SCREENING OF EGGPLANT AGAINST WILT DISEASE

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This is to certify that thesis entitled, "Screening of eggplant against wilt disease" submitted to the Department of Plant Pathology , Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in PLANT PATHOLOGY, embodies the result of a piece of bonafide research work carried out by Md. Ashrafur Rahman, Registration No. 26180/00474 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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Dedicated to

My

Parents & Teachers who laid the foundation of my success

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ABSTARCT

An experiment was conducted in the Field of SAU (Sher-e-Bangla Agricultural University) farm allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka to screen out the resistant cultivars of eggplant against wilt disease. Eight cultivars viz. Nayantara, Singhnath, Dhundul, Kazla, Marich Begun Luffa, Kata Begun and Uttara were used as treatments. At 55 days after transplanting (DAT) the cultivar Luffa exhibit the highest bacterial wilt incidence (80%) and the lowest wilt incidence was recorded in the cultivar Kata Begun (30%). At 90 DAT the highest Fusarium and Nemic wilt incidence was recorded in the cultivar Luffa and the lowest wilt incidences were recorded in the cultivar Kata Begun. The highest shoot height was recorded in the cultivar Kata Begun and the lowest shoot height was recorded in the cultivar Singhnath. The highest gall number was recorded in the cultivar Luffa and the lowest gall number was recorded in the cultivar Kata Begun. The highest yield per hectare (29.84 t/ha) was recorded in the cultivar Nayantara and the lowest yield (10.50 t/ha) was recorded in the cultivar Dhundhul. Among the cultivars Kata Begun graded as resistant for both Bacterial, Fungal and Nemic wilt.

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ABBREVIATIONS AND ACRONYMS

AEZ	Agro Ecological Zone
BARI	Bangladesh Agricultural Research Institute
CV	Cultivar
^0C	Degree Celsius
cm	Centimeter
DAS	Days After Planting
Ed	edited
Ed.	Edition
et al.	and others
Gm	Gram
Kg	Kilogram
LSD	Least Significant Difference
M	Meter
Mg	Milligram
MP	Murate of Potash
N	Nitrogen
NS	Non Significant
P^H	Hydrogen Ion Conc.
PDA	Potato Dextrose Agar
PPM	Parts Per million
RBD	Randomized Block Design
RH	Relative Humidity
SAU	Sher-e-Bangla Agriculture University
T	ton
t/ha	ton per hectare
TSP	Triple Super Phosphate
TZC	Tetrazolium chloride
Viz.	Namely
Var.	Variety

Chapter 1
Introduction

INTRODUCTION

Eggplant or Brinjal (*Solanum melongena* L.) belongs to the family Solanaceae is the most important and widely consumed nutritious vegetable in Bangladesh. It is cultivated commercially throughout the tropical and subtropical region of the world. In tropical climate, eggplant can be grown throughout the season as perennial crop and in sub-tropical, it is grown as summer annual. It is grown extensively in Bangladesh, China, India, Pakistan and Philippines. It is also popular in other countries like Balkan area, France, Indonesia, Italy, Japan, Mediterranean, Turkey and United states (Bose and Som, 1986).

It is locally known as Begoon and its early European name is Aubergine or eggplant. Eggplant is the species of *S. melongena* also known as Guinea squash and garden egg (Nonnecke, 1989). It is thought to be originated in Indian sub-continent because of maximum genetic diversity and closely related species of Solanum are grown in this region (Rashid, 1976; Zevan and Zhukovsky, 1975).

Eggplant is nutritious vegetable and has got multifarious use as a dish item (Bose and Som, 1986 and Rashid, 1993). It is largely cultivated in almost all districts of Bangladesh. It can be grown at homestead area and kitchen garden because of its popularity especially for urban people. About 8 million farm families are involved in eggplant cultivation (Islam, 2005). This gives small, marginal and landless farmers a continious source of income and provides employment facilities for the rural people. For most of the time, except peak production period, market price of eggplant compared to other vegetables remain high which is in favour of the farmers solvency. So, it plays a vital role to boost our national economy.

Eggplant is the second most important vegetable crop next to potato in Bangladesh in respect of acreage and production (BBS, 2005).The total area of eggplant cultivation is 60100 hectare where 22500 ha in Kharif season and

37500 ha in Rabi season with total annual production of 358400 mt. and the average yield is 6.0 t/ha in 2003-04 (BBS, 2005). The yield potential of eggplant is low in Bangladesh compared to other countries. Of many reasons for high price of eggplant, lower production rate is important. Incidence of insect pests and diseases greatly hampered the production of eggplant. This crop suffers from the various diseases; about 13 different disease so far recorded in Bangladesh (Das *et al.* 2000; and Rashid, 2000). Among those diseases wilt of eggplant has been treated as one of the major constrains in eggplant cultivation in the country (Ali, 1993). In Bangladesh, problem of the diseases is common in non-flooded high lands where solanaceous vegetables are grown continuously without crop rotation. Sudden wilting of eggplant is very acute and occurs commonly in kitchen gardens in these non-flooded areas (Ali *et al.*, 1994).

Eggplant cultivation in Bangladesh is severly impaired by three important wilt causing pathogens viz. *Pseudomonas solanacearum, Fusarium oxysporum* and *Meloidogyne incognita*, the causal agent of Bacterial wilt, Fusarium wilt, Nemic wilt, respectively and caused considerable damage of eggplant (Timm and Ameen, 1960; Talukder, 1974; Ahmed and Hossain, 1985; Mian,1986 and Ali *et al.*, 1994). These are also the major limiting factors for eggplant production throughout the world (Hinata, 1986). Wilt problems are especially severe in the humid tropics. In some cases 100% of the plants are found to die in Kitchen gardens of Bangladesh due to wilt problem (Ali *et al.*, 1994).

The Fusarium wilt and Nemic wilt are very acute in Bangladesh. Once the plant is affected by wilting organisms, it does not produce yield and gradually die. The nematode infection is expressed by gall formation in the root system and ultimately the plant become weak due to interruption in nutrient uptake from the soil. Moreover, due to nematode infection, the root system becomes injured facilitating easy entry of the wilt causing organisms into the plant root system. Root-knot nematode caused by *Meloidogyne incognita* is another widely distributed important disease in the country (Talukder, 1974; Tamim and

Ameen, 1960; Ahmed and Hossain, 1985; and Mian, 1986).The disease is expressed by gall formation in the root system and ultimately the plant becomes weak due to interruption in nutritient uptake from the soil, at severe infection the plants may die. Due to nematode infection, the root system becomes injured facilitating easy entry of the wilt causing organism into the plant. In Bangladesh root knot may cause as much 27.2% loss in fruit yield of eggplant (Bari,2001).

The Fusarium wilt is expressed by one sided wilting of plant. The fungal growth blocks the xylem vessel of the affected plant and interrupts with the water and nutrient uptake from the soil. Thus the plant become weaken and ultimately wilted.

Bacterial wilt caused by *Ralostonia solanacearum* (Yabuuchi E. 1992). is a wide spread crop disease in the tropical, subtropical and temperate regions of the world. Once the eggplants are affected by Bacterial wilt, they die within three to four days. The organism when injected in the susceptible hosts through the root systems cause vascular wilt and cause ultimate death of the plant (kelman,1953). It is the most destructive bacterial plant pathogen especially in the warm weather . In recent year, bacterial wilt has become a great problem for eggplant cultivation in Bangladesh (Rashid, 1976). Bacterial wilt caused by *P. solanacearum* (E.F. Smith) is not new in Bangladesh. At present it is noted as a widely distributed disease of eggplant. In this country, studies on bacterial wilt have been done in limited scale on eggplant for resistant varieties. But available information suggests that very few of the cultivars were reported as resistant to this disease. It is a major disease of various crops under different families in many countries causing considerable yield losses (Hayward 1991, Hayward and Hartman 1994, and Ali 1993,). In India, Das and Chattopadhyay (1995) recorded 54-62% yield reduction in eggplant.From Indonesia, Hanudin and Machmud (1994) reported that 15-32% annual loss of eggplant production is caused due to infection of bacterial wilt pathogen. But the severity of wilting varied from 7.16 to 9.5% on eggplant (Ashduzzaman et al 2000). Screening of germplasms of eggplant to evaluate their resistance against *R. solanacearum* have immense value for the management of the disease in this country. Seveal workers attempted to search for bacterial wilt resistant varieties of eggplant (Ali *et al.* 1980, Hoque *et al.* 1981, Rahman and Hoque 1986, Khan and Mondal 1991, Hossain *et al.* 1991).

Ralstonia solanacearum (Yabuchi *et al.* 1992), synonym *Pseudomonas solanacearum* Smith 1914 is a cosmopolitan bacterial plant pathogen (Buddenhagen 1986, Hayward 1991). It has a wide host range, which includes several hundred crop species representing about 53 families (Hayward and Hartman 1994). Among the host crops eggplant is highly susceptible to the pathogen.

Among the causes of low yield incidence of various diseases, especially bacterial wilt and root-knot nematode are the main constrain to produce eggplant. In Bangladesh, as much as 53-62% loss in fruit yield of eggplant was recorded under experimental conditions (Anon, 1986). A report from India reveals that bacterial wilt can cause 27% loss in eggplant (Reddy, 1986). Yield loss of 50% was also recorded in the USA (Winstead and Kelmann, 1960).

For the management of such important bacterial, Fusarial and Nemic diseases a few evidence of research work exists in Bangladesh. Search of resistant germplasms for the management of crop disease is considered as a ecofriendly approach. Besides, the use of chemicals for controlling soil borne pathogen like wilt pathogens are very costly to the growers. Thus the experiment was undertaken to screenout the resistant germplasm against Bacterial (*R. solanacearum*), Fungal (*Fusarium oxysporum*), Nemic (*Meloidogyne spp*) wilt of eggplant.

Chapter 2
Review of literature

CHAPTER 2

REVIEW OF LITERATURE

Evidences of research work regarding screening of Fusarium wilt, Nemic wilt and Bacterial wilt of eggplant are very limited. However some available and important findings on various aspects of Bacterial wilt, Fusarium wilt and Nemic wilt has been compiled and presented below.

2.1 Symptoms of Fusarium wilt of eggplant

Fusarium are generally classified as soil borne fungi that cause various vascular wilts and root and stem rots of cultivated plants (Armstrong and Armstrong, 1975; Burgess, 1981).

Walker (1969) described the symptoms of wilt caused by Fusarium sp. as yellowing of the lower leaves, usually affecting the leaflets unilaterally. The affected leaves die and the symptoms continue to appear on successively younger leaves. The plant as a whole is stunted and eventually goes into a permanent wilt.

Roberts and Boothroyd (1972) described that, all vascular wilt disease symptoms of Fusarium and Verticillium infection include drooping of above-ground parts. In the early stages of disease, plants wilt during the day and recover their turgor at night. As the disease progresses, the permanent wilting point is reached and turgor is never regained. The diagnostic symptom of any pathological wilt disease is the brown discoloration of the vascular region, visible in cross-sections of infected stems or roots and in sections tangential to the xylem.

Rangswami (1988) observed the symptoms of Fusarium wilt that the younger leaves may die in succession and the entire plant may wilt and die in the course of a few days.

Haware *et al.,* (1993) described that *Fusarium oxysporum* is a cosmopolitan fungus that exists in many pathogenic forms (Armstrong and Armstrong, 1981). It survives in soil in the form of chlamydospores and mycelia. Several pathogenic strains, designated as formae speciales, exist within *Fusarium oxysporum* and within formae speciales, races have been found to exist. These formae speciales cause vascular wilt.

Hartman and Datnoff (1997) stated that, plants infected with the fungus *Fusarium* sp. that caused wilt and root rot have yellow leaf margins on the oldest leaves (Sherf and MacNab, 1985). Lower leaves become necrotic and drop off from the plant. Plants defoliate from lower to upper leaves as they becomes more necrotic. Plants may wilt and die quickly. Roots become dry and the cortex and xylem turn brown.

Miller *et al.*, (2005) also described details about Fusarium wilt of solanaceous crops. The wilt organism usually enters the plant through young roots and then grows into the water conducting vessels of the roots and stem. As the vessels are plugged and collapse, the water supply to the leaves is blocked. With a limited water supply, leaves begin to wilt on sunny days and recover at night. The process may continue until the entire plant is wilted, stunted, or dead.

2.2 Pathogenic description of *Fusarium oxysporum*

Barnett and Hunter (1972) described details about *Fusarium* spp. 'Mycelium of *Fusarium* is extensive and cottony in culture, conidiophores variable, slender, simple, short, branched irregularly or bearing a whorl of phialides, single or grouped into sporodochia; conidia hyaline, variable, principally of two kinds, macroconidia several-celled slightly curved or bent at the pointed ends, microconidia 1-celled, ovoid to oblong, borne singly or in chains.

Roberts and Boothroyd (1972) described that, *Fusarium* produces sickle-shaped, multi-septate conidia on sporodochia. *Fusarium* survives for five to ten years in the soil as a "saprophyte". The fungus could survive for some years without obtaining anything more than water from the soil solution. In any event, soil, once infested with *Fusarium oxysporum*, is likely to remain infested for five to ten years. The fungus grows to the region of the xylem and develops in the tracheids and vessels, and also invades the xylem parenchyma. Fusarium secretes pectolytic enzymes that catalyze the hydrolytic reactions that result in the partial destruction of the middle lamellae of the xylem parenchyma and in the degradation of pectic compounds in the walls of vessels and tracheids. *Fusarium* produces extracellular toxins that move to the leaves, where they induce loss of turgor in the ground parenchyma. The combined effects of toxins, plugging by the fungus, and plugging by the gel of pectic compounds probably account for the wilting of plants infected by *Fusarium oxysporum.*

Hartman and Datnoff (1997) and Miller *et al.*, (2005) described about the pathogen of Fusarium wilt of solanaceous crops is caused by several types of the fungus *Fusarium oxysporum*. These are *F. oxysporum* f. sp. *lycopersici* (tomato), *F. oxysporum* f. sp. *melongenae* (eggplant) and *F. oxysporum* f. sp. *vasinfectum* (pepper). All of the Fusarium wilt pathogens are generally specific to their hosts and are soilborne. The fungus persists in the soil as chlamydospores and penetrates the host roots directly or through wounds.

