HEALTH AND QUALITY OF VEGETABLE SEEDS GROWN IN NORTHERN BANGLADESH

N. Khatun[1], I. Hossain[2] and P. Dey[3]

[1]MS student, [2]Professor, Department of Plant Pathology, [3]Scientific Officer, Seed Pathology Centre, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail of corresponding author dhossain69@gmail.com

(This is a part of MS thesis of the first author)

ABSTRACT

N. Khatun, I. Hossain and P. Dey. 2014. Health and quality of vegetable seeds grown in northern Bangladesh. Bangladesh J. Plant Pathol. 30(1&2):17-22.

Seed health and quality status of laffa (*Malva verticillata*), mustard (*Brassica* spp.), Indian spinach (*Basella alba*), jute (*Corchorus capsularis*), red amaranth (*Amaranthus tricolor*), swamp cabbage (*Ipomoea aquatica*), spinach (*Beta vulgaris* var. *Bengalensis*), cabbage (*Brassica oleracea* var. *capitata*), amaranth (*Amaranthus gangetica*), snake gourd (*Trichosanthes anguina*), cucumber var. khira (*Cucumis sativus*), cucumber var. shosa (*Cucumis sativus*), bottle gourd (*Lagenaria siceraria*), wax gourd (*Benincasa hispida*), sweet gourd (*Cucurbita moschata*), bitter gourd (*Momordica charantia*), ridge gourd (*Luffa acutangula*), radish (*Raphanus sativus*), carrot (*Daucus carrota* var. *sativa*), yard long bean (*Vigna unguiculata*), tomato (*Lycopersicon esculentum L.*), brinjal (*Solanum melongena*), cauliflower (*Brassica oleracea* var. *Botrytis*) and bean (*Phaseolus vulgaris*) grown in northern part of Bangladesh were tested. A total of ten seed-borne fungi were found to be associated with their seeds. The seed-borne fungi detected in the test were *Alternaria* spp., *Aspergillus flavus*, *Aspergillus niger*, *Curvularia* spp., *Fusarium oxysporum*, *Fusarium moniliforme*, *Penicillium* spp., *Phoma* spp., *Chaetomium* spp. and *Rhizopus* spp. Total seed-borne fungal infection was the highest in bean seed (159%) and the lowest in brinjal (3.5%). Germination of seeds ranged from 11 to 92% showing the highest germination in cucumber var. khira and the lowest in cabbage. Among the seed samples of 24 vegetables, the highest seedling vigor was found in snake gourd (3030.3) followed by bean (2433.4) and the lowest in cabbage (78.43).

Key words: Vegetable seed, seed health, germination, seedling vigour.

INTRODUCTION

Vegetables constitute an important group of crops in Bangladesh. Area under vegetables during 2010-11 was 298,380 hectares and total production was 105.68 million metric tons (Anon. 2012). Vegetables are important sources of vitamins like A, C, niacin, riboflavin and thiamine, and minerals such as calcium and iron. They contribute to intake of essential nutrients from other foods by making them more palatable. They provide dietary fiber necessary for digestion, and they are essential to maintain health and cure nutritional disorders (Mandol 2013).

In Bangladesh, production and availability of vegetables are not uniform round the year. Availability is plenty in winter but less available in summer. Bangladesh mainly produces two kinds of vegetables, namely, summer vegetables (brinjal, cucumber, pointed gourd, teasel gourd, Indian spinach, bitter gourd, etc.) and winter vegetables (cabbage, cauliflower, tomato, etc.) (Anon. 2012).

Among the agricultural inputs, seed is the most vital one. Healthy seeds are considered as the vital factor for desired plant population and good harvest. Seeds of vegetables are more vulnerable to the attack by pathogens and quickly deteriorate in storage. About 200 different seed-borne pathogens including more than 100 fungi have been reported to cause diseases in different vegetable crops in the world (Richardson 1990). Sultana (2009) estimated eight seed-borne fungi associated with the seeds of bottle gourd, sweet gourd, snake gourd, ridge gourd, cucumber, wax gourd and sponge gourd collected from Bangladesh Agricultural Development Corporation, a public seed producing organization, and private seed company. She found that *Aspergillus* spp. was highly prevalent in all the vegetable seeds ranging from 1.6-14%. A total of 18 seed-borne fungal pathogens have been reported from the seeds of those crops (Richardson 1990, Fakir *et al.* 1991, Islam 2005). Sowing of high quality healthy seeds is necessary to improve crop yields thus increasing food production. So, it is important to test the seeds for

disease organism before sowing. A substantial quantity of vegetable is grown in the northern part of Bangladesh, and therefore, information about health of vegetable seeds used by farmers of this region is crucial.

