Journal of Science and Technology 13(June 2015): 75-81

STUDY ON EPIDEMIOLOGY AND CHEMICAL CONTROL OF RHIZOME ROT DISEASE OF GINGER (*Zingiber officinale* Rose)

S.M.M. Hossain[1*], M.M. Hasan[1], M.A. Alam[2] and M.M. Islam[1]

[1]*Department of Plant Pathology;* [2]*Department of Statistics, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh*

ABSTRACT

A field experiments was conducted at Hajee Mohammad Danesh Science & Technology University, Dinajpur during 2013-2014 to know the epidemiology for the development of rhizome rot disease of ginger as well as to control the disease by using several new fungicides available in Bangladesh. Seed treatment and foliar spray of fungicides were performed with Acrobat MZ, Metaril, Nuben, Ridomil gold and Secure. Rhizome rot of ginger is favored at saturated soil with moisture of 39.43% and soil temperature between 33-34^{0}C. The disease is favored by heavy rainfall during July to August (339-515 mm), 90% relative humidity and air temperature 27-28^0 C. Fungicide Acrobat MZ, Metaril, Nuben, Ridomil gold and Secure were found to increase the germination of rhizome and plant growth by reducing the incidence and disease severity of rhizome rot of ginger. Among the fungicide used, Acrobat MZ was the most effective to control the disease severity by 27.19% but increased the rhizome yield by 5.76 times over control.

Keywords: Chemical control, disease severity, epidemiology, ginger, rhizome rot

INTRODUCTION

Ginger (*Zingiber officinale*) is one of the most essential spices crop grown in everywhere of the world including Bangladesh. It has special significance for tropical countries where it is produced and consumed in large quantities (Rahim 1992). The useful part of ginger is rhizomes (Purseglove *et al*. 1988) and in western countries, it is widely used for culinary purpose in ginger bread, biscuits, cake, pudding, soups and pickles. It is a common constituent of curry powder. Ginger is also used in medicine as a carminative and aromatic stimulant to the gastrointestinal tract, externally as an aphrodisiac and internally as a pubefacient and counter irritant. Now a days, it is used popularly as chewing purpose (Purseglove *et al*. 1988).

Bangladesh is not self-sufficient in the production of ginger and is imported from abroad by exchanging the foreign currency. Bangladesh produces about 55,000 metric tons of ginger from 21,000 acreage of land during the 2007-2008 cropping seasons (BBS, 2008) and the annual yield is 2.46 mt/acre. The yield per unit area of ginger is not sufficient to fulfill the requirement of the country. So, it is urgently needed to improve per unit production of ginger in the country. However, diseases of ginger are the most limiting factors for improving the yield of ginger. Ginger is attacked by various diseases, such as rhizome rot, bacterial wilt, leaf spot, anthracnose, leaf blight and leaf blotch etc. Among the various diseases, rhizome rot is the most damaging one (Chattopadhya 1997). Due to this disease, the internal tissue is rotted completely and the plant is wilted and died (Mahanta and Samajdar 2013).

There is no suitable methods available in Bangladesh to control rhizome rot disease of ginger. Moreover, no systematic research work has been done to the control of the disease. The disease is very sensitive to water logged condition in the field. So, the soil moisture along with other environmental conditions becomes a limiting factor for emergence and growth of ginger. The disease may become epidemic in favorable environmental conditions along with susceptible host. However, it is very important to find out the most favorable environmental conditions for the onset of the disease in order to find out a sustainable control measure of this disease.

The incidence of rhizome rot in field condition can be minimized by different ways including seed

**Corresponding author: Sk. Md. Mobarak Hossain, PhD, Dept. of Plant Pathology, Hajee Mohammad Danesh Science and Technology University,Dinajpur 5200, Bangladesh, Cell Phone: 01713-163330*

treatment, soil treatment, soil amendment, sanitation and drainage (Rahman 2001). However, information regarding sustainable control measures of rhizome rot of ginger is not sufficient in Bangladesh. Therefore, our aim is to study the epidemic condition of this disease and to find out appropriate control measures of rhizome rot of ginger.