Kistler *et al.*, (1997) described that *Fusarium oxsporum* is a cosmopolitan fungal pathogen responsible for wilt and cortical rot diseases of more than 100 economically important plant host. Genetic diversity within *Fusarium oxsporum* has been categorized extensively by vegetative compatibility grouping in laboratories around the World. Detailed studies indicate that isolates belonging to the same vegetative compatibility group (VCG) typically possess very similar or identical multilocus haplotypes and belong to the same clonal lineage VCGs, therefore, can be good predictors of genetic similarity, clonal lineage, or both.

2.3 Symptoms of Nemic wilt of eggplant

Root-Knot caused by *Meloidogyne incognita.* is an important and widely distributed disease in the country (Talukder, 1974; Ahmed and Hossain, 1985 and Mian, 1986). The nematodes are soil borne roundworms that attack the root system of eggplant, preventing water and nutrient uptake. The plant will be stunted and wilt during the sunny day and recover their turgor at night and finally they exhibit wilting.

Ali (1993) reported that, the problems of root knot nematode infection in eggplant is expressed by gall formation in the root system and ultimately the plant become weak due to interruption in nutrient uptake from the soil and ultimately the infected plant may also die. Moreover, due to nematode infection, the root system becomes injured facilitating easy entry of the wilt causing organisms like bacteria and fungi into the root system. Root symptoms may appear as root knots or root galls. The root symptoms are usually accompanied by non characteristics symptoms in the aboveground parts of plants and appearing primarily as reduced growth, symptoms of nutrient deficiencies such as yellowing of foliage, excessive wilt in hot or dry weather reduced yields and poor quality of products.

The soil and climatic condition of Bangladesh has made her an ideal abode for nematodes. A preliminary survey found 15 genera of plant parasitic nematodes associated with commercial crops in Bangladesh where root-knot nematode *Meloidogyne* is the most abundant and widespread pathogen (Timm and Ameen, 1960 and Ahmad, 1977b). Moreover, the nematode population in the soils of Bangladesh is increasing day by day (Chowdhury, 1976). In Bangladesh, root knot disease ranks as one of the most important disease of crop because of its wide host range. The common, species of root-knot nematode are *Meloidogyne incognita* and *Meloidogyne javanica*. They attack a wide variety of field, fruit and vegetable crop including brinjal (Biswas, 1979).

2.4 Pathogenic description of *Meloidogyne incognita*

Saxena *et al.*, (1985) reported that different vegetable crops were inoculated with single egg mass population of *Meloidogyne incognita* in order to determine the extent of morphometric and allometric variations. The different hosts influenced the female dimensions to a varied degree. Large and robust females were produced on highly susceptible plants like *Trigonella foenum graccum, Pisum sativum* and *Coriandum sativum. Solanum melongena* while smaller females were produced on plants like *Lycopersicon esculentum*, cv *pelicum, L. pimpinellifolium* (Red fruit), which are tolerant to nematode attack.

Singh and Sitaramaiah (1994) stated that, root knot nematode *Meloidogyne* spp. are the first plant parasitic nematode to be recognized. The mature female of *Meloidogyne* sp. are swollen, pear or subspherical in shape. They are sedentary endoparasites. The body will remains soft, white and does not form a cyst. Female stylet is slender with well developed basal knobs. First moult occurs within the egg. Males are vermiform and migratory. Second stage juveniles are vermiform, migratory and infective. Third and fourth larval stages are swollen.

Hillocks and Waller (1997b) reported that, sedentary endoparasitic nematodes such as the root-knot nematodes (RKN) (*Meloidogyne* spp.) enter into the root and move through the cortex to the vascular system, where they begin to feed and remain to complete the life cycle. In general, the sedentary endoparasites have the most profound effects on the physiology of their hosts and the most complex effects on disease susceptibility. The cortical feeding nematodes may predispose the root to infection but the effect is localized, providing entry sites for pathogens or increasing nutrient leakage.

2.5 Symptom of Bacterial Wilt:

Dube *et al.*, (1978) described that the most obvious symptom is the epinasty i.e., drooping down of the leaves, petioles and branches, much in the same way as seen when plants are not watered. The other important symptom is the browning of vascular tissues. Vein-clearing, chlorosis of leaves, defoliation and stunting of growth also accompany wilting and browning symptoms.

Bacterial wilt of solanaceous plants was first reported by Burril (1890) and its causal organism *Pseudomonas solanacearum* E.F. Smith was first described. The pathogen causes severe diseases in chilli, eggplant, potato, tomato and other Solanaceous vegetables resulting severe yield reduction (Rao,1976;).

Singh *et al.*, (1995) described that as in potato, the characteristic symptoms of disease are wilting, stunting, yellowing of the foliage and finally collapse of the entire plant. The lower leaves may droop first before wilting occurs. The vascular system turns brown and if a segment of the lower stem is cut and squeezed it yields bacterial ooze. Development of adventitious roots from the stem is considerably enhanced. In many cases, when nematode infection is also present, the stem at the base becomes dark brown and constricted, leading to toppling down of plant. During a continued humid weather when the temperature is also high the most conspicuous symptom seen in tomato is sudden drooping of the leaves without yellowing, and rooting of the stem from any point. The roots appear healthy and often are will developed. However, the brown discoloration is present inside.

2.6 Pathogenic Description of *Ralstonia solanacearum*

Rahman *et al.*, (1986) described the races, biovars groupings and their distribution in a locality or country that indicats the possible variability of the pathogen. This information is important in the interpretation of results of experiments such as in the evaluation of resistance of different crops against a particular race or biotype and, ultimately, the development of control strategies.

Swanepoel *et al.*, (1990) described races differed in host range, geographic distribution and ability to survive under different environmental conditions. Strain 1, the solanaceous strain, has a wide host range, distributed throughout the lowlands of the tropics and subtropics. Strain 2, the musaceous strain, is restricted to Musa (banana) and some other plant. Initially it was limited to the American tropics but now it has spread to Asia. Strain 3, the potato strain, is restricted mainly to potato and sometimes on tomato and a few weed hosts in the tropics and subtropics; many strains adapted to growth and pathogenesis at low temperatures (Swanepoel, 1990). Strain 4, the ginger strain was reported from the Philippines while strain 5, the mulberry strain was reported from China.

Hayward *et al.*, (1991) described traditionally, *R. solanacearum* strains have been divided into five strains on the basis of host range and into five biovars on the basis of biochemical properties.

Recently, a greater understanding of the intra-specific groupings within *R. solanacearum* has been gained through a number of molecular techniques (Cook *et al.*,, 1989;). The analysis of fatty acid profile use of restriction fragment length polymorphisms (RFLPs) DNA finger printing rRNA sequencing and other molecular techniques of analysis allowed an interpretation of the phylogeny of *R. solanacearum* and has provided new sight into the possible evolution of this organism. These studies have indicated that *R. solanacearum* evolved as two major and distinct groups, as a result of geographic separation: one group originated in Asia and Australia, and the other division originated in the America. The occurrence of intra-specific groups outside their centre of origin probably resulted from human activity.

Rahman *et al.*, (1997) described that *Ralstonia solanacearum* belongs to pseudomonas rRNA homology group II as determined by rRNA-DNA homology and to the beta subclass of the Proteobacteria *R. solanacearum* is also one of the small group of non-fluorescent pseudomonas that accumulates poly-β-hydroxybutyrate but does not form arginine dihydrolase. The wild-type virulent form is usually non-motile, whereas avirulent mutant are actively motile. The organism is a heterogeneous species which exhibits significant phenotypic diversity (Cook *et al*, 1989; Hayward, 1991), strains of which have been assigned to sub-specific classifications.

2.7 Association of *Meloidogyne* spp. with *Ralstonia solanacearum*

Adams *et al.*, (1963) described that greenhouse experiments were conducted with 3 species of plant-parasitic nematodes *Meloidogyne* to determine their potential role in infection and development of bacterial wilt of solanaceous plant (*Pseudomonas solananacearum* E. F. Smith.). *M. hapla* increased incidence and severity of wilt. Confirming experimental work of Lucas. *et al.*, with *M. incognita* had no significant effect. In one experiment, approximately 10% of the plants in soil infested with *Pseudomonas solananacearum* but without nematodes or artificial root injury became an infected.

2.8 Association of *Meloidogyne* spp. with *Fusarium oxysporum*

Van Gundy and Tsao (1963) found that the Fusarium population was favoured to roots gall by *Meloidogyne javanica.*

Lue *et al.*, (1990) stated that, root-invading nematodes can be important in the process of infection by soilborne fungi and bacteria. The feeding of nematodes on crop roots increases nutrient leakage and provides wounds through which pathogens can gain entry to the root cortex. *Meloidogyne* spp. assist fungal growth after invasion of the root and they also interfere with physiological processes involved in host defenses against vascular infection.

Singh and Sitaramaiah (1994) stated that, *Meloidogyne incognita* increases severity of Fusarial wilt of tomato, eggplant, cotton, tobacco, muskmelon, cabbage and other plants. Fusarium wilt of sesame is associated with a high nematode population (*Meloidogyne* spp.) in South America (Kolte, 1985).

Hillocks and Waller (1997b) reported that, sedentary endoparasitic nematodes increased disease caused by vascular wilt fungi. Localized wounding and nutrient sink effects around the nematode feeding site play a role in increased infection by Fusarium wilt pathogens. *Meloidogyne* spp. also exerts a systemic effect on disease susceptibility in some hosts. Mechanism of nematode enhanced susceptibility was shown to be a retardation of host defense mechanisms in the xylem.

Corazza (1998) observed that presence of *Meloidogyne* spp. can reduce or annihilate the resistance of plants to *Fusarium oxysporum* f. sp. *melonis*. Coffee wilt caused by *Fusarium oxysporum* develops vascular wilt symptoms and is associated with nematode damage. In case of Fusarium wilt of sunflower (*Fusarium oxysporum* f. sp. *carthami*), the nematode *Meloidogyne incognita* plays a vital role in enhancing disease severity (Kulthe and Pedgaonkar, 1991).

Avelar *et al.*, (2001) found that the root knot nematodes initiated the attack and the magnitude of the symptoms could be due to the presence of fungi which caused root rot. In case of tobacco, *M incognita* increased Fusarium wilt infection when nematode and fungus were on opposite root halves.. However, when similar work was done with cowpea and cotton, infection was increased only when the two organisms were inoculated onto the same root half (Hillocks, 1986).

2.9 Screening against Bacterial Wilt

Mochizuki *et al.* (1979 b) and Yamakawa (1979a) worked on resistance of selected eggplant cultivar and related wild solanum to bacterial wilt. They reported that among eggplant cultivars tested "Dingaras Multiple Purple" and "Aubergine" from USA showed higher resistance to bacterial wilt than "Taiwan Naga", one of the resistant cultivars in Japan. Eggplant No. 1(from Malaysia) and Sinampiro, Makiling and Mayon (from the Philippines) showed resistance similar to that of "Taiwan Naga". Among wild solanum species tested, *S. toxicarium* (from Brazil) showed the highest resistance to the disease. *Solanum nigrum* (from Nigeria) and *S. sisymbriifolium* (from Brazil), showed higher resistance than "Taiwan Naga". *Solanum maroninace* (from Brazil), *S. torvum* (from Nigeria) and *S. xanthocarpum* (from India) showed some what higher resistance than eggplant cultivars and other Solanum species tested.

Hoque *et al.*, (1981) screened 16 eggplant varieties. The first symptom of wilting was observed on the 15th day of inoculation. The percentage of wilting varied from 13.3 to 100. The variety D.R. Chowdhury gave resistant reaction with 13.3% wilting, variety Khatkhatia (long) was moderately resistant with 33.3% wilting and the rest of the varieties showed susceptible reaction.

Rashid *et al.*, (1985) screened twenty three local and exotic cultivars of eggplant and three wild relatives of the crop were screened in the glass house against bacterial wilt (*Pseudomonas solanacearum* E.F. Sm) through artificial inoculation at Citrus and vegetable Seed Research Centre, BARI, Joydebpur. The wild relatives *Solanum mammosum* was found resistant while the cultivar Dingaras Multiple Purple and Khatkhatia long were found moderately resistant. The cultivars Nayankazal, Khatkhatia round, Taiwan Naga, Nagasaki Naga and Kurume Naga were found moderately susceptible while the rest of the cultivars were highly susceptible.

Hoque *et al.*, (1985) described that nineteen varieties of brinjal were tested through artificial inoculation for their reaction to bacterial wilt. The varieties like, D.R. Chowdhury, Japani, Khatkhatia (long), Khatkhatia (round), Barafkuli, Muktokeshi, Nayankazal, Bhangor, Singnath, Baromashi, White Jumke, Bigkuli, Rangpur, Longla, Islampuri, Black beauty, Black kind, Rajshahi-14 and Rajshahi-9 showed resistant reaction to wilt.

Miah *et al.*, (1986) screened 8 varieties of eggplant against Bacterial wilt diseases and found that the varieties like, D.R. Chowdhury & Rajshahi-6 were resistant, 4 vars, moderately resistant while the rest were highly susceptible which were Blackbeauty, Islampuri and_Japani.