The present research project was undertaken to assess the health and quality of vegetable seeds collected from the northern part of Bangladesh.

MATERIALS AND METHODS

Collection of seed samples: Seeds of laffa (*Malva verticillata*), mustard (*Brassica* spp.), Indian spinach (*Basella alba*), jute (*Corchorus capsularis*), red amaranth (*Amaranthus tricolor*), swamp cabbage (*Ipomoea aquatica*), spinach (*Beta vulgaris* var. *Bengalensis*), cabbage (*Brassica oleracea* var. *Capitata*), amaranth (*Amaranthus gangetica*), snake gourd (*Trichosanthes anguina*), cucumber var. khira (*Cucumis sativus*), cucumber var. shosa (*Cucumis sativus*), bottle gourd (*Lagenaria siceraria*), wax gourd (*Benincasa hispida*), sweet gourd (*Cucurbita moschata*), bitter gourd (*Momordica charantia*), ridge gourd (*Luffa acutangula*), radish (*Raphanus sativus*), carrot (*Daucus carrota* var. *Sativa*), yard long bean (*Vigna unguiculata*), tomato (*Lycopersicon esculentum*), brinjal (*Solanum melongena*), cauliflower (*Brassica oleracea* var. *Botrytis*) and bean (*Phaseolus vulgaris*) were collected from northern regions of Bangladesh. The vegetables were grown in those areas and seeds were stored under farmers' conditions. Seed samples were obtained from the farmers just at sowing time. Collected seeds were poured in polyethylene bags and stored in a refrigerator at 4C.

Detection of seed-borne fungal pathogen: Working samples of 200 seeds of each crop were taken from the refrigerator and used for detection of seed-borne fungi. Standard blotter method as suggested by International Seed Testing Association (ISTA) was followed to detect seed-borne plant pathogenic fungi associated with the collected seeds (Anon. 1996). Working seed samples were surface sterilized in 1% chlorox for 5 minutes, rinsed in sterilized water for three times and plated on blotter in 90 mm glass Petri dishes. Each Petri dish received 5 to 10 seeds depending on seed size. After 10 days of incubation, fungi grown on the seeds were isolated and identified based on morphological characters observed under binocular compound microscope (Mathur *et al.* 1975).

Germination test: Standard procedure suggested by ISTA was followed for testing seed germination. Substrates, temperature and duration of test were the same as recommended by ISTA (Anon. 1976). Working samples of 400 seeds were used for germination test.

Seedling vigor test: The vigor of the seedlings was determined following the formula suggested by Baki and Anderson (1972) as shown below:

Vigor Index= (mean root length + mean shoot length) × percent seed germination

Experimental design and data analysis: All experiments were conducted in the laboratory of Seed Pathology Centre, Bangladesh Agricultural University, Mymensingh during the period from 2010 to 2011. The experiments were laid out following a completely randomized design with sufficient number of replicated plates.

Data were analyzed using MSTAT-C computer program. Analysis of variance and level of significance were done following Gomez and Gomez (1984). Mean differences were judged using Duncan's multiple range test.