MATERIALS AND METHODS

Seed collection and land preparation: The experiment was conducted in the research field of Hajee Mohammad Danesh Science and Technology University, Dinajpur during 2013-2014. The seed rhizomes bearing one to three bud with 40-50 g weight were collected from the local market of Dinajpur. Well decomposed cowdung and recommended dose of fertilizer for ginger were applied during land preparation and intercultural operations were done on need basis. The experiment was laid out in a Randomized Complete Black Design (RCBD) with three replications.

Data collection on epidemiological parameter: Soil moisture content, soil temperature, rain fall, relative humidity, atmospheric temperature on percent plant infection, number of infected tillers /hill, number of healthy tillers/ hill were recorded from May 2013 to January 2014. Soil texture was also analyzed before sowing of rhizome seeds according to hydrometer method and the particle size was separated followed by the USDA size limits. The textural classes of soil were determined using Marshall's Triangular Co-ordinates diagram.

Preparation and Application of fungicide: Five fungicides available in Bangladesh including Acrobat MZ, Metaril, Nuben, Ridomil gold and Secure were selected based on their nature of action. All the fungicides were prepared for seed treatment and foliar spray as well. For seed treatment, seeds of ginger were dipped in fungicidal solution contained in a plastic tray for half an hour followed by drying by blotting paper for 2 hours before planting. For foliar spray, fungicidal solutions were prepared by dissolving recommended dose in required quantity of distilled water. Spray was done just after the detection of rhizome rot symptom in the field and was repeated thrice at 10 days interval. Spray was done in afternoon and in such a way so that, both upper and lower surface of leaves as well as stems were completely soaked and distilled water was applied as negative control.

Analysis of Data: All data were analyzed for analysis of variance by using MSTAT-C computer program. Means were compared with Duncan's Multiple Range Test (DMRT).

RESULTS

Epidemiological Parameter

Soil moisture: Percent plant infection and infected tiller per hill were found to increase with the increasing of soil moisture content. Plant infections found near to zero in soil moisture around 15% which were then increased with the increasing of soil moisture. Maximum soil moisture was recorded in September and subsequently the highest plant infection was found in October, 2013 (Figure 1A).

Soil temperature: The favorable soil temperature for infection of ginger was found in between the month of September and October. Maximum plant infection was found during the month of September to October, 2013 where soil temperature was around 30^0 C (Figure 1B).

Air temperature: Air temperature varied from 16.9^0 C-29.5^0 C during the study period. Percent plant infections were rapidly increased during June-October when the average air temperature was found moderately higher. Tillering of plants was also found to increase in the moderate temperature (Figure 1C).

Relative Humidity: The relative humidity was varied from 87-92% during the entire study period. Maximum percent plant infection recorded in September to October, 2013 where relative humidity was found between 90% - 91% (Figure 1D).

Rainfall: During the study period, maximum (515 mm) rainfall was occurred during the month of July and August and just following high rainfall, percent plant infection were increased and reached maximum level (about 35%) during the month of September-October. The soil was fully saturated during the heavy rainfall of August which found to exist up to October and became favorable for infection of rhizome rot (Figure 1E).

Fungicidal effects

Germination: Both at 30 DAS and 40 DAS, highest germination of rhizome (98.35% and 100%) was recorded with the application of Secure and surprisingly, lowest germination (73.35% and 88.35%) was recorded with Metaril (Table 1). All other fungicides and control showed the statistical identical effect on germination with secure at 30 DAS.

Plant height and tiller per plant: All fungicides used in this study showed the better plant height of ginger plant compared to control. Among the fungicides used, Ridomil gold showed the best plant height (75.44 cm) over control (48.33 cm). Likewise plant height, all the fungicides were also showed positive effect to increase the tiller number per plant and Acrobat MZ gave the maximum number of tiller (20.33) whereas, plant without fungicidal (control) treatment gave the lowest tiller (6.66).

Yield: A tremendous increase in yield was observed of rhizome of ginger using fungicides in this study. Among the fungicides, Acrobat MZ gave the highest yield (10.08 t ha^{-1}) followed by Secure (7.37 t ha^{-1}), Metaril (5.88 t ha^{-1}) and Ridomil gold (5.77 t ha^{-1}); whereas, control plant gave lowest (1.75 t ha^{-1}) yield of rhizome.