Anonymous *et al.*, (1987) screened eggplant varieties against Bacterial wilt disease and found that the percentage of wilting ranged from 49.9 to 95.5 %. Among the tested varieties none was found resistant. The vars./lines Rajshahi-9, Rajshahi-2, Rajshahi-6, Rajshahi-3, Pusa Purple long, Singnath-1, Malyasia, Langla were either moderately susceptible or susceptible in their reaction.

Peter *et al.*, (1987) screened 26 selected aubergine lines against *Pseudomonas solanacearum* in a wilt-sick plot. Three of the lines (SM 6-1 SP, SM 6-1 M and SM 6-7 SP) were rated resistant and the remainder were moderately resistant.

Okubo *et al.*, (1990) described resistance of *Solanum melongena*, its wild relatives and 6 intervarietal/interspecific hybrids of Solanum to 5 specialized plant pathogenic strains of *Pseudomonas solanacearum* was evaluated. *S. melongena* was highly susceptible to all the strains except one, to which it showed moderate reaction. *S. ferox* and *S. toxicarium* were immune to 4 and 5 strains, respectively. Moderate susceptibility was evident in *S. sisymbriifolium* against most of the strains. *S. integrifolium* and its hybrids with *S. melongena* were highly tolerant of 2-3 strains. The poorest level of resistance was observed in *S. melongena* var. *insanum, S. gilo* and their hybrids with *S. melongena*. In general, symptom severity decreased with age. Differential pathogenicity among the strains was also recorded.

Ali *et. al.*, (1993) evaluated that most of the eggplant varieties/genotypes showed susceptible reaction against bacterial wilt. However, one line BL 081 showed resistant reaction while the genotype BL099 showed moderately resistant reaction. Six genotypes BL 117, ISDOII, ISD001, BLS 18, BLS2 and Tarapuri were found moderately susceptible to bacterial wilt. All other varieties/genotypes showed susceptible to highly susceptible reaction. It was revealed that all the wild Solanum species had low wilt incidence. *S. sisymbriifolium, S. torvum* and *S. integrifolium* showed resistant reaction. *S. indicum* and ishowed moderately resistant while *S. sanitwongsci* showed medium susceptible reaction.

Bora *et al.*, (1993) screened a total of 29 aubergine cultivars and breeding lines for resistance to bacterial wilt caused by *Pseudomonas solanacearum* during 1990-92 in Jorhat, India. Cultivars BWR 34, Pusa purple cluster, Yein and Rathaiah were resistant. BB 49, BG-1, JC-1, JC-2 and HOE 404 were moderately susceptible and the remaining cultivars and breeding lines were either susceptible or highly susceptible.

Prakash *et al.*,(1994) screened 11 parents and 18 crosses of brinjal for bacterial wilt (*Pseudomonas solanacearum*) resistance. High percentage survival was recorded among the resistant lines West Coast Green Round (WCGR) and SM-6. Out of the 18 hybrids, only three hybrids WCGR X Taiwan Naga, SM-6 X Taiwan Naga and WCGR X Ceylon were resistant and two hybrids WCGR X P-18 and SM-6 X Ceylon recorded moderate resistance.

Sharma *et al.*, (1995) screened aubergines elite lines BB1, BB7, BB11, Arka Nidhi (BWR 12), Arka Neelkanth (BWR 54), SM 6-7, BB 44, SM 6-6, Plant Samrat and Arka Keshav were tested during 1987-92 in Chotanagpur, Bihar, India, for resistance to *P. solanacearum*. BB11 and BB7 were resistant, showed high yield potentials and are recommended for cultivation in the Chotanagpur region.

Lopes *et al.*, (1997) described four resistant eggplant [aubergines, *Solanum melongena*] genotypes (CNPH 171, 175, 407 and 408) from the germplasm collection of the National Research Centre for Vegetable Crops (EMBRAPA-Hortalicas) were evaluated in greenhouse conditions against bacterial wilt. Significant differences were detected among the interactions between genotypes and strains. CNPH 171 showed significantly lower disease severity than the susceptible controls for all strains used. The bacterial strain RS 54 was chosen for future selection tests as it showed a virulence level to allow clear differentiation between susceptible and resistant genotypes.

Ponnuswami *et al.*, (1997) screened a total of 95 eggplant (aubergines, *Solanum melongena*) accessions, with resistant (TS56B) and susceptible (Bonne) controls inoculated with *Pseudomonas solanacearum* [*Ralstonia solanacearum*] strain Pss 97 by root cutting and soil drenching. Of the 95 accessions, 12 demonstrated a high level of resistance to bacterial wilt, of which 8 showed no symptoms (Arka Nidhi, Arka Keshav, Arka Neel Kantha, BB1, BB44, BB49, EP143 and Surya).

Singh *et al.*, (1998) reported that aubergine varieties/accessions were evaluated in the wilt sick soil of the warm humid tropical climate of Vellanikkara, Kerala, India . Varieties Surya, Swetha, Annapurna, BB7, BB13-1, BB44 and Arka Keshav were resistant to bacterial wilt following inoculation with *Pseudomonas solanacearum* [*Ralstonia solanacearum*]. The bacterial wilt resistant and white fruited Swetha ranked first in yield (3.86 kg/plant). Resistant varieties Annapurna, West Coast Green and Surya were also highly productive with acceptable fruit qualities.

Ponnuswami *et al.*, (1998) investigated on The effect of inoculum concentration and seedling age on bacterial wilt (*Pseudomonas solanacearum* [*Ralstonia solanacearum*]) severity of aubergine varieties. At different inoculum concentrations there was not much difference in disease severity on adult plants but differences in response of the varieties was evident when seedlings were used. For mass screening of segregating populations, 20-day-old seedlings and an inoculum concentration of 108 cells/ml are recommended.

Rashid *et al.*, (2000) screened 68 brinjal lines/variety against *R. solanacearum*. Ten lines namely BL005, BL009, BL 113, ISD 004, FAO 599, Islampuri (BADC), BL 097, BL 146, Mixture and BI. 104 showed resistant reaction., Several lines also showed moderately resistant reaction.

Alam *et al.*, (2000) conducted a field experiment to identify resistant germplasms of brinjal (*Solanum melongena*) against bacterial wilt. Fifteen brinjal germplasms were tested. Two cultivars, namely Oli-begoon and Shingnath, showed moderate resistance while Uttara showed moderate susceptibility.

Kishan *et al.*,(2000) evaluated 19 aubergine cultivars to determine to bacterial wilt which are suitable for Andaman and Nicobar Islands, India. The cultivars were investigated at monthly intervals up to 150 days of transplanting. The highest survival percentage was recorded in cv. Arka Keshav (91.60%) followed by BB-60-C (90.0%), 95-4 Round (88.46%), and CHES-309 (87.50%). Minimum survival was recorded in cv. BB-44 (0.00%) after 150 days of transplanting.

Mathew *et al.*,(2000) evaluated comparative performance of 13 aubergine (*Solanum melongena*) varieties and lines over five years (1987-89, 1989-90, 1991-92 and 1993-94) in Kerala, India. That revealed the superiority of SM-141 (Haritha) in terms of yield, quality and resistance to bacterial wilt (*R. solanacearum*).

Sharma *et al.*,(2000) evaluated nine genotypes of brinjal [aubergines] (*Solanum melongena*) viz., Arka Kesav, Arka Neelkanth, Hisar Shyamal, Pusa Purple Cluster, Pusa Purple Long, SM 6-6, SM 6-7, Arka Nidhi and Punjab Barsati during 1996-98 for the incidence of bacterial wilt (*Ralstonia solanacearum*) in the mid-hills of Himachal Pradesh, India. The genotypes Arka Kesav, Arka Neelkanth, Arka Nidhi and SM 6-6 were resistant to bacterial wilt whereas fruit borer incidence in these varieties varied from 2.88 (Arka Kesav) to 5.64 (SM 6-6) percent. The cultivars also possessed good agronomic traits.

Reddy *et al.*, (2001) screened twelve bacterial wilt (*Ralstonia solanacearum*) resistant aubergine lines in Karnataka, India on wilt-infested soil, followed by artificial inoculations with bacterial suspension, for three years (1998 to 2000). Of the twelve entries, only two lines, viz. EG 191 and TS-3, had 100% survival in all three years. Seven entries, viz. EG190, EG192, EG193, EG203, EG219, TS-7 and TS-69, recorded less than 5% mean wilt incidence. Susceptible controls EG 064 and IIHR 228 succumbed to complete wilt.

Rashid *et al.*, (2002) evaluated 43 eggpalnt varieties against *R. solanacearum* where five lines such as EG 203, BL 009, ISD006 and 30 X 13 were found resistant. Three line namely Mixture, BL SA-200 and 30 X 15 showed moderately resistant reaction. Rest of the lines including Kazla, Nayantara, Uttara, Singhnath showed moderate to highly Susceptible in reactions. Resistant and moderately resistant lines, having desirable agronomic traits may be recommended for cultivation as resistance source in bacteria prone areas.

2.10 Screening against Nemic Wilt

Hoque *et al.*, (1985) reported that seedlings of a number of brinjal varieties were screened in a *Meloidogyne* spp. infested field. It was found that only 2 varieties like Jumka and Purple king were resistant and four varieties Rajshahi-9, Rajshahi-11, Pusa purple long and. D.R. Choudhury showed tolerant reaction to the disease.

Shetty *et al.*, (1988) evaluated 69 cultivars and lines of aubergines (eggplant) for their reaction to *M. javanica* and *M. incognita*, only cv. Gulla was highly resistant to race 1 and 2 of M. incognita but slightly susceptible to race 3 of *M. incognita.*

Hossain *et. al.*, (1990) evaluated eleven eggplant (*Solanum melongena*) cultivars, namely, Pusha country, Pasha purple, Rajshahi-6, Rajshahi-9, Dohazari local, Uttara, Khatkhatia long, Khatkhatia round, Nayankazal, Singhnath, and Islampuri against root-knot nematode (*Meloidogyne incognita* Chitwood). Dohazarilal and Pupsa were graded as susceptible and other cultivars as moderately susceptible. Two brinjal cultivars, Islampuri and Khatkhatia round were graded as susceptible and the remaining cultivars were very susceptible to *M. incognita.*

Catalono *et al.*, (1992) screened accessions of *Solanum macrocarpon* (Sm), *S. sisymbriifolium* (Ss), *S .torvum* (St) and *S. warscewiczii* (Sw), wild relatives of *S melongena* were inoculated with 5000 eggs and juveniles/plant of *M. incognita, M. javanica, M. arenaria* and *M. hapla* in the greenhouse. Nine plants of Ss accession MG202155 were resistant to *M. incognita*, 5 were resistant to *M. javanica* and 8 were resistant to *M. arenaria*; all were resistant to *M. hapla*. Some plants of Ss accession MM284 were resistant to *M. incognita* and *M. javanica*, but susceptible to *M. arenaria* and *M. hapla*. Some plants of St accession MM392 were resistant to all nematodes tested, but MM456 and MM353 were resistant only to *M. incognita* and *M. javanica*. Three out of 8 plants and 1 out of 10 of Sw line MM448 were resistant to *M. incognita* and *M. javanica*, respectively. All plants of Sm MM150 were susceptible to all nematodes tested.

Ali *et al.*, (1992 b) evaluated resistance of eggplant, its wild relatives, interspecific Solanum hybrids and amphidiploids to *M. incognita* through inoculation of seedlings and grafted and non-grafted plants. They observed immunity or high resistance in *S. khusianum, S. torvum* and *S. toxicurium*. Small swellings were formed in *S. sisymbriifolium*, their hybrids and amphidiploids, and *S. indicum* failed to show resistance against the rootknot nematode. *Solanum mammosum* and *S. surattense* were highly susceptible to *M. incognita*.

Ali *et. al.*, (1993) evaluated 20 eggplant varieties against root knot nematode while Islampui and ISD 0011 were found moderately resistant against root-knot nematode. The varieties/ genotypes BL 009, BL 099. BL S2. BL 1 14, BL 045, BL 081, BL 072, Singhnath, Sufala and Uttara were susceptible. Among the six wild species *S. sisymbriifolium* and *S. torvum* gave resistant reaction and *Solanum khasianum* gave moderately resistant reaction to root-knot nematode and the rest was found susceptible.

Khan *et al.*,(1998) tested 17 cultivars where 12 were found susceptible. Cultivars Surti Gota and China Velvet were tolerant and Long Singapuri and American Black Beauty were hyper-susceptible to *Meloidogyne incognita, M. javanica* and *M. arenaria.*

Anonymous *et al.*, (1998) screened 23 germplasm/variety of eggplant against root knot (*Meloidogyne* spp). The result showed that higher gall number, eggmass number, and gall index were associated with reduced shoot height, shoot weight and root weight. The plant growth decreased with increasing disease incidence. Considering the gall index value, 13 varieties/lines showed moderately resistant reaction. Out of them, seven showed higher number of galls and eggmass per gram root.. The varieties/lines Islampuri, A. Keshar, BLS1E; BLS118, ISD001 and mixture were considered moderately resistant to root knot nematode.

Rashid *et al.*, (2001) screened 70 germplasms of eggplant where only 4 were found moderately resistance, 36 showed susceptible reactions and the rest gave highly susceptible reaction to root knot nematode. The minimum average gall number was counted in BL 111 (26/ gm root) and the maximum in BL 072 (103/gm root). The lowest gall indexing value was recorded in BL 111 followed by BL 156, . BL 97(2), ISD 06, ISD 006 and S56 white the highest in BL 113.