RESULTS AND DISCUSSION

Prevalence of seed-borne fungi in leafy vegetable seeds: Prevalence of *Alternaria* spp., *Aspergillus flavus*, *A. niger*, *Curvularia* spp., *F. oxysporum*, *F. moniliforme*, *Penicillium* spp., *Phoma* spp., and *Rhizopus* spp. were 1.0-26.5, 0.0-12.0, 0.0-11.0, 0.0-10.0, 2.0-16.0, 1.0-26.5, 0.0-18.0, 0.0-2.0 and 0.0-20.0, respectively in seeds of different leafy vegetables. *Alternaria* spp. was found only in seeds of Indian spinach, red amaranth and laffa with the prevalence of 5.5, 1.0 and 0.5%, respectively. *Aspergillus flavus* was found in seeds of swamp cabbage, red amaranth, Indian spinach and laffa showing 12.0, 3.5, 1.0 and 1.0% prevalence, respectively. The maximum prevalence of *A. niger* was found in Indian spinach followed by swamp cabbage, amaranth and red amaranth. Seeds of other leafy vegetables were free from this fungus. *Curvularia* spp. was found in seeds of spinach, Indian spinach and amaranth at the prevalence of 10.0, 1.0 and 1.0%, respectively. Occurrences of two species of *Fusarium* were recorded from seeds of all leafy vegetables. In case of *F. oxysporum*, the maximum prevalence of 16.0% was observed in laffa followed by Indian spinach and spinach. The lowest prevalence of 2.0% was observed in red amaranth and amaranth. The maximum prevalence of *F. moniliforme* was recorded from seeds of Indian spinach and minimum was found in cabbage and amaranth seeds. The highest prevalence of *Penicillium* spp. was recorded in swamp cabbage but no prevalence of this fungus was recorded in laffa and jute seeds. The prevalence of *Phoma* spp. was recorded only in spinach. In case of *Rhizopus* spp., the prevalence was the highest in Indian spinach but the seeds of mustard, jute, red amaranth, swamp cabbage, spinach, cabbage and amaranth were free from this fungus (Table 1).

Table 1. Prevalence of seed-borne fungi on seeds of nine vegetables collected from northern region of Bangladesh

Leafy vegetables	Seed-borne infection (%)								
	Alternaria spp.	*Aspergillus flavus*	*Aspergillus niger*	*Curvularia* spp.	*Fusarium oxysporum*	*F. moniliforme*	*Penicillium* spp.	*Phoma* spp.	*Rhizopus* spp.
Laffa	0.5b	1.0c	0.0c	0.0b	16.0a	1.5b	0.0c	0.0b	1.0b
Mustard	0.0b	0.0c	0. 0c	0.0b	3.0bc	21.5a	4.0bc	0.0b	0.0b
Indian spinach	5.5a	1.0c	11.0a	1.0b	8.5b	26.5a	0.5 c	0.0b	20.0a
Jute	0.0b	0.0c	0.0c	0.0b	6.5bc	5.5b	0.0c	0.0b	0.0b
Red amaranth	1.0b	3.5b	0.5bc	0.0b	2.0c	5.5b	8.0b	0.0b	0.0b
Swamp cabbage	0.0b	12.0a	2.0b	0.0b	8.5b	3.0b	18.0a	0.0b	0.0b
Spinach	0.0 b	0.0c	0.0c	10.0a	3.5bc	26.0a	1.0c	2.0a	0.0b
Cabbage	0.0b	0.5c	0.0c	0.5b	3.5bc	1.0b	0.5c	0.0b	0.0b
Amaranth	0.0b	4.5b	1.0bc	1.0b	2.0c	1.0b	8.5b	0.0b	0.0b

Figures within the same column having a common letter (s) do not differ significantly (P=0.05).

Seed-borne prevalence of fungi varied with the variation in types of cucurbitaceous vegetables. Only 3% seeds of snake gourd and cucumber var. shosa yielded *Alternaria*. Seeds of other cucurbits were free from the fungus. In case of *A. flavus*, the maximum prevalence was found in bitter gourd followed by bottle gourd. The lowest prevalence was found in seeds of snake gourd. Other cucurbitaceous vegetables were free from *A. flavus*. The maximum prevalence of *A. niger* was recorded from bitter gourd seeds followed by snake gourd, ridge gourd and sweet gourd. Seeds of other four cucurbits were free from the fungus. The occurrence of *Curvularia* spp. was found only in seeds of cucumber var. shosa and cucumber var. khira. The prevalence of *F. oxysporum* was recorded from seeds of all of the cucurbits within the range of 2.0-13.0%. The highest prevalence was found in snake gourd and bottle gourd and the lowest in cucumber var. khira seeds. Seeds of cucumber var. khira, cucumber var. shosa and bitter gourd were free of *F. moniliformae*. Its prevalence was 9.0-40.0% in seeds of other cucurbits with the maximum in snake gourd and minimum in sweet gourd. Except cucumber var khira, 2.0-24.0% seeds of cucurbitaceous vegetables yielded *Penicillium* spp. The highest incidence was found in wax gourd, and the lowest in cucumber var shosa. *Phoma* was recorded from seeds of bottle gourd, wax gourd, sweet gourd and bitter gourd within the range of 5.0-15.0%. *Rhizopus* was recorded from only sweet gourd seeds showing 26.0% prevalence. *Chaetomium* spp. was found in seeds of bitter gourd and ridge gourd showing 34 and 29% prevalence, respectively (Table 2).