Percent plant infection: Percent plant infections were recorded at 90, 120, 150 and 180 DAS. At 90 DAS, highest infected plants (23.76%) were recorded in the control plant followed by plant treated (20.00%) with Metaril; whereas, the lowest infected plants (3.33%) were recorded in Acrobat MZ treated plant. At 120 DAS, the highest infected plants (25.01%) were recorded in control plant which were statistically similar with Metail treated plant (25.00%) followed by plant (15.00%) treated with Secure; whereas, the lowest infected plants (6.67%) were recorded in Acrobat MZ treated plant. Similarly both at 150 DAS and 180 DAS, the highest infected plants (38.33 and 69.00%) were recorded in control plant and the lowest infected plants (11.64 and 28.34%) in Acrobat MZ treatment (Table 2).

Disease severity: Data on disease severity (%) of ginger plants were recorded at 90, 120, 150 and 180 DAS. At 90 DAS, the highest (30.97%) disease severity was recorded in control plant followed by disease severity (19.22%) in plant treated with Metaril; whereas, the lowest disease severity (3.33%) were recorded in Acerobat MZ treated plant. At 120 DAS, the highest disease severity (41.67%) was recorded in control plant and the lowest disease severity (10.22%) was in Acrobat MZ treated plant, which were statistical identical disease severity (11.67%) to Ridomil gold treated plants. Similarly, at 150 DAS and 180 DAS, highest disease severity (59.14 and 79.67%) was recorded in control plant and lowest (19.00 and 21.67%) was in Acrobat MZ treated plants (Table 4).

DISCUSSION

Rhizome rot is caused by a soil-borne pathogen (*Pythium aphanidermatum. P. vexans* and *P. myriotylum*) which multiplies with the buildup of soil moisture (Sasikumar *et al*. 2009). Atmospheric environment plays an important role for the onset of rhizome rot disease of ginger which predisposed ginger and make vulnerable to attack by the pathogen. The weather factors such as rainfall, air temperature, relative humidity, soil temperature, soil moisture etc. influence the establishment of rhizome rot disease of ginger. Rhizome rot of ginger developed in the exceptionally wet conditions and more than 90% of the plants found affected upto 311 mm rain (Stirling *et al.* 2009). We observed that, maximum rainfall occurs during the month of July to August and disease severity reached maximum in September to October. Maximum (80%) rainfall received during June to October is favorable for disease incidence of ginger (Sharmal *et al.* 2010) because, saturated conditions of soil exists up to October which become favorable for infection of rhizome rot pathogen. The wet soil conditions, high soil moisture and relative humidity and high soil temperature are most important factors influencing the development of soft rot disease of ginger caused by *Pythium aphanidermatum* (Dohroo *et al.* 2012).

Ginger requires humid weather with air temperature ranged from 28-30 ^{0}C and which are also conducive for the onset of rhizome rot disease (Stirling *et al.* 2009). We found maximum plant infection with relative humidity 90% and air temperature 27-28^{0}C, similar observation was also found (Sharmal *et al*. 2010) where rhizome rot disease development reported in 65-95% relative humidity and 26-30^{o}C temperature. High soil water and low soil temperature are favorable for zoospore production so that, they can easily disperse to the distance by using soil water (Dohroo 2005). Stagnation of water predisposes the plant to infection (Sasikumar *et al*. 2009) and high soil temperature and high rainfall accelerate rhizome rot of ginger (Rahman and Sarker 2009).

Chemical control of rhizome rot is very significant to control plant diseases and reduction of yield loss of rhizome. Several fungicides are used to find out their effect and it was found that all the used fungicides have good effect on rhizome seed germination, plant