Haider *et al.*,(2001) evaluated available aubergine germplasm was evaluated for resistance to *M. incognita* race-2 from 1995 to 1999, in Samastipur, Bihar, India. On the basis of root-knot index and rate of multiplication of nematode, none of the cultivars/lines showed highly resistant reaction. Annamolai, KS-224, Vijay and 71-19 appeared resistant. Azad Kranti, Arka Kusmaker, Banaras Giant, Rajendra Annapurna, Rajendra Baigan-II, Pant Rituraj, KS-223, M-53A, 71-14, 71-24, 72-12, 74-1, 74-8, 80-2, 80-13, 82-8, 83-4, 83-5 and 88-26 were moderately resistant. The rest were susceptible or highly susceptible.

Anonymous *et al.*, (2001) reported that among 34 germplasms, only 7 were found moderately resistant and the rest gave susceptible reaction to root knot nematode. The lowest gall indexing value was recorded in BL97 and BL-102 followed by BL 156(II), BL-122, BL 009, BL 156(III) and BL Sl (S) 1, while the highest in S00128.

Rashid *et al.*, (2002) evaluated 36 eggplant varieties against rootknot nematode. Results indicated that gall number varied from 11 to 64 for eggplant whereas gall index varied from 1.33 to 5.67 for eggplant. According to gall number and gall index 10 eggplant lines showed resistant reaction, 16 moderately resistant including Uttara, Luffa and the rest were susceptible to highly susceptible to their reaction.

Sultana *et al.*, (2003) evaluated 36 germplasm of eggplant against root knot and found that 9 eggplant including Uttara showed resistant reaction and 16 eggplant germplasm showed moderate resistant including Kazla and rest of the were showed susceptible to highly susceptible.

Rahman *et al.*, (2004) reported that screened that results among 28 germplasm, Lines 6X10, 7X12, 8XI3 and 9X11 showed resistant reaction having gall index 1.00-2.00; and 13 lilies gave moderately resistant reaction to root knot nematode. The rest lines showed susceptible reaction. Growth was found stunted in the lines being infected heavily

2.11 Screening against Fusarium Wilt

Nishio *et al.*,(1997) desctibed that Fusarium wilt, caused by *Fusarium oxysporum* f.sp. *melongenae*, is one of the most serious soil-borne diseases of eggplant (aubergines, *Solanum melongena*) in Japan. Fusarium wilt resistant accession LS174 was identified, carrying a dominant resistance gene. Using LS174 as a resistant parent, breeding for Fusarium wilt resistance was initiated at the National Research Institute of Vegetables and development an eggplant parental line 1 resistant against Fusarium wilt caused by *Fusarium oxysporum.*

Chapter 3
Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

3.1 Experimental site

The experiment was conducted in the Field of SAU (Sher-e-Bangla Agricultural University) farm allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207.

3.2 Experimental period

The experiment was carried out during the period form September 2005 to April 2006.

3.3Soil type

The soil of the experimental plot was loam to clay loam in texture belonging to the Madhupur Tract (AEZ-28). The description of the Agro Ecological Zone (UNDP and FAO, 1988) of the experimental site is sited below:

Agro Ecological Region	: Madhupur Tract (AEZ-28)
Land type	: Medium high land.
General soil type	: Non-Calcareous
Soil series	: Tejgaon
Topography	: Up land
Elevation	: 8.45
Location	: SAU Farm, Dhaka.
Field level	: Above flood level.
Drainage	: Fairly good.
Firmness (consistency)	: Compact to friable when dry.

The physical and chemical characteristics of the soil have collected from soil Resource Development Institute (SRDI), Farmgate, Dhaka and is presented below (For 0-14 cm depth):

Particle size distribution:

Sand	: 34%
Silt	: 46%
Clay	: 20%
Soil texture	: Loam to clay loam.

3.4 Climate

The climate of the experimental area was of sub-tropical in nature characterized by high temperature associated with heavy rainfall during Kharif season (April to September) and scanty rainfall with moderately low temperature during Rabi season (October to March).

3.5 Weather

The monthly mean of daily maximum, minimum and average temperature, relative humidity, monthly total rainfall and sunshine hours received at the experimental site during the period of the study have been collected from the surface synoptic data card, Bangladesh Metrological Department, Sher-e-Bangla Nagar, Dhaka and Shown in Appendix I.

3.6 Variety used

Eggplant varieties Nayantara, Kazla, Uttara, Singhnath, Dhundul, Katabegun, Marichbegun, Luffa-s were used in the experiment for screening against wilt diseases.

3.7 Collection of Seed

Healthy, mature and disease free seeds of eggplant varieties were collected from different sources like IPM Lab of Bangladesh Agricultural University, Bangladesh Agricultural Research Institute, and local market of eggplant growing areas on the second week of September. Ten grams (10g) of Healthy seeds were collected for each varieties

3.8 Treatments of the experiment

In this study eight (8) varieties were used treatments were used as designated by T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8 which were as follows:

1) T_1 = Noyantara
2) T_2 = Shingnath
3) T_3 = Dhundul
4) T_4 = Kazla
5) T_5 = Marich Begun
6) T_6 = Luffa
7) T_7 = Kata Begun
8) T_8 = Uttara

3.9 Land preparation

The land was firstly ploughed with a power tiller and prepared using well decomposed cowdung in the third week of November 2005 and left exposed to sunlight for 7 days. Then the land was ploughed and cross-ploughed by a country plough until the soil had a good tilth. It required six times ploughing and every ploughing was followed by several ladering. After each ploughing weeds and rubbish were removed to obtain desirable tilth. Finally spade was used to prepare plots and drains.

3.10 Application of Manure and Fertilizers

Manure and fertilizers were applied as per standard recommendation.The following doses were used for carrying out the field experiment (Anonymous, 1997).

3.11 Fertilizers and manures used in the experimental field

Fertilizers and manures	Rate (Kg/ha)
Urea	250.00
TSP	240.00
MP	200.00
Cowdung	18500.00

A half of the total amount of cowdung and TSP were applied during final land preparation and remaining half was applied in pits before transplanting. Urea and MP were applied in two installments as ring dressing after 15 and 35 days of transplanting.

3.12 Design and layout of the experiment

The experiment was laid out in Randomized Block Design (RBD) with three replications. The whole plot was divided into three blocks each containing eight (8) plots of 3.5m x 1.0m size giving 24 unit plots. Each of the treatment put once at each block. The space kept between the blocks was 1m wide and between plots it was 0.5m. Plant to plant distance was maintained 75cm and each unit plot contained five plants (appendix 8).

3.13 Raising of seedling

Plastic trays were taken and filled up with fertile soil. Then the seeds of eggplant cultivars treated with Vitavax-200 (0.2%) were sown in plastic trays containing sterilized sandy soil on 18th September, 2005. Seeds were sown in parallel line on the surface level of the seed bed making about 2 cm. line depth and then a very thin cover was made with sandy soil. Four trays were taken for raising of seedlings. Seedlings were observed regularly and watering was done as per necessity up to transplanting in the field.

3.14 Transplanting of seedling

After preparation of main pot in the net house 45 days old seedling were be uprooted from the seedbed and transplanted in the experimental pot on the 16th November 2005 in the afternoon of the same day. Two hour before transplanting the seedlings watered before removing the seedlings from the tray to minimize root damage. Plant to plant distance was maintained 75 cm and each plot contain five plants. A sufficient irrigation was given just after transplantation with the help of a bucket sprinkler. For keeping seedlings upright, support with bamboo sticks were provided. One seedling was placed in a pit. The transplanted seedlings were protected from the sunlight, shading with banana leaf sheath cuttings. Shading and watering was continued till the seedlings were established in the field.

3.15 Intercultural operation

After transplantation gap filling was done in case of seedling died. In 15 to 20 days after planting (DAP) weeding was done which followed split doze fertilizer application. First split application was done on the 7th February ' 2006 and the second split application was done on the 26 February 2006 as treatment of double dose nitrogenous fertilizer. After weeding and fertilizer application flood irrigation was given (in case of second split) by filling the drains surrounding the beds by pumping water in those drains with a water pump. After soaking the plots excess water was allowed to be drained out. The plants were observed regularly. General field sanitation was maintained throughout the growing period by removing infected and blighted leaves wilted. Insecticides named Ektara (0.2%) and Malathion @0.2% was sprayed at 15 days intervals to protect the crop from shoot & fruit borer infestation.

3.16 Inoculation of *Fusarium oxysporum*:

Fusarium oxysporum. grown on PDA (Potato Dextrose Agar) medium at 25 ^{0} C temperature. After sporulation (15-20 days), added 5-ml/plate sterile water and the spore masses scraped away with sterile needle/scalpel. The conditional suspension thus made with additional water was then blended in a Moulinex blender for 2 minutes in medium speed and filtered through sterile cheesecloth, adjusted by Hemacytometer concentration 1.2×10^7 conidia/ml solution. Then inoculation done at the root zone of plant by drenching of spore suspension @ 250ml/plant with the help of compressed air hand sprayer following pulverized the soil to mix up the *Fusarium oxysporum* spores thoroughly to the soil. Inoculation done at 30 Days After Transplanting (DAT).

3.17 Inoculation of *Meloidogyne incognita*:

Mature eggmass of nematode (*M. incognita*) was collected from severely galled roots of eggplants using fine forceps. After thorough rinsing with sterile distilled water the egg mass were transferred to 75 mm (diameter) petridishes containing 10ml sterilized distilled water and were incubated at 28-29° C for four days. Inoculum suspension of freshly hatched larvae was prepared in distilled water having diluated about 500 larvae per ml. Inoculation was done by powering the inoculum containing 1000 nematode suspended in 2 ml of water into two depressions made on the surface of the soil near the root system of seedlings. Inoculation done at 30 Days After Transplanting (DAT).

3.18 Inoculation of *Ralstonia solanacearum*:

Pure culture of *Ralstonia solanacearum* E.F. Sm. was prepared on TZC (Tetrazolium chloride) medium by isolating the organism from the eggplant showing typical symptoms of bacterial wilt. The identification of the isolate was confirmed by Cock's postulate.

The sick bed was established by inoculating the soil with a mixture of *Ralstonia solanacearum* isolates. The population density of the bacteria in the bed prior to set up the experiments was estimated about 2.3 x 10^8 CFU/Ml of water by dilution plate method.

3.19 Isolation of Fusarium

The experimental plots were inspected routinely to observe the Fusarium wilted plant. To identify the pathogen, the diseased plants were collected from the field and were taken to the laboratory, The diseased stem were cut into small pieces (about 0.5-1 cm) from the vascular region of the stem and surface sterilized by dipping in 10% Sodium Hypochlorite solution for 2-3 minutes or $HgCl_2$ solution (0.01) for 30 second. The cut pieces were then washed in water at three times and were placed into PDA media in sterilized petridish with the help of sterile forceps and incubated at 25±1°C for 10-15 days. Later the pathogen was purified using hyphal tip culture method and grown on PDA media at 25±1°C for 2 weeks. Causal organisms were identified under stereobinocular and compound microscopes.

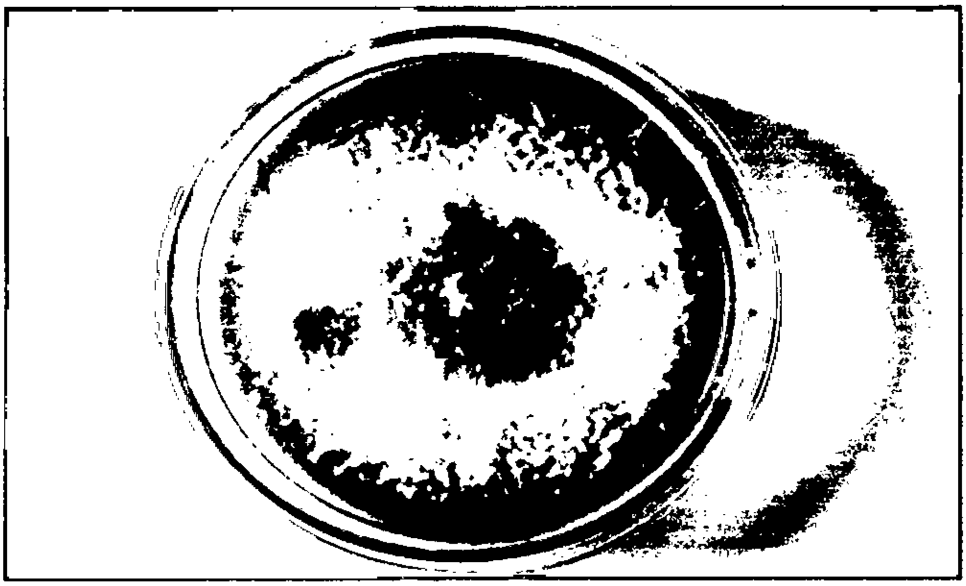


Figure: Twelve days old culture (*Fusarium oxysporum f. sp.melongenea)*.