The prevalence of *A. niger* was the highest in radish seeds and lowest in carrot seeds (0.5%). The maximum seed-borne prevalence of *F. oxysporum* was recorded in radish and minimum in carrot. The incidence of *F. moniliforme* was found only in carrot seeds. *Penicillium* and *Rhizopus* were recorded in radish by 2.0% and 15.5%, respectively (Table 3).

Prevalence of fungal infection of seeds varied depending on different vegetables. The seed-borne fungus, *Alternaria* was found only in cauliflower and bean seeds. The prevalence of *A. flavus* was 51% in seeds of bean but seeds of tomato, brinjal and cauliflower were free from the fungus. The highest incidence of *A. niger* was recorded in yard long bean and lowest in tomato. *Curvularia* spp. was found in brinjal and bean seeds but the prevalence was only 1-2%. Seeds of yard long bean, tomato and cauliflower were free from *Curvularia* spp. The incidence of *F. oxysporum* was the highest in bean and lowest in brinjal (0.5%). In case of *F. moniliforme*, the maximum prevalence was recorded in bean seeds and minimum in tomato seeds. Prevalence of *Penicillium* spp. was 33% in yard long bean but seeds of tomato and brinjal were free from the fungus. The incidence of *Phoma* spp. was recorded only from tomato seeds, while *Rhizopus* was recorded only in yard long bean. Maximum mean association of seed-borne fungi was *A. flavus* followed by *Penicillium* spp., *A. niger*, *F. moniliforme*, *F. oxysporum*, *Rhizopus*, *Phoma*, *Alternaria* and *Curvularia* (Table 4).

Germination and seedling vigor: Germination of seeds of leafy vegetables varied from 11 to 90%. In case of cucurbit vegetable seeds, germination varied from 12 to 92% depending on vegetables. Germination ranged 57 to 76% in different root vegetables. Germination of other vegetable seeds varied from 15 to 72% depending on vegetable crops. Seedling vigor ranged 78.43 to 3030.3. The highest vigor index was found in snake gourd, while the lowest was recorded in cabbage. The highest germination of 92% was recorded in cucumber var. khira and the lowest in cabbage. Shoot length was the highest in bean and lowest in red amaranth. Root length was the highest in bottle gourd and lowest in red amaranth. There was variations in vegetables in respect of seed germination, shoot and root length, and vigor index (Table 5).

Table 2. Prevalence of seed-borne fungi associated with seeds of cucurbit vegetables collected from northern region of Bangladesh

Cucurbitaceous vegetables	Seed-borne infection (%)									
	Alternaria spp.	*Aspergillus flavus*	*Aspergillus niger*	*Curvularia* spp.	*Fusarium oxysporum*	*F. moniliforme*	*Penicillium* spp.	*Phoma* spp.	*Rhizopus* spp.	*Chaetomium* spp.
Snake gourd	3.0a	1.0c	11.0b	0.0c	13.0a	40.0a	9.0bc	0.0c	0.0b	0.0c
Khira	0.0b	0.0c	0.0c	4.0a	0.5e	0.0d	0.0d	0.0c	0.0b	0.0c
Shosha	3.0a	0.0c	0.0c	1.0b	4.0cde	0.0c	2.0d	0.0c	0.0b	0.0c
Bottle gourd	0.0b	17.0b	0.0c	0. 0c	13.0a	13.0bc	3.0cd	9.0b	0.0b	0.0c
Wax gourd	0.0b	0.0c	0.0c	0.0c	6.0bcd	17.0bc	24.0a	15.0a	0.0b	0.0c
Sweet gourd	0.0b	0.0c	4.0c	0.0c	2.0de	9.0cd	22.0a	5.0bc	26.0a	0.0c
Bitter gourd	0.0b	27.0a	18.0a	0.0c	8.0bc	0.0d	15.0b	7.0b	0.0b	34.0a
Ridge gourd	0.0b	0.0c	9.0b	0.0c	9.0ab	21.0b	15.0b	0.0c	0.0b	29.0b

Figures within the same column having a common letter (s) do not differ significantly.