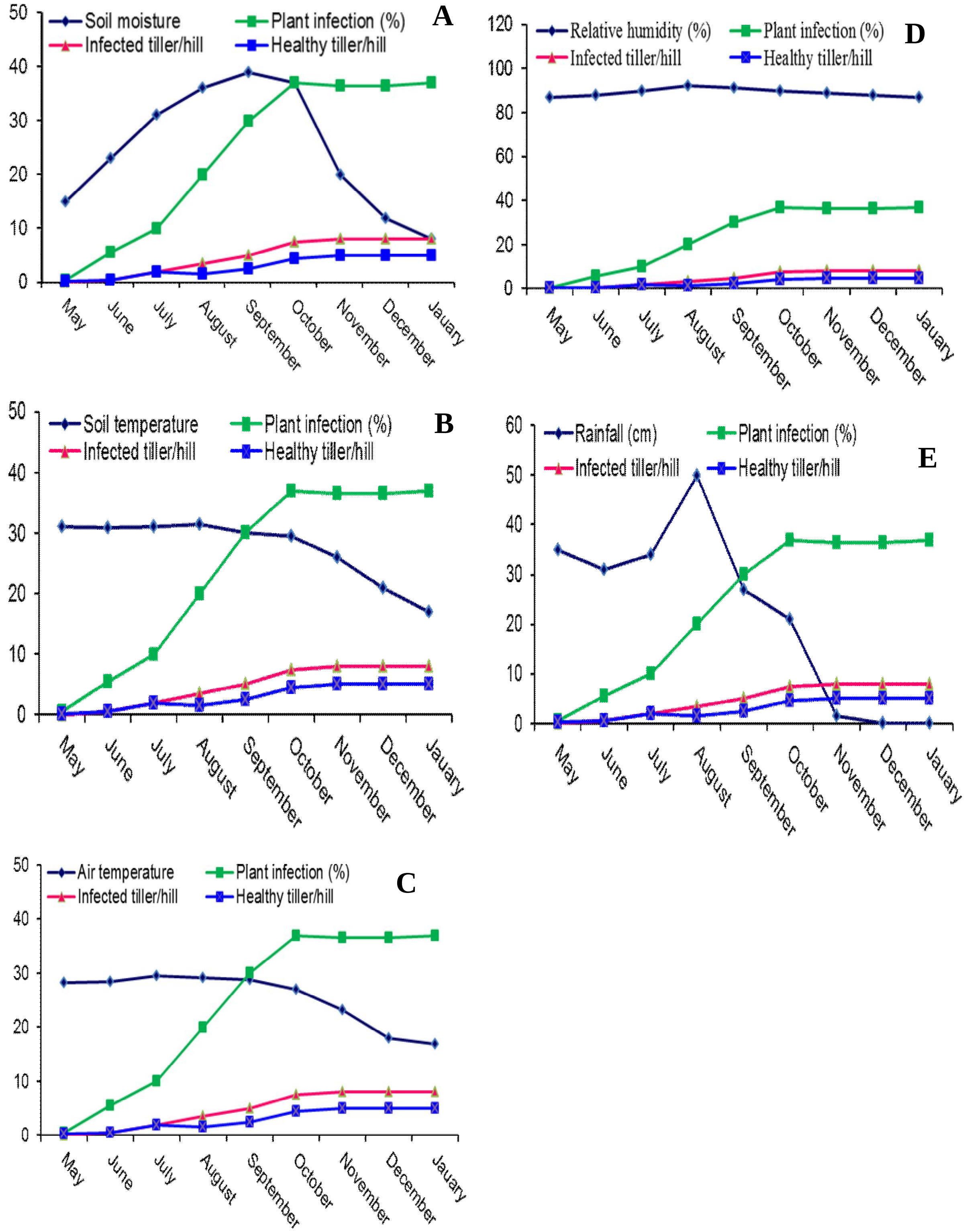

Figure 1. Epidemiological effects on the development of rhizome rot disease of ginger; A. Effect of soil moisture, B. Effect of soil temperature, C. Effect of air temperature, D. Effect of relative humidity and E. Effect of rainfall

Table 1. Plant parameter of ginger in response to different fungicide

Fungicides	Germination (%)		Plant height	Tiller per plant	Yield (t/ha)
	30 DAS	40 DAS	180 DAS	180 DAS	At harvest
Acrobat MZ	90.00 ab	96.65 ab	75.03 a	20.33 a	10.08a
Metaril	73.35b	88.35b	73.52 a	10.33 cd	3.88d
Nuben	78.35ab	91.65 ab	75.20 a	12.00 c	5.88 c
Ridomil gold	88.35ab	95.00ab	75.44 a	16.33 ab	5.77c
Secure	98.35a	100.00a	66.82 b	13.67 bc	7.37b
Control	81.65ab	88.35b	48.33 c	6.66 d	1.75e

Within column values bears different letter(s) are significantly different

Table 2. Percent plant infection in correspondence with different fungicides after different dates of sowing.