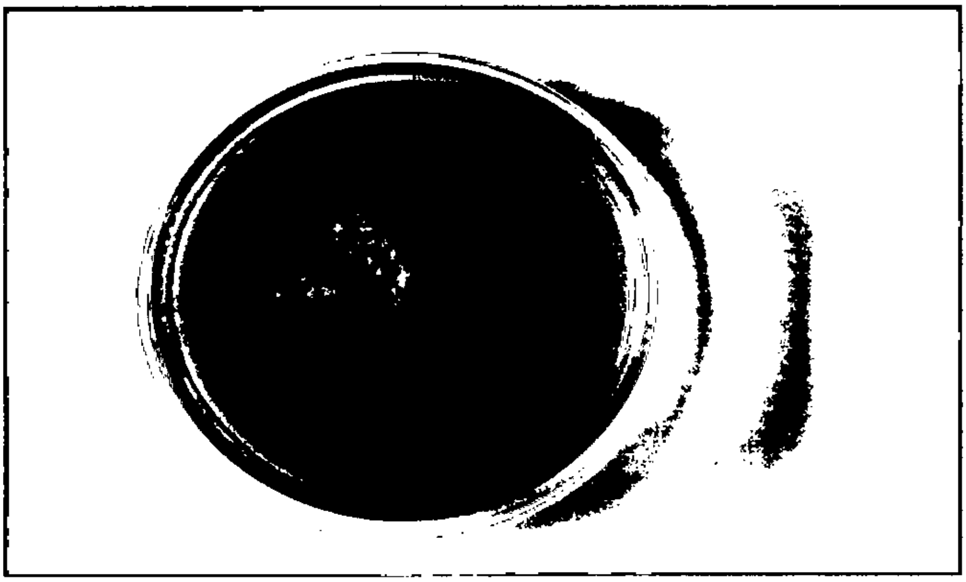


Figure: Twenty six days old culture (*Fusarium oxysporum f. sp.melongenea)*.

3.20 Isolation of Nematode

The experimental plots were inspected routinely to observe the Nematode wilted plant. To identify the nematode the diseased plants were collected from the field and were taken to the laboratory, and collected freshly soil sample of about 100-300cm^3 and the nematodes in it isolated by the Baermann funnel method. The funnel is placed on a stand and filled with water. Then soil sample, which is wrapped by 5-6 cm circular piece of cloth is placed in the funnel below the surface of the water and allowed them to stand overnight or for several hours. The active nematodes migrate through the cloth into the water and sink to the bottom of the water just above pinch up. 90% of the live nematode are recovered in the first 5-8ml of water drown from the rubber tubing. After extraction the water sample containing nematodes is placed in a dish for examination. Causal organisms were identified under stereo binocular and compound microscopes to find out nematode egg and adult.

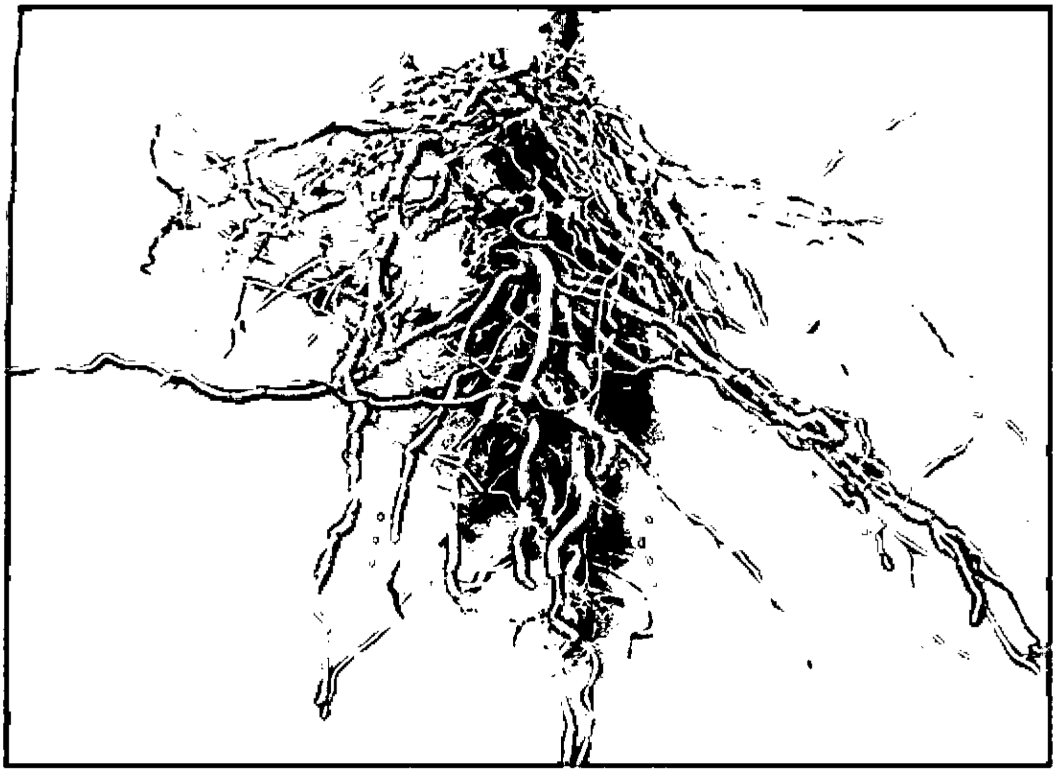


Figure : Infected root of eggplant caused by *Meloidogyne* sp.

Figure: Eggs of *Meloidogyne incognita* in a crush gall of eggplant root (X 400)

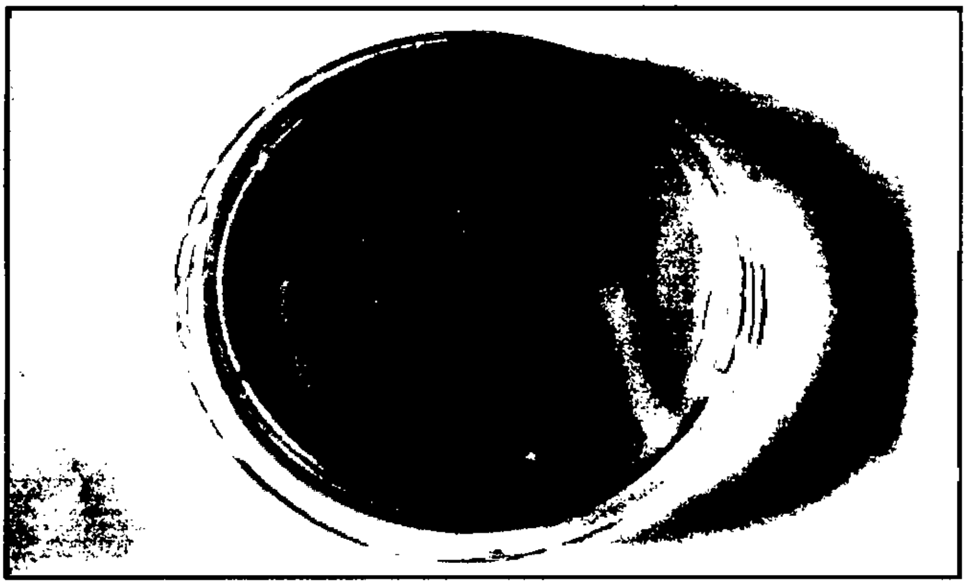


Figure: Four days old culture (*Ralstonia solanacearum*).

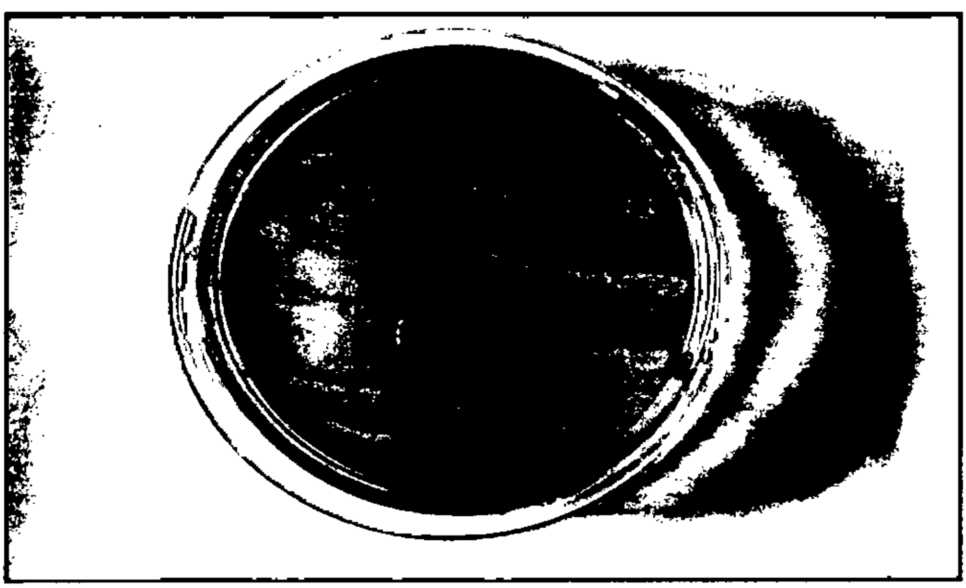


Figure : Eighteen days old culture (*Ralstonia solanacearum*).

3.22 Data recording and harvesting

Data on incidence of wilts were recorded in case of Bacterial wilt at 25, 35, 45, and 55 days after transplanting and Fusarium & Nematode wilt at 50, 65, 80, and 95days after transplanting by observation of visual symptoms. The disease incidence was calculated by the following formula:

$$\% \text{ Disease incidence} = \frac{\textbf{Number of infected}}{\textbf{Number of total inspected}} \times 100$$

The following parameters were considered for data collection.

3.23 Observations: (Disease incidence)

a) Number of wilted plant

b) Number of galls/plant.

3.24 Observations: (Yield and yield contributing characters)

a) Length of shoot (cm)

b) Fresh weight of shoot (g)

c) Length of root (cm)

d) Fresh weight of root (g)

e) Yield/ha

3.25 Measurement of length of shoot and root, fresh weight of shoot and root and number of branching

For this purpose, the whole plant along with soil attached to roots was lifted from the soil and dipped in a bucket full of water. Before placing the roots in the bucket a sieve was placed at the bottom of bucket. Then by gradual movement of the roots in water, the roots were separated from the soil. Roots were further cleaned in gently running tap water and peat masses were removed with forceps. Any broken root portion collected in the sieve was carefully washed out. The root portion was separated from shoot. The length of the shoot was measured from the base of the stem to the growing point of the youngest leaf. The length of root was measured from the growing point of root to the longest available lateral root apex. For fresh weight of shoot and root the portion was blotted dry and the weight was recorded before the materials could get dessicated. The number of primary and secondary branching also counted by eye estimation.

3.26 Counting of nematode galls

After washing the roots were preserved in 5% formalin solution. For easy observation the bigger roots were cut into small pieces and individual piece was examined for counting the number of galls formed. The galls were indexed on a 0-4 scale to score galling level as followed by Ahmed (1977b) modified from Daulton and Nusbaum, 1961; Cook, 1972; Fassuliotis, 1973; and Amosu and Franckowiak 1974 as described below:

Galling level index

Scales	Specification	No of galls
0	No galling	0
1	Light galling	<10
2	Moderate galling	10-15
3	Heavy galling, mostly discreate	50-100
4	Very heavy galling, many coalesced	>100

3.27 Analysis of data

The data were statistically analyzed using analysis of variance to find out the variation of results from experimental treatments. Treatment means were compared by DMRT (Duncan's Multiple Range Test). Correlation and Regression study was done to establish relationship between shoot length, shoot weight, root length, root weight with galling incidence among the treatments.

Chapter 4

Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

The present experiment was conducted to screen out the resistant cultivars of eggplant against wilt disease. The analysis of variance (ANOVA) of the data on disease incidence, different yield components and yield of eggplants of different cultivars after inoculation of *Ralstonia solanacearum*, *Fusarium oxysporum* f. sp. *melongenae*, *Meloidogyne incognita* are given in Appendix (1-4). The results have been presented and discussed, and possible interpretations have been given under the following headings:

4.1 Bacterial wilt incidence

The reactions of different cultivars of eggplant in terms of bacterial wilt incidence significantly differed under the present experiment recorded at different days after transplanting (DAT) of eggplant. The variation of wilt incidence for different cultivar varied with in a certain range for all the DAT.

4.1.1 Bacterial wilt incidence (%) at 25 DAT

Eggplant cultivar showed statistically significant variation in respect of Bacterial wilt incidence under the present trail at 25 DAT (Appendix 1). All the cultivars performed comparatively lower wilt incidence at 25 DAT and the average wilt incidence varied from 20.00% to 41.00% (Table 1). The highest Bacterial wilt incidence (41.00%) was recorded in the cultivar Luffa which was statistically identical with the cultivar Kazla (40.00%). The lowest wilt incidences (20.00%) were recorded in the cultivar Singhnath and Kata Begun which was closely followed by the cultivar Dhundul and Uttara (30.00%). According to grading followed the variety D.R. Chowdhury gave resistant reaction with 13.3% wilting, variety Khatkhatia (long) was moderately resistant with 33.3% wilting and the rest of the varieties showed susceptible reaction.

4.1.2 Bacterial wilt incidence (%) at 35 DAT

Statistically significant variation was recorded among the eggplant cultivars in terms of Bacterial wilt incidence under the present trail at 35 DAT (Appendix 1). All the cultivars performed comparatively medium level of wilt incidence at 35 DAT and it varied from 30.00% to 51.00 cm (Table 2). In the cultivar Luffa the highest bacterial wilt incidence (51.00%) was recorded which was statistically identical with the cultivar Kazla and Uttara (50.00%). The lowest wilt incidences (30.00%) were recorded in the cultivar Kata Begun which was closely followed by the cultivar Dhundal and Uttara (30.00%).

4.1.3 Bacterial wilt incidence (%) at 45 DAT

In the present experiment eggplant cultivar showed statistically significant variation in respect of Bacterial wilt incidence under the present trail at 45 DAT (Appendix 1). All the cultivars performed comparatively higher wilt incidence at 45 DAT and the average wilt incidence at 45 DAT varied from 30.00% to 60.67% (Table 3). The highest Bacterial wilt incidence (60.67%) was recorded in the cultivar Nayatara and Luffa which was statistically identical with the cultivar Singhnath, Kazla and Marich Begun (40.00%). The lowest wilt incidences (30.00%) were recorded in the cultivar Kata Begun which was closely followed by the cultivar Dhundul and Uttara (50.00%). Hoque *et al.*, (1981) screened 16 eggplant varieties and the first symptom of wilting was observed on the 15th days after inoculation. Data on wilting collected after 43 days of inoculation were varied from 13.3 to 100%.