Table 3. Prevalence of seed-borne fungi of root vegetables grown in northern Bangladesh

Root vegetables	Seed-borne infection (%)				
	Aspergillus niger	*Fusarium oxysporum*	*F. moniliforme*	*Penicillium* spp.	*Rhizopus* spp.
Radish	5.0a	12.5a	0.0b	2.0a	15.5a
Carrot	0.5b	2.0b	10.0a	0.0b	0.0b

Figures within the same column having a common letter (s) do not differ significantly.

Germination and seedling vigor: Germination of seeds of leafy vegetables varied from 11 to 90%. In case of cucurbit vegetable seeds, germination varied from 12 to 92% depending on vegetables. Germination ranged 57 to 76% in different root vegetables. Germination of other vegetable seeds varied from 15 to 72% depending on vegetable crops. Seedling vigor ranged 78.43 to 3030.3. The highest vigor index was found in snake gourd, while the lowest was recorded in cabbage. The highest germination of 92% was recorded in cucumber var. khira and the lowest in cabbage. Shoot length was found highest in bean and lowest in red amaranth. Root length was the highest in bottle gourd and lowest in red amaranth. There was difference among different vegetables in respect of seed germination, shoot and root length, and vigor index (Table 5).

The seed-borne fungi recorded in the present study have also been reported by other investigators. Hossain *et al.* (2014) reported seed-borne fungi of leafy vegetables collected from Mymensingh region of Bangladesh. Good number of seed-borne fungi of leafy vegetables has also been reported by Richardson (1990). *Alternaria*, *Aspergillus*, *Fusarium* and *Penicillium* were found in seeds of red amaranth. Among the seed-borne fungi of leafy vegetables, *Aspergillus, C. capsici, Fusarium, Penicillium* and *Rhizopus* were detected by Islam (2005).

Table 4. Prevalence of seed-borne fungi on seeds of other vegetables collected from northern part of Bangladesh

Other vegetables	Seed-borne infection (%)								
	Alternaria spp.	*Aspergillus flavus*	*Aspergillus niger*	*Curvularia* spp.	*Fusarium oxysporum*	*Fusarium moniliforme*	*Penicillium* spp.	*Phoma* spp.	*Rhizopus* spp.
Yard long bean	0.0c	25.0b	40.0a	0.0b	1.0bc	2.0c	33.0a	0.0b	13.0a
Tomato	0.0c	0.0c	0.5c	0.0b	4.5b	0.5c	0.0c	6.50a	0.0b
Brinjal	0.0c	0.0c	0.0c	1.0ab	0.5c	2.0c	0.0c	0.0b	0.0b
Cauliflower	1.0b	0.0c	0.0c	0.0b	1.5bc	18.5b	13.0b	0.0b	0.0b
Bean	2.0a	51.0a	31.0b	2.0a	12.0a	33.0a	28.0a	0.0b	0.0b

Figures within the same column having a common letter (s) do not differ significantly.

Table 5. Germination and seedling vigor of different vegetable seeds collected from northern region of Bangladesh

Name of vegetables	Germination (%)	Shoot length (cm)	Root length (cm)	Vigor index
Laffa	52.00±2.5	6.15	2.85	468.00
Mustard	79.00±1.5	12.60	3.05	1236.35
Indian spinach	36.00±2.0	9.65	2.90	451.80
Jute	90.00±1.0	5.40	2.00	666.00
Red amaranth	59.00±3.0	3.90	1.25	303.85
Swamp cabbage	83.00±3.0	11.50	5.40	1402.70
Spinach	67.00±1.5	10.20	3.10	891.10
Cabbage	11.00±1.5	5.19	1.94	78.43
Amaranth	41.00±4.5	4.05	1.50	227.55
Snake gourd	74.00±5.0	28.70	12.25	3030.30
Cucumber (khira)	92.00±3.0	19.35	5.70	2304.60
Cucumber (shosa)	86.00±4.0	20.40	5.90	2261.80
Bottle gourd	76.00±7.0	19.65	12.35	2432.00
Wax gourd	30.00±3.0	12.10	5.50	528.00
Sweet gourd	58.00±6.0	20.95	6.00	1563.10
Bitter gourd	12.00±1.0	20.50	8.50	348.00
Ridge gourd	26.00±12.0	17.35	6.90	630.50
Radish	76.00±2.0	13.750	5.05	1428.80
Carrot	57.00±4.0	5.65	2.25	450.30
Yard long bean	58.00±11.0	26.80	11.70	2233.00
Tomato	56.00±4.5	8.10	2.80	610.40
Brinjal	72.00±7.5	4.50	2.70	518.40
Cauliflower	15.00±1.5	8.10	1.55	144.75
Bean	46.00±4.0	41.10	11.80	2433.40

