of different treatments on yield and yield promoting characters of eggplant at 120 days after transplanting (DAT)

Treatment	Plant height (cm)*	No. of branch/plant*	No. of leaf/branch*	Yield (t/ha)*
T_1= Control	61.00 g	4.33 d	12.00 f	8.70 f
T_2= Bavistin 50 WP	88.00 a	7.33 a	25.33 a	25.17 a
T_3= Topgan 50 WP	85.00 b	6.67 ab	23.33 ab	22.87 b
T_4= Ridomil Gold	85.00 b	6.33 a-c	22.67 b	22.23 b
T_5= Bordeaux mixture	84.00 b	6.00 a-c	21.67 bc	19.43 cd
T_6= Dithane M-45	81.33 c	6.00 a-c	20.00 cd	19.82 c
T_7= Neem leaf extract	79.00 d	5.33 b-d	18.67 d	18.00 d
T_8= Alamanda leaf extract	74.00 e	5.33 b-d	16.00 e	13.40 e
T_9= Poultry manure	70.33 f	5.00 cd	14.33 e	12.30 e
T_{10}= *Trichoderma harzianum*	79.33 d	5.67 b-d	18.33 d	17.80 d
$LSD_{(0.05)}$	1.989	1.283	2.087	1.622
CV (%)	1.47	12.89	6.15	5.26

*Means followed by the same letter did not differ at the 5% level of significant by LSD.

Table 4. Effect of different treatments on benefit cost ration (BCR) of eggplant production against foot and root rot disease

Treatment	Benefit Cost Ratio (BCR)
T_1= Control	0.65
T_2= Bavistin 50 WP	1.89
T_3= Topgan 50 WP	1.72
T_4= Ridomil Gold	1.67
T_5= Bordeaux mixture	1.46
T_6= Dithane M-45	1.49
T_7= Neem leaf extract	1.35
T_8= Alamanda leaf extract	1.01
T_9= Poultry manure	0.92
T_{10}= *Trichoderma harzianum*	1.34

4. Conclusions

The chemical fungicide Bavistin 50 WP (Carbendazim) showed the best effects among the treatments in reducing foot and root rot disease and increasing the fruit yield in eggplant. Moreover, *Trichoderma harzianum* was also found effective against *Sclerotium rolfsii*. So, Bavistin 50 WP and soil application of *Trichoderma harzianum* may be suggested to use by the farmer for controlling foot and root rot disease of eggplant.

References

Abu Noman Faruq Ahmmed. 2012. Management of Fusarium and Nemic Wilt of Eggplant-Eco-friendly Practices with Cost-Benefit Analysis. LAMBERT Academic

Publishing (LAP), Germany, 117 pp. ISBN: 978-3-8484-3930-0.

Ahmed F. 1980. Control of foot and root rot disease of wheat. M.S. thesis, Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh.

Arun AC., Tekha, Chitra A. 1995. Effects of garlic extracts on two fungi. *Indian Journal of Mycological Plant Pathology*, 259: 316-318.

Ashrafuzzaman H., Hossain I. 1992. Antifungal activity of crude extracts of plants against *Rhizoctonia solani* and *Bipolaris sorokiniana*. Proc, BAU. Res. Prog.6:188-192.

Bari MA. 2000. Effect of fungal antagonistic to suppress foot and root rot of barley. *Bangladesh Journal of Plant Pathology*, 16: 17-21.

BBS. 2011. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh, Dhaka.

Biswas KK., Sen C. 2000. Management of stem rot of groundnut caused by *Sclerotium rolfsii* through *Trichoderma harzianum*. *Indian Phytopathology*, 53(3): 290-295.

Dasgupta B., Maiti S. 2008. Assessment of *Phytophthora* root rot of betel vine and its management using chemicals. *Indian Journal of Mycological Plant Pathology*, 29:91-95.

Dasgupta B. 2000. Diseases of plantation crops spices, eggplant and betel vine, pp.133-137.

Datta P. Das BC. 2002. Management of collar rot of tomato by *Trichoderma* spp. and chemicals. *Indian Phytopathology*, 55(2): 235-237.

Dayaram, Tewari, 1994. Collar rot of chickpea caused by *Sclerotium rolfsii*. *Indian Phytopathology*, 52(3): 310.

Gurjar RBS., Bansal RK., Gupta RBL. 2003. Effect of soil amendments on collar rot of chilli caused by *Sclerotium rolfsii*. *Journal of Mycological Plant Pahtology*, 33(3): 482.

Islam M. 2005. Country news. *Holiday publication limited*, 8: 3-4.

Mian IH. 1995. Methods in plant pathology. IPSA-JICA Project Publication, 24:100.

Mirsha BK., Bais BS. 1987. Studies on seedling blight and foot rot of barley caused by *Sclerotium rolfsii*. *Indian Phytopathology*, 40: 161-167.

Mohanty B., Roy JK., Dasgupta B., Sen C. 2000. Relative efficacy of promising fungicides and bio-control agent *Trichoderma* in the management of foot rot of betel vine. *Journal Plantation Crops*, 28: 179-184.

Mukhopadhyay. 1994. Biological seeds treatment for control of soil borne pathogens FAO. *Plant Protection Bulletin*, 40: 21- 30.

Patil MR., Waghe SV., Wangikar PD., Khune NN. 1986. Chemical control of wilt of betel vine. *Pesticides*, 20: 28-29.

Rahman ML., Haque MS., Muqit A., Alam KB., Ali S. 1994. Response of *Phytophthora parasitica* to different fungicides. *Bangladesh Journal of Plant Pathology*, 10: 1-2, 35-36.

Saralamrna S., Vithal RT. 2003. Integrated management of *Sclerotium* root rot in groundnut. National seminar on stress management in oil seeds for attaining self reliance in vegetable oil Indian society of oil seeds research. Directorate of oil seeds research, Hyderabad, January 28 - 30. 20 - 21 pp.

Sheoraj S., Prajapati RK., Srivastava SSL. 2005. Efficacy of fungicides against *Sclerotium rolfsii* causing collar rot in lentil, *Farm Science Journal*, 14(2): 68-69.

Siddique MNA., Ahmmed ANF., Mazumder MGH., Khaiyam MO., Islam MR. 2016. Evaluation of Some Fungicides and Bio-Agents against *Sclerotium rolfsii* and Foot and Root Rot Disease of Eggplant (*Solanum melongena* L.). *The Agriculturists*, 14(1):92-97. DOI: http://dx.doi.org/10.3329/agric.v14i1.29105.

Singh RS. (1982). Plant pathogen-The fungi. Oxford and IBH Publishing Co. New Delhi. p.564.

Tiwari RK., Ashok S. 2004. Efficacy of fungicides on *Rhizoctonia solani* and *Sclerotium rolfsii* and their effect on *Trichoderma harzianum* and *Rhizobium leguminosarum*. *Journal of Mycology and Plant Pathology*, 34(2): 482-485.

Vanitha S., Suresh M. 2002. Management of collar rot of brinjal (*Sclerotium rolfsii*) by non-chemical methods. *South Indian Horticulture*, 50(4-6): 602-606.