Fungicides	Percent plant infection			
	90 DAS	120 DAS	150 DAS	180 DAS
Acrobat MZ	3.33 e	6.67 e	11.64 d	28.34 e
Metaril	20.00 b	25.00 a	30.67 b	60.16 b
Nuben	6.67 d	9.03 d	12.33 d	38.67 c
Ridomil gold	6.66 d	11.64 c	31.67 b	58.66 b
Secure	13.33 c	15.00 b	15.00 c	32.69 d
Control	23.76 a	25.01 a	38.33 a	69.00 a

Within column values bears different letter(s) are significantly different

Table 3. Effect of different fungicides on disease severity (%) of ginger plant after different dates of sowing.

Fungicides	Disease severity (%)			
	90 DAS	120 DAS	150 DAS	180 DAS
Acrobat MZ	3.33 e	10.22 e	19.00 f	21.67 f
Metaril	19.22 b	33.33 b	38.33 b	59.00 b
Nuben	16.26 c	18.33 c	22.33 e	25.00 e
Ridomil gold	10.16 d	11.67 de	29.17 c	38.35 c
Secure	9.00 d	13.33 d	25.83 d	35.17 d
Control	30.97 a	41.67 a	59.17 a	79.67 a

Within column values bears different letter(s) are significantly different growth, rhizome yield and reduction of incidence and severity of rhizome rot disease. Acrobat MZ, Secure, Nuben and Ridomil Gold proved their effectiveness to increase the germination of rhizome compared to control. More than 90% seed germination was recorded with all fungicides used in this study. High germination of ginger by using Captan, Captafol, Dithane M-45 as seed treatment was reported by many authors (Rahman 2001; Hossain 2011; Das *et al*. 1990). Seed treatment with fungicide might reduce the inoculum potential present in the seed rhizome as well as adjacent soil of the rhizome (Ramachandran *et al.* 1989). Seed treatment and foliar spray of fungicides significantly increased the plant height and tiller number per plant compared to control. Fungicides may reduce the primary and secondary inoculum of pathogen present in seed and soil and may also inhibit the growth of fungi and as a result, higher plant stature was observed (Rahman 2001). All the fungicides used in this study were found to reduce percent plant infection and disease severity compared to control and among the fungicides. Among the fungicides used, Acrobat MZ showed the best effect however, Secure, Ridomil Gold and Nuben also performed better result by reducing the rhizome rot severity of plants. By using Ridomil, less number of dead plant in comparison with control were reported by many authors (Rahman 2001; BAR, 2005; BARI 2007; BARI 2009). Secure and Antracol as seed treatment were also found to decrease the number of rhizome rot infected plants (Ara 2013). Treatment of seed rhizomes with Mancozeb before storage and once again before planting reduced the incidence of the disease (Sasikumar *et al*. 2009). All the fungicides significantly increased the yield over control; however, Acrobat MZ produced highest yield rhizome of ginger. Higher seed germination, lowest disease incidence and increased yield by the application of Ridomil were reported by many authors (Jayasekhar *et al.* 2000; Singh *et al.* 2004).

CONCLUSIONS

Weather factors such as rainfall, air temperature, relative humidity and soil condition including soil temperature, soil moisture etc. influence the development of rhizome rot disease of ginger. Rhizome rot become severe during the month of September to October because of high soil moisture and temperature. Acrobat MZ, Nuben, Ridomil gold and Secure increased the germination, plant stature, yield of rhizome and also reduce the rhizome rot disease where Acrobat MZ and Secur treatment showed the better performance among all the fungicide used in this experiment. Further detailed investigation needed to elucidate the eco-friendly sustainable management of rhizome rot disease of ginger.

ACKNOWLEDGEMENT

The work was financially supported by the University Grant Commission (UGC) of Bangladesh through the Institute of Research and Training (IRT), Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur.

REFERENCES

Ara A. 2013. Intercropping of ginger with indigenous plants and seed treatment with fungicides to control rhizome rot of ginger. MS Thesis. Department of Plant Pathology, HSTU, Dinajpur 5200. pp. 68.

BARI. 2005. Annual Report 2004-2005. Bangladesh Agricultural Research Institute, Joydevpur, Gazipur. pp. 224-225.