Richardson (1990) reported prevalence of only *Alternaria amaranthi* in the seeds of *Amaranthus* spp. Peregrine *et al*. (1984) and Peregrine and Ahmed (1983) recorded *Aspergillus*, *Rhizopus*, *Cladosporium*, *Helminthosporium*, *Alternaria*, *Fusarium*, *Curvularia*, *Penicillium*, *Botrytis*, *Verticillium*, *Cylindrocephalum*, *Colletotrichum*, *Corynespora* and *Ascochytula* from seeds of cucurbits. Sultana (2009) reported *Aspergillus*, *Curvularia*, *Colletotrichum*, *Fusarium*, *Penicillium* and *Botrytis* as seed-borne fungi of vegetables. From the findings of the present study, it may be concluded that the seed samples of different vegetables collected from northern region of Bangladesh were of good quality except sweet gourd, bitter gourd, bean, cabbage and cauliflower.

ACKNOWLEDGEMENT

The authors thankfully acknowledge the support provided by Seed Pathology Centre, Bangladesh Agricultural University, Mymensingh for conducting the present piece of research.

LITERATURE CITED

Anonymous. 1976. International Rules for Seed Testing. International Seed- Testing Association, Seed Sc. And Tech. 24:39-42.

Anonymous. 1996. International Rules for Seed Testing. International Seed- Testing Association, Seed Sc. And Tech. 24:39-42.

Anonymous. 2012. The Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Government of the Peoples' Republic of Bangladesh, Dhaka. p. 305.

Baki, A. A. and Anderson. J. D. 1972. Physiological and biological deterioration of seeds. *In* Seed Biology, Academic Pess, New York. 2:283-315.

Fakir, G. A., Rahman, G. M. M., and Islam, M. F. 1991. Occurrence of diseases on lentil and country bean germplasm and their reaction to the selected major pathogens. Proc. Res. Prog. Bangladesh Agric. Univ. 5:1-10.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research. 2nd Edn. John Willey and Sons., New York. 97-111 pp.

Hossain, I., Dey, P. and Dilruba, K. 2014. Quality of vegetable seeds collected from Mymensingh region in Bangladseh. *International Journal of Applied Sciences and Biotechnology*. 2(1):103-108.

Islam, M. R. 2005. Studies on the health and seedling diseases of some leafy vegetables. M.Sc. Thesis, Department of Plant pathology, BAU, Mymensingh. 67 pp.

Mathur, S. K., Mathur S. B. and Neergard, P. 1975. Detection of seed borne fungi in sorghum and location of *Fusarium moniliforme* in the seed. Seed Sci. Tech. 3:683-690.

Mandol, P. 2013. Study of marketing system and shelf life extension of brinjal. Department of Horticulture. Bangladesh Agricultural University, Mymensingh. pp.1-3.

Peregrine, W. T. H., Ahmad, K. B. and Momin, M. 1984. Controlling anthracnose in water melon. World Crops. 36(5):184-185.

Peregrine, W. T .H. and Ahmad, K.B. 1983. Chemical and cultural control of anthracnose (*Colletotrichum lagenarium*) in water melon. Trop. Pest Mang. 29(1): 42-46.

Richardson, M. J. 1990. An annotated list of seed-borne diseases. 4th ed. The International Seed Testing Association, Switzerland. 338 pp.

Sultana, L. 2009. Assessment of health status of Truthfully labeled seeds (TLS) in the markets of Bangladesh. M. Sc. Ag. Thesis, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh. 39 pp.