4.1.4 Bacterial wilt incidence (%) at 55 DAT

A statistically significant variation was recorded among the eggplant cultivars in terms of Bacterial wilt incidence under the present trail at 55 DAT (Appendix 1). All the cultivars executed comparatively higher level of wilt incidence at 55 DAT and it varied from 30.00% to 80.00 cm (Table 4). In the cultivar Luffa, the highest bacterial wilt incidence (80.00%) was recorded. The lowest wilt incidences (30.00%) was recorded in the cultivar Kata Begun which was closely followed by the cultivar Dhundul and Marich Begun (60.00%). Anonymous *et al.*, (1987) screened and eggplant varieties against Bacterial wilt disease and found that the percentage of wilting ranged from 49.9 to 95.5 %. Among the tested varieties none was found resistant.

4.1.5 Reaction of eggplant cultivar to bacterial wilt

On the basis of wilt incidence different cultivars of eggplant were categorized into different groups mentioning their susceptible reactions to bacterial wilt (Table 5). Among the cultivars used in this trail only the cultivar Kata Begun was resistant to bacterial wilt whereas cultivar Marich Begun and Dundul were moderately resistant. On the other hand cultivar Kazla and Luffa were susceptible to bacterial wilt whereas Nayantara, Singhnath and Uttara were the moderately susceptible.

Table 1. Bacterial wilt incidence at 25 DAT on different eggplant varieties

Treatments	Bacterial wilt incidence at 25 DAT (%)
Nayantara	30.67 b
Singhnath	20.00 c
Dhundul	30.00 b
Kazla	40.00 a
Marich Begun	20.00 c
Luffa	41.00 a
Kata Begun	20.00 c
Uttara	30.00 b
$LSD_{(0.05)}$	1.33
Level of Significance	**
CV (%)	2.62

In a column means having similar letter(s) or without letter are identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Table 2. Bacterial wilt incidence at 35 DAT on different eggplant varieties

Treatments	Bacterial wilt incidence at 35 DAT (%)
Nayantara	40.67 c
Singhnath	40.00 c
Dhundul	40.00 c
Kazla	50.00 b
Marich Begun	44.00 c
Luffa	51.00 b
Kata Begun	30.00 d
Uttara	50.00 b
$LSD_{(0.05)}$	1.33
Level of Significance	**
CV (%)	4.45

In a column means having similar letter(s) or without letter are identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Table 3. Bacterial wilt incidence at 45 DAT on different eggplant varieties

Treatments	Bacterial wilt incidence at 45 DAT (%)
Nayantara	60.67 a
Singhnath	60.00 a
Dhundul	50.00 b
Kazla	60.00 a
Marich Begun	60.67 a
Luffa	60.00 a
Kata Begun	30.00 c
Uttara	50.00 b
$LSD_{(0.05)}$	1.046
Level of Significance	**
CV (%)	5.05

In a column means having similar letter(s) or without letter are identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Table 4. Bacterial wilt incidence at 55 DAT on different eggplant varieties

Treatments	Bacterial wilt incidence at 55 DAT (%)
Nayantara	70.00 b
Singhnath	70.00 b
Dhundul	60.00 c
Kazla	72.33 b
Marich Begun	60.00 c
Luffa	80.00 a
Kata Begun	30.00 d
Uttara	60.67 c
$LSD_{(0.05)}$	2.651
Level of Significance	**
CV (%)	7.86

In a column means having similar letter(s) or without letter are identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Table 5. Reaction of brinjal cultivar to bacterial wilt

Treatments	Bacterial wilt incidence (%) at 55 DAT	Reaction
Nayantara	70.00	Moderately susceptible (MS)
Singhnath	70.00	Moderately susceptible (MS)
Dhundul	60.00	Moderately resistant (MR)
Kazla	72.33	Susceptible (S)
Marich Begun	60.00	Moderately resistant (MR)
Luffa	80.00	Susceptible (S)
Kata Begun	30.00	Resistant (R)
Uttara	60.67	Moderately susceptible (MS)

Resistant : 30% and below wilted plant;

Moderately resistant : 31%-50% wilted plant;

Moderately susceptible : 51%-70% and wilted plant

Susceptible (S) : 71% and above wilted plant

(Rashid *et. al.*, 2004)

4.2 Fusarium + Nematode wilt incidence (%)

The reactions of different cultivars of eggplant in terms of Fusarium + Nematode wilt incidence significantly differed under the present trail recorded at different days after transplanting (DAT) of eggplant. The variation of wilt incidence for different cultivar varied within the certain range for all the DAT in all cultivars.

4.2.1 Fusarium + Nematode wilt incidence (%) at 50 DAT

In the present experiment eggplant cultivar showed statistically significant variation in respect of Fusarium + Nematode wilt incidence at 50 DAT (Appendix 2). All the cultivars performed comparatively lower wilt incidence at 50 DAT and the average wilt incidence at 50 DAT varied from 20.00% to 50.00% (Table 6). The highest Fusarium + Nematode wilt incidence (50.00%) was recorded in the cultivar Luffa which was statistically identical with the cultivar Dhudul (40.00%). The lowest wilt incidence (20.00%) was recorded in the cultivar Kata Begun which was identical with the cultivar Uttara (20.33%).

4.2.2 Fusarium + Nematode wilt incidence (%) at 65 DAT

Eggplant cultivar showed statistically significant variation in terms of Fusarium + Nematode wilt incidence under the present trail at 65 DAT (Appendix 2). All the cultivars performed comparatively medium wilt incidence at 65 DAT and the average wilt incidence varied from 30.00% to 60.00% (Table 7). The highest Fusarium + Nematode wilt incidence (60.00%) was recorded in the cultivar Luffa and Kazla which was statistically identical with the cultivar Singhnath, Dhudul and Marich Begun (50.00%). The lowest wilt incidence (30.00%) was recorded in the cultivar Kata Begun which was closely followed by the cultivar Nayantara (40.33%) and Uttara (40.33%).

4.2.3 Fusarium + Nematode wilt incidence (%) at 80 DAT

In the present experiment eggplant cultivar showed statistically significant variation in respect of Fusarium + Nematode wilt incidence at 80 DAT (Appendix 2). All the cultivars performed comparatively higher wilt incidence at 80 DAT and the average wilt incidence varied from 30.00% to 80.00% (Table 8). The highest Fusarium + Nematode wilt incidence (80.00%) was recorded in the cultivar Luffa which was closely followed by Kazla (70.00%). The lowest wilt incidence (30.00%) was recorded in the cultivar Kata Begun which was identical with the cultivar Nayantara and Uttara (50.33 and 50.67%, respectively).

4.2.4 Fusarium + Nematode wilt incidence (%) at 95 DAT

Fusarium + Nematode wilt incidence on eggplant cultivars showed statistically significant variation under the present trail at 95 DAT (Appendix 2). All the cultivars performed comparatively higher wilt incidence at 95 DAT and the average wilt incidence varied from 30.00% to 80.00% (Table 9). The highest Fusarium + Nematode wilt incidence was recorded in the cultivar Luffa (80.00%) and the lowest wilt incidence was recorded in the cultivar Kata Begun (30.00%) which was closely followed by the cultivar Uttara (57.00%).

4.1.5 Reaction of eggplant cultivars to Fusarium + Nematode wilt

On the basis of Fusariun + Nematode wilt incidence, different cultivars of eggplant were categorized into different groups mentioning susceptible reactions (Table 10). Among the cultivars used in this screening program, only cultivar Kata Begun was found resistant to Fusarium + Nematode wilt. On the other hand cultivar Luffa was susceptible to Fusariun + Nematode wilt whereas Nayantara, Singhnath, Dhundul, Kazla, Marich Begun and Uttara were the moderately susceptible.

Table 6. Fusarium and Nematode wilt incidence at 50 DAT on different eggplant varieties

Treatments	Fusarium + Nematode wilt incidence at 50 DAT (%)
Nayantara	30.00 c
Singhnath	30.00 c
Dhundul	40.00 b
Kazla	30.33 c
Marich	30.00 c
Luffa	50.00 a
Kata	20.00 d
Uttara	20.33 d
$LSD_{(0.05)}$	0.522
Level of Significance	**
CV (%)	3.85

In a column means having similar letter (s) or without letter are identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Table 7. Fusarium and Nematode wilt incidence at 65 DAT on different eggplant varieties

Treatments	Fusarium + Nematode wilt incidence at 65 DAT (%)
Nayantara	40.33 c
Singhnath	50.00 b
Dhundul	50.00 b
Kazla	60.00 a
Marich	50.00 b
Luffa	60.00 a
Kata	30.00 d
Uttara	40.33 c
$LSD_{(0.05)}$	0.545
Level of Significance	**
CV (%)	7.63

In a column means having similar letter (s) or without letter are identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Table 8. Fusarium and Nematode wilt incidence at 80 DAT on different eggplant varieties

Treatments	Fusarium + Nematode wilt incidence at 80 DAT (%)
Nayantara	50.33 d
Singhnath	60.00 c
Dhundul	60.00 c
Kazla	70.00 b
Marich	60.00 c
Luffa	80.00 a
Kata	30.00 e
Uttara	50.67 d
$LSD_{(0.05)}$	0.821
Level of Significance	**
CV (%)	4.85

In a column means having similar letter (s) or without letter are identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Table 9. Fusarium and Nematode wilt incidence at 95 DAT on different eggplant varieties

Treatments	Fusarium + Nematode wilt incidence at 95 DAT (%)
Nayantara	70.00 b
Singhnath	50.67 e
Dhundul	70.00 b
Kazla	70.00 b
Marich	60.00 c
Luffa	80.00 a
Kata	30.00 f
Uttara	57.00 d
$LSD_{(0.05)}$	1.562
Level of Significance	**
CV (%)	6.58

In a column means having similar letter (s) or without letter are identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Table 10. Reaction of brinjal cultivars to Fusariun + Nematode wilt

Treatments	Fusarium+ Nematode wilt incidence (%) at 95 DAT	Reaction
Nayantara	70.00	Moderately susceptible (MS)
Singhnath	50.67	Moderately susceptible (MS)
Dhundal	70.00	Moderately susceptible (MS)
Kazla	70.00	Moderately susceptible (MS)
Marich Begun	60.00	Moderately susceptible (MS)
Luffa	80.00	Susceptible (S)
Kata Begun	30.00	Resistant (R)
Uttara	57.00	Moderately susceptible (MS)

Resistant : 30% and below wilted plant;

Moderately resistant : 31%-50% wilted plant;

Moderately susceptible : 51%-70% and wilted plant

Susceptible (S) : 70% and above wilted plant

(Rashid *et. al.*, 2004)

4.3 Shoot height/plant

Eggplant cultivar showed statistically significant variation in respect of shoot height under the present trail (Appendix 3). Different cultivars performed different shoot height and it varied from 41.06 cm to 69.45 cm (Table 11). The highest shoot height (69.45 cm) was recorded in the cultivar Kata Begun which was statistically identical with the cultivar Marich Begun (68.55 cm). The lowest shoot height (41.06 cm) was recorded in the cultivar Singhnath which was closely followed by the cultivar Uttra, Dhundal and Kazla (46.80 cm, 48.05 and 48.18 cm, respectively). Rashid *et al.*, (2001) screened 70 germplasms. Where the shoot height ranged from 23.87 to 53.37 cm. The highest shoot height was recorded in BL 111 followed by ISD 06, BL 093, ISD 411, BL, 158 and Kazla. The variation of shoot height ranged from 6.50 to 57.67 gm.

4.4 Shoot weight/plant

Eggplant cultivar showed statistically significant variation in terms of shoot weight under the present experiment (Appendix 3). Cultivar performed unusual and diverse shoot weight and it varied from 27.08 g to 73.20 g (Table 11). The highest shoot weight (73.20 g) was recorded in the cultivar Dhundul which was closely followed by the cultivar Nayantara (52.25 g). The lowest shoot weight (27.08 g) was recorded in the cultivar Singhnath which was closely followed by the cultivar Uttra (31.37 g).

4.5 Root length

Eggplant cultivar showed statistically significant variation in respect of root length under the present trail (Appendix 3). All the cultivars performed medium root length and the average root length varied from 10.35 cm to 22.27 cm (Table 11). The highest root length (22.27 cm) was recorded in the cultivar Uttara which was closely followed by the cultivar Kata Begun (21.40 cm). The lowest root lengths (10.35 cm) was recorded in the cultivar Singhnath which was closely followed by the cultivar Dhundal and Nayantara (16.75 cm and 17.36 cm). Miller *et al.*, (2005) reported that wilt organism usually enters the plant through young roots and then grows into the water conducting vessels of the roots and stem. As the vessels are plugged and collapse, the water supply to the leaves is blocked. Talukder, 1974; Ahmed and Hossain, 1985 and Mian, 1986 reported same results earlier.

4.6 Root weight

Statistically significant variation among the root weight was recorded in eggplant cultivars under the present trail (Appendix 3). Root length varied from 8.90 g to 17.36 g (Table 11). The highest root weight (17.36 g) was recorded in the cultivar Nayantara which was closely followed by the cultivar Kazla (16.35 g). The lowest root weight (8.90 g) was recorded in the cultivar Uttara which was closely followed by the cultivar Singhnath (9.61 g).