BARI. 2007. Annual Report 2006-07. Bangladesh Agricultural Research Institute, Joydevpur, Gazipur. pp. 159-160.

BARI. 2009. Annual Report 2008-09. Bangladesh Agricultural Research Institute, Joydevpur, Gazipur. pp. 175.

BBS, 2008. Monthly statistical bulletin Bangladesh. Bangladesh Bureu of Statistics, Ministry of planning, Dhaka. p. 57.

Chattopadhya SB. 1997. Disease of plants yielding Drugs, Dyes and spices, New Delhi: Indian council of Agric. Research.

Das TMP, Devadas VS and Pillai GR. 1990. Efficiency of fungicides for seed treatment against pre-emergence rhizome rot of ginger. Indian cocoa, Arecanut and spices journal 14(1): 13-15.

Dohroo NP. 2005. Diseases of ginger. In Ginger, the genus Zingiberi. (Eds. PN Ravindran, K.

Nirmal Babu, CRC Press: Boca Raton). pp. 305-340.

Dohroo NP, Sandeep K, Ahluwalia N. 2012. Status of soft rot of ginger (*Zingiber officinale* Roscoe) Department of Vegetable Science, Dr. Y. S. Parmar University of Horticulture & Forestry Nauni, Solan-173230 (HP). pp. 22.

Hossain SMM. 2011. Study on epidemiology and management of rhizome rot of ginger. Project report. Department of Plant Pathology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200. pp.26.

Jayasekhar M, Joshua JP and Pillai OAA. 2000. Management of rhizome rot of ginger caused by *Pythium aphanidermatum*. Madras Agricultural Journal. 87(1-3): 170-17l.

Mahanta J and Samajdar T. 2013. Diseases of Ginger. Krishi Vigyan Kendra, Tura, ICAR RC for new region, Sangsanggiri, West Garo Hill District, Meghalaya-794005. pp. 4.

Purseglove JW, Brown EG, Green CL and Robbins SRJ. 1988. Spices. Co-published in the United States with John Wiley & Sons. Inc. New York. pp.533-540.

Rahim MA. 1992. Spices and plantation crops in national economy. Proceedings, Sixth National Horticulture Convention and Symposium. 1992. BAU, Mymensingh, Bangladesh.

Rahman A and Sarker D. 2009. Comparative efficacy of bio-fertilizer and chemicals in reducing rhizome damage of ginger. Research report on rhizome damage of ginger. p. 2.

Rahman MM. 2001. Integrated management of Rhizome rot of ginger. MS Thesis, Department of Plant Pathology, BAU, Mymensingh. p. 76.

Ramachandran N, Dake GN and Sharma YR. 1989. Effect of systemic fungicides on in vitro growth of *Pythium aphanidermatum*, the rhizome rot pathogen of ginger. Indian J. phytopathology. 42 (3): 463-465.

Sasikumar B, Thankamani CK, Srinivasan V, Devasahayam S, Santhosh J, Eapen KA and Zacharaiah JT. 2009. Ginger (Extension Pamphlet). *Editors:* Srinivasan V., Thankamani C. K., Dinesh R., Kandiannan K., Rajeev P., *Publisher:* V. A. Parthasarathy, Director, Indian Institute of Spices Research, Calicut. *Re-published by*: Spices Board, Ministry of Commerce & Industry Government of India, Cochin-682 025. *Printed at:* Niseema Printers & Publishers, Kochi. pp. 14-18.

Sharmal BR, Dutta S, Roy S, Debnath A and Roy DM. 2010. The effect of soil physio-chemical properties on rhizome rot and wilt disease complex incidence of ginger under hill agro-climatic region of West Bengal. Plant Pathol. J. 26(2): 198-202.

Singh SK, Rai B and Kumar B. 2004. Evaluation of different fungicides in controlling the rhizome rot of ginger under storage and field conditions. Annals of Agri-Bio-Research 9(1): 63 - 65.

Stirling GR, Turaganivalu EU, Stirling AM, Lomavatu MF and Smith MK. 2009. Rhizome rot of ginger (Zingiber officinale) caused by *Pythium myriotylum* in Fiji and Australia. Australasian Plant Pathology. 38: 453-460.