4.7 Average Gall number

Eggplant cultivar showed statistically significant variation in terms of average gall number under the present trail (Appendix 3). All the cultivars performed medium to highest gall number and it varied from 30.50 to 52.50 (Table 11). The highest gall number (52.50) was recorded in the cultivar Luffa which was closely followed by the cultivar Dhundul (50.00). The lowest gall number (30.50) was recorded in the cultivar Kata Begun which was closely followed by the cultivar Uttara (35.83). Anonymous *et al.*, (2001) screened 34 germplasms, only 7 were found moderately resistant and the rest gave susceptible reaction to root knot nematode. The shoot height ranged from 31.90 to 45.17 cm. Most of the germplasms showed higher gall indexing value due to higher nematode population in the soil. Rashid *et al.*, (2002) screened 36 eggplant varieties against rootknot nematode. Results indicated that gall number varied from 11 to 64 for eggplant whereas gall indices varied from 1.33 to 5.67 for eggplant.

4.8 Yield of different eggplant varieties (Kg/plot)

A statistically significant variation was recorded in eggplant cultivar in terms of average yield per plot (Appendix 4). The average yield per plot varied from 1.97 to 8.95 Kg/plot (Table 12). The highest yield per plot (8.95 Kg/ha) was recorded in the cultivar Nayantara which was closely followed by the cultivar by Kazla and Kata begun (6.78 and 6.13 Kg/ha). The lowest yield (1.97 Kg/ha) was recorded in the cultivar Dhundul.

4.9 Yield of different eggplant varieties (t/ha)

Average yield per hectare under the present trail eggplant cultivar showed statistically significant variation (Appendix 4). The average yield per hectare varied from 6.57 to 29.84 ton (Table 12). The highest per hectare yield (29.84 t/ha) was recorded in the cultivar Nayantara which was closely followed by the cultivar Singhnath (23.83 t/ha). The lowest yield (6.57 t/ha) was recorded in the cultivar Dhundul (Figure 3).

Table 11. Yield contributing characters of wilt infected different eggplant varieties

Treatments	Shoot height/ plant (cm)	Shoot weight/ plant (g)	Root length (cm)	Root weight (g)	Average Gall number
Nayantara	63.52 c	52.25 b	17.36 e	17.36 a	46.00 c
Singnath	41.06 e	27.08 f	10.35 f	9.61 g	37.67 e
Dhundal	48.18 d	73.20 a	16.75 e	10.65 f	50.00 b
Kazla	48.05 d	30.55 c	18.80 d	16.35 b	40.00 d
Marich	68.55 a	50.05 c	18.32 d	14.85 d	36.50 f
Luffa	66.30 b	44.95 d	19.75 c	15.80 c	52.50 a
Kata	69.45 a	49.15 c	21.40 b	13.95 e	30.50 g
Uttara	46.80 d	31.37 e	22.27 a	8.90 h	35.83 f
$LSD_{(0.05)}$	1.562	1.982	0.814	0.525	0.824
Level of Significance	**	**	**	**	**
CV (%)	4.48	3.56	5.55	3.85	5.89

In a column means having similar letter (s) or without letter are identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

Table 12. Yield from wilt infected different eggplant varieties

Treatments	Yield (Kg/plot)	Yield (t/ha)
Nayantara	8.95 a	29.84 a
Singnath	7.15 b	23.83 b
Dhundal	1.97 d	6.57 d
Kazla	6.78 b	22.60 b
Marich	3.96 c	13.20 c
Luffa	3.98 c	13.27 c
Kata	6.13 b	20.43 b
Uttara	4.62 c	12.08 c
$LSD_{(0.05)}$	1.204	2.785
Level of Significance	**	**
CV (%)	7.58	7.58

In a column means having similar letter (s) or without letter are identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

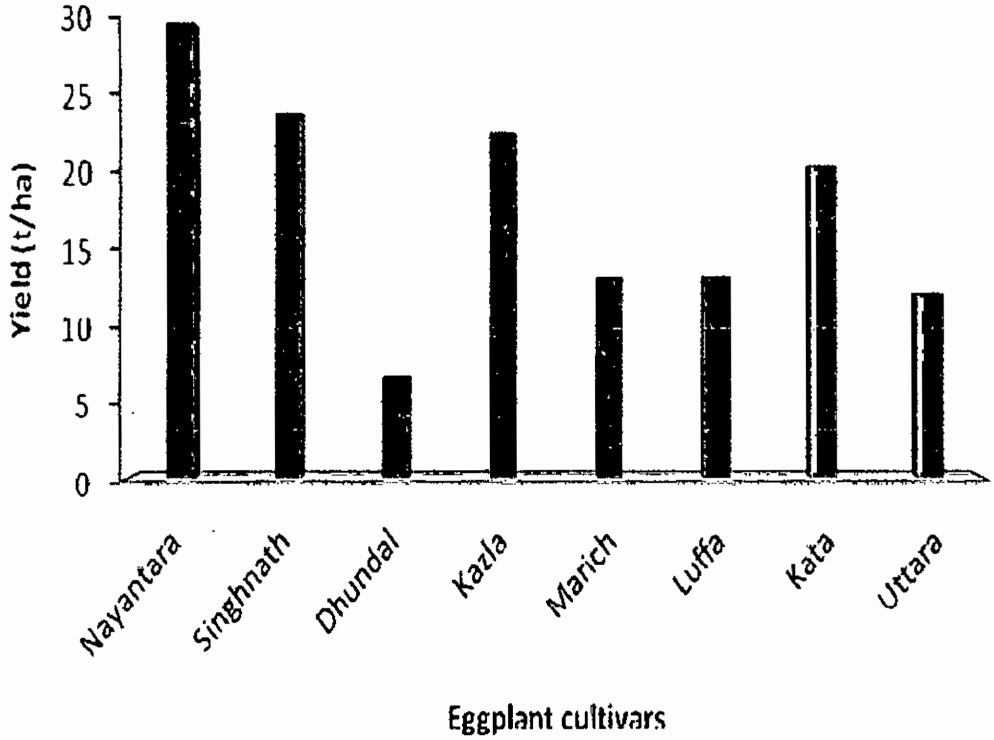


Figure 1. Yield per hectare of different eggplant cultivars

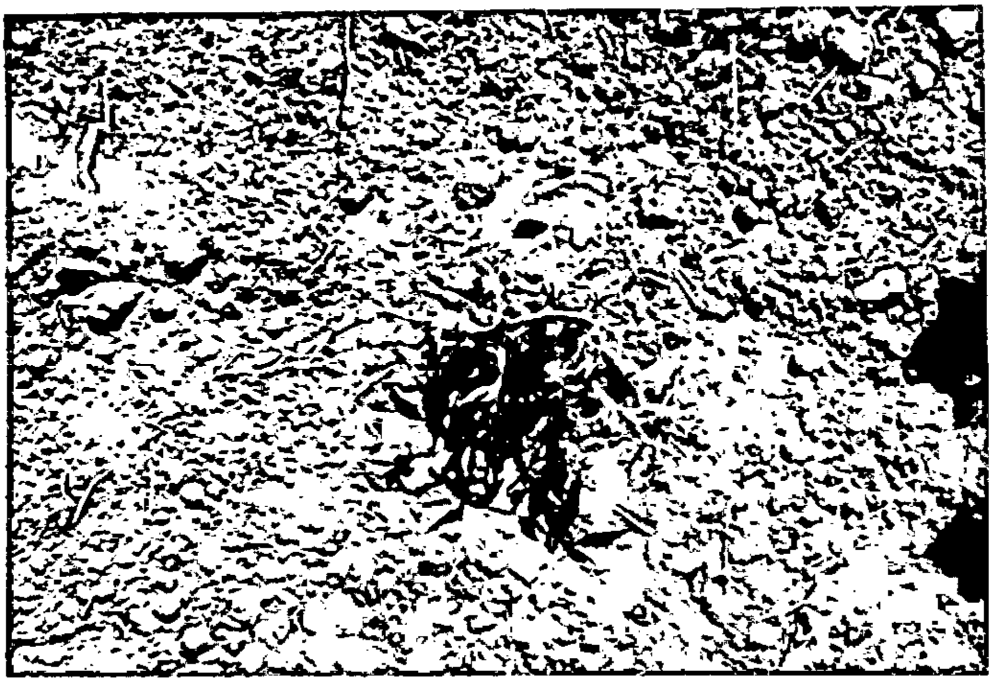


Figure: Eggplant affected by Bacterial wilt (*Ralstonia solanacearum*)

Figure. Eggplant affected by nemic wilt (*Meloidogyne sp.*)

Chapter 5

Summary and Conclusion

Chapter V

SUMMARY AND CONCLUSION

An experiment was conducted in the field of SAU (Sher-e-Bangla Agricultural University) farm allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka to screen out the resistant cultivars of eggplant against wilt disease. In this study, eight (8) varieties were used as treatments. The experiment was laid out in Randomized Block Design (RBD) with three replications. Inoculation done at the root zone of plant by drenching of spore suspension @ 250ml/plant with the help of compressed air hand sprayer following pulverized the soil to mix up the *Fusarium oxysporum* spores thoroughly to the soil, similarly mature eggmass of nematode (*M. incognita*) suspension mix up on the surface of the soil near the root system of seedlings and bacterial suspension mix up the sick bed. Inoculation done at 30 days after transplanting (DAT). Data on incidence of wilts were recorded in case of bacterial wilt at 25, 35, 45, and 55 days after transplanting and Fusarium & Nematode wilt at 50, 65, 80, and 95days after transplanting by observation of visual symptoms.

All the cultivars performed comparatively lower wilt incidence at 25. The highest Bacterial wilt incidence (41.00%) was recorded in the cultivar Luffa and the lowest wilt incidences (20.00%) were recorded in the cultivar Singhnath and Kata Begun. At 55 DAT from the cultivar Luffa exhibit the highest bacterial wilt incidence (80.00) and the lowest wilt incidences (40.00%) were recorded in the cultivar Kata Begun. Cultivar Kata Begun was resistant to bacterial wilt where as cultivar Marich Begun and Dundul are moderately resistant. On the other hand cultivar Kazla and Luffa are susceptible to bacterial wilt where as Nayantara, Singhnath and Uttara are the moderately susceptible.

The highest Fusarium + Nematode wilt incidence (50.00%) was recorded in the cultivar Luffa and the lowest wilt incidences (20.00%) were recorded in the cultivar Kata Begun. At 90 DAT the highest Fusarium + Nematode wilt incidence (80.00%) was recorded in the cultivar Luffa and the lowest wilt incidences (30.00%) were recorded in the cultivar Kata Begun. Among the cultivars used in this trail only cultivar Kata Begun were resistant to Fusarium + Nematode wilt. On the other hand cultivar Kazla are susceptible to Fusariun + Nematode wilt where as Nayantara, Singhnath, Dhundul, Kazla, Marich Begun and Uttara are moderately susceptible.

The highest shoot height (69.45 cm) was recorded in the cultivar Kata Begun and the lowest shoot height (41.06 cm) was recorded in the cultivar Singhnath. Cultivar performed diverse shoot weight and it varied from 27.08 g to 73.20 g. The highest shoot weight (73.20 g) was recorded in the cultivar Dhundul. The lowest shoot weight (27.08 g) was recorded in the cultivar Singhnath. The highest root length (22.27 cm) was recorded in the cultivar Uttara and the lowest root lengths (10.35 cm) were recorded in the cultivar Singhnath which was closely followed by the cultivar Dhundul and Nayantara (16.75 cm and 17.36 cm). Root length varied from 8.90 g to 17.36 g. The highest root weight (17.36 g) was recorded in the cultivar Nayantara which was closely followed by the cultivar Kazla (16.35 g) and the lowest root weight (8.90 g) was recorded in the cultivar Uttara. All the cultivars performed medium to highest gall number and it varied from 30.50 to 52.50. The highest gall number (52.50) was recorded in the cultivar Luffa. The lowest gall number (30.50) was recorded in the cultivar Kata Begun.

The average yield per plot varied from 1.97 to 8.95 kg/plot. The highest yield per plot (8.95 kg/ha) was recorded in the cultivar Nayantara and the lowest yield (1.97 kg/ha) was recorded in the cultivar Dhundul. The average yield per hectare varied from 6.57 to 29.84 ton. The highest yield per hectare (29.84 t/ha) was recorded in the cultivar Nayantara and the lowest yield (6.57 t/ha) was recorded in the cultivar Dhundul.

Considering the overall results it may be concluded that cultivar Kata Begun was graded as resistant against Bacterial, Fungal and Nemie wilt among the cultivars used in the experiment. However, further experiment need to conduct including more cultivars available in the country at different agro-ecological zone in the country.

References

REFERENCES

Adams, E., Leach, G. and Robert, J. (1963). Role of certain plant parasitic nematodes in infection of solanaceous plant by *Pseudomonas solanacearum*. *Phytopathology*. **54** : 151- 152.

Ahmed, H. U. and Hossain, M. (1985). Crop disease survey and establishment of herbarium at BARI. Final report of the project (1982-85), Plant Pathology Div. BARI, Joydebpur Gazipur. 107 pp.

Ahmed, M. U. (1977b). A review of plant Parasititic Nematodes in Bangladesh. A paper presented in a seminar in the Imperial College of Science and Technology, University of London, U.K. 3 p.

Alam, S. M. K. and Khalequzzaman, K. M. (2000). Screening of brinjal germ-plasms against bacterial wilt. Plant Pathology Division, BARI, Gazipur, Bangladesh. *Bangladesh-Journal-of-Training-and-Development*. **13** (1-2): 237-242.

Ali, M.I., Ali, M.S., and Rahman, M.S. (1980). Field observation of wilt disease and shoot and fruit borer attack on different cultivars of brinjal. *Bangladesh J. Agril. Sci.* **7**(2):193-194.

Ali, M. Matsuzoe, N. Okubo, H. and Fujieda, K.(1992). Resistance of non-tuberous Solanum to root knot nematode. *J. Japan. Soc. Hort. Sci.* **60**(4): 921-926.

Ali, M., (1993). Workshop on Research and Development of vegetable crops. 9-10 March. 9-10, Institute of Post graduate Studies in Agriculture (IPSA), Gazipur-1703.pp 68-75.

Ali, M.,(1993). Screening and evaluation of brinial varieties against bacterial wilt. Ann. Rept. (1993-1994). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. (198-199).

Ali, M. Alam. M.Z. and Akanda, M.A.M. (1994). Grafting : A technique of control soil borne diseases of tomato and eggplant. IPSA-JICA publication No. 4. Institute of Post graduate Studies in Agriculture (IPSA), Gazipur-1703. Bangladesh. 10 pp.

Anonymous, (1986 a). Studies on the yield loss of brinjal due to root-knot disease. Ann. Rept. (1985-86). Plant Pathol. Div., BARI, Joydebpur, Gazipur. pp. 103-104.

Anonymous, (1987). Annual report (1987-88). Plant Pathology Division, Bangladesh Agricultural Research Institute, Gazipur. Bangladesh.pp 40-106 pp.

Anonymous, (1998). Screening and evaluation of brinial varieties against root-knot disease. Ann. Rept. (1998-99). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 273-274.

Anonymous, (2001). Screening and evaluation of brinial varieties against root-knot disease. Ann. Rept. (2000-2001). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. (198-199).

Armstrong, G.M. and Armstrong, J. K. (1975). Reflection on the wilt Fusaria. Annual Reviews of *Phytopathology.* **13**. 95-103 pp.

Assaduzzaman. M.D. (2000). Races and biovers of *Ralstonia solanacearum* in Bangladesh and its reaction to some crop species. MS. Thesis. BSMRAU. Gazipur.

Avelar, M. J. J. Tehz, O. D. and Zavaleta, M. F. (2001). Pathogens association to 'Guava Decline'. *Revista-Mexicana-de-Fitopatologia.* **19**(2) : 223-229 pp.

Bari, M.A. (2001). Biological Control of soil borne diseases of vegetables. Contract Research Project , Plant Pathology Division, Bangladesh Agril. Res. Inst., Joydevpur, Gazipur. 21-49 pp.

Barnett, H. L. and Hunter, B. B. (1972). Illustrated genera of imperfect fungi. Third edition. Burgess Publishing Company. USA. 126 p.

BBS, (2005). Year Book of Agricultural Statistics of Bangladesh. Statistics Division, Bangladesh Bureu of Statistics (Monthly Statistical Bulletin, Bangladesh, December 2003). Ministry of Planning, Government of the peoples Republic of Bangladesh. 55 p.

Biswas, A. K. (1979). Effect of different organic soil amendment on the development of root-knot disease on *Solanum melongena* at the early growth stage. M. S. thesis, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Bora, L.C. (1993). Screening for resistance against bacterial wilt of brinjal in Assam. *Journal-of-the-Agricultural-Science-Society-of-North-East-India.* **6**: 83-84.

Bose, T. K. and Som, M. G. (1986). Vegetable crops in India. 1st Edn. Naya Prakash. Kalkata. Pp. 262-264.

Buddenhagen, I.W. and Kelman, A. (1986). Biological and physical aspect of bacterial wilt caused by *Pseudomonus solanacearum*. *Phytopathology.* **2**:203-230.

Burgess, L. W. (1981). General ecology of the Fusaria. In: Nelson, P.E.; Toussoun, T.A. and Cook, R.J. (eds) *Fusarium:* Disease , biology, and taxonomy. The Pennsylvania State University Press. University Park. Pp. 225-235.

Burril, T.1. (1890). Preliminary notes upon the rotting of potatoes. Sac. prom. Ag. Sci., Proc. 11th Ann. Meet. **8**: 21-22.

Catalano, F. Vito, M. and Zaccheo. G. (1992). Source for resistance to root-knot nematodes (*Meloidogyne* sp.) in eggplant. Capsicum-Newsletter. Special issue, 301-303; EUCARPIA VIII th meeting on genetics and breeding on capsicum and eggplant, Rome, Italy, 7-10 September 1992.

Chowdhury, B. C. (1976). Phashaler krimi Rog. Krishi Katha. 36:141 pp. V'

Cook, R. 1972. Reaction of some oat culture to *Meloidogyne naasi. Pl. path.*, **21**: 41-43.

Cook, D., Barlow, E. and Sequeira, L. (1989). Genetic diversity of *Pseudomonus solanaceanrm* detection of restriction fragment length pollymorplusm with DNA probes that specify virulence and the hypersensitive response. *Mol. Plant Mic. Inter.* 1:113-121.

Corazza, L. (1998). Fusariosis of winter melon, *Colture-Protette* **27** (5): 39-41.

Das, C.R. and Chattopadhyay, S.B. (1995). Bacterial wilt of eggplant. *Indian Phytopathol.* **62**:130-135.

Das, G. P.; Ramaswamy S. and Bari, M. A. (2000). Integrated crop management practices for the control of the brinjal shoot and fruit borer in Bangladesh. DAE-DANIDA Strengthening Plant Protection Services (SPPS) Project. Dept. of Agril. Extension. Khamarbari, Dhaka. 12pp.

Dube, H.C. (1978). A textbook of fungi, bacteria and viruses. Vikas pubnlishing house pvt Ltd. Gujarat, India. Pp. 200-201.

Haidar, M.G. and Nath. R.P. (2001). Evaluation of brinjal (*Solanum melongena* L.) germplasm for resistance against *Meloidogyne incognita* race-2. *Indian Journal of Nematology*. **31**: 1, 93-94.

Hanudin and Machmud, M. (1994). Effect of bacteria Terlai and *Pseudomonas flurescent* on bacterial wilt of tomato. ACI Bact. Wilt Newsl.10:10.

Hartman, G. L. and Datnoff. (1997). Vegetables Crops. Cited in: Soilborne diseases of tropical crops, eds. R.J. Hillocks and J.M. Waller, CAB International. New York, USA. 165 pp.

Haware, M.P. (1993). Frsarium diseases of crops in India. *Indian Phytopathological society*. **46**(2): 101-109.

Hayward, A.C. (1991). Biology and Epidemiology of bacterial wilt caused by *Pseudomonas solanacearum.* Ann. Rev. *Phytepathol.* **29**:65-87.

Hayward, A. C. and Hartman, G. L. (1994). Bacterial wilt, the disese and its causative agent, *Pseudomonas solanacearum.* Wallingford. 259 pp.

Hillocks, R. J. (1986). Localized and systemic effects of root-knot nematode on incidence and severity of Fusarium wilt in cotton. *Nematologica.* **32**. 202-208.

Hillocks, R. J. and Waller, J. M. (1997b). Association between soilborne pathogens and other soil-inhabiting microorganisms. Cited in: Soilborne diseases of tropical crops, eds. R.J. Hillocks and J.M. Waller, CAB International. New York, USA. 358-359 pp.

Hinata, K. (1986). Eggplant (*Solanum melongena* L.). in : Y.P.S. Bajaj (Ed). Biotechnology in Agricultural and Forestry, Springer Verlag, Berlin, Heidelberg. **2**(1) : 363-370 pp.

Hoque, M.O., Hoq, M.L and Chowdhury, B.C. (1981). Screening tomato varieties for resistance to bacterial wilt. *Bangladesh J. Agric. Res.* **6**(1):55.

Hoque, M.O. (1985). Screening and evaluation of brinial varieties against root-knot disease. Ann. Rept. (1984-1985). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 10-11.

Hoque, M.O. (1985). Screening and evaluation of brinial varieties against bacterial wilt disease. Ann. Rept. (1984-1985). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 9-10.

Hossain, M.S. and Azad, A. K. (1990). Reaction of some potato and brinjal cultivars to *Meloidogyne incognita. Bangladesh J. plant pathol.* 6 (1&2) : 1-3.

Hossain, M. M., Islam, T. and Rahman, S. (1991). A note on the incidence of bacterial wilt of tomato. *Bangladesh J. Agril. Sci.* **18**(2): 291-292.

Islam, M. M. (2005). Management of phomopsis blight and fruit rot of eggplant through chemicals and plant extracts. An M.S. thesis submitted to the Dept. of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-120 7. 60 pp.

Kelman, A. (1953). Bacterial wilt caused by *Pseudomonas solanacearum*. North Carolina Agric. Exp. Stn. Tech. Bull. 99. 194. P.

Khan, M.A. and Mondal, S.N. (1991). Screening and evaluation of brinial varieties against bacterial wilt. Ann. Rept. (1991-1992). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. (198-199).

Khan, A. A., Badshah, K. and Khan, M. W. (1998).Resistance of aubergine cultivars to root-knot nematodes. *Tests-of-Agrochemicals-and-Cultivars*. **19**. 40-41.

Kishan, S. and Sharma, T.V.R.S. (2000). Screening of brinjal (*Solanum melongena* L.) varieties for bacterial wilt resistance and higher yield in Andaman & Nicobar Islands. Central Agricultural Research Institute, Port Blair - 744 101, A & N Islands, *India. Journal-of-Tropical-Agriculture*. **38**: 1-2, 90-91; 6.

Kistler, H.C. and Bentley, S. (1997). Systematic numbering of vegetative compatibility groups in the plant pathogenic fungus *Fusarium oxyporum. The American phytopathological society*. **103** :1-10.

Kolte, S.J. (1985). Diseases of Annual Edible Oilseed Crops, Vol. ii, CRC Press, Boca Raton, Florida. USA. 135 p.

Kulthe, D.V. and Pedgaonkar, S.M. (1991). Studies on individual and concomitant effect of wilt, dry root rot, and nematode pathogen in disease development of safflower. *Indian Phytopathology*. 44 (Suppl.), (abstr. 92).

Lopes, C.A., Buso, J.A. and Accatino, P. (1997). Screening of Auberins for resistance to bacterial wilt in Brazl: Methods and Preliminary Results. ACIAR Bact. Wilt Newsl,9:3.

Lue, M. Sikora R. A. and Bridge, J. (1990). Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International. Wallingford. UK. 629 pp.

Mathew, S. K.GopalakrishnanT. R. and Singh,P. K.(2000). Evaluation of brinjal varieties for yield and resistance to bacterial wilt (*Ralstonia solanacearum*). *Journal-of-Tropical-Agriculture.* **38**: 1-2, 15-17.

Miah, M.J. (1986). Screening and evaluation of brinial varieties against bacterial wilt. Ann. Rept. (1986-1987). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. (119-120).

Mian, I. H. (1986). Plant parasitic nematodes associated with some crop species in Bangladesh. *Bangladesh J. Plant Path.* **23**: 73.

Miller, S. A.; Rowe, R. C. and Riedel, R. M. (2005). Fusarium and Verticillium Wilts of Tomato, Potato, Pepper and Eggplant, Factsheet, The Ohio State University Extension, 2021 Coffey Road, Columbus, USA.

Mochizuki, H. and Yamakawa, K. (1979a). Resistance of selected eggplant cultivars andrelated wild *Solanum*` species to bacterial wilt *(Pseudomonas solanacearum*) Bull.Veg. and Ornams. *Crops Res. Stn. Ser.* **6**:1-1.

Mochizuki, H. and K.Yamakawa. (1979 b). Potential utilization of bacterial wilt resistant Solanum species as root stocks for eggplant production Bull. Veg. Ornam. *Crops Res. Stn Ser.* **6**: 1-10.

Nishio, E., Sato,T. and Matsunaga, H. (1997). Evaluation of resistance to bacterial, Fusarium and Verticillium wilt in eggplant. *Capsicum-and-Eggplant-Newsletter.* **15** : 71-72

Nonnecke, J.L. (1989). Vegetable Production. Van Nostrand Reinhold, New York. 247 p.

Okubo, H. Quadir, M. A.. Ali, M and Fujieda, K. (1990b). Resistance of eggplant / tomato, its wild relatives and their hybrids to different strains of *Psedomonas solanacearum. Scientia Hort.* **45** :1-9 pp.

Peter, K.V., Goth, R.E. and Webb,R.E. (1987) Indian hot peppers as new sources of resistance to bacterial wilt, *Phytopthora* root-rot, and root-knot nematodes. *Horti. Sci.* **19**: 277-278.

Ponnuswami, V., (1997). Screening for bacterial wilt resistance in brinjal. *Capsicum-and-Eggplant-Newsletter.* **16**: 115-117.

Ponnuswami, V. (1998). Inoculum concentration, seedling age and B.W. severity to standardize screening in eggplant. *Capsicum-and-Eggplant-Newsletter.* **17**: 80-83.

Prakash, S. Shivashankar, K. T. and Gowda, P. H .R. (1994). Assessment of resistance to bacterial wilt disease in brinjal (*Solanum melongena* L.). *Karnataka-Journal-of-Agricultural-Sciences.* **7** (3): 273-276.

Rahman, M.A. and Hoque, M.O. (1986). Screening of eggplant varieties/lines against bacterial wilt. *Bangladesh. Plant Pathol.* **2**(1): 15- 18.

Rahman, M. A. (1997). Infection and some aspects of Resistance mechanism of *Capsicum annum* to *Ralstonia solanacearum*. Ph. D. thesis. BARI, Gazipur, Bangladesh.

Rahman, M. A. Sultana, N. and Rashid, M. A. (2004). Screening and evaluation of brinial varieties against root-knot disease. Ann. Rept. (2002-2003). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 173-174.

Rangaswami, G.(1988). Disease of crop plants in India. 3rd Edn. Prentice-Hallof India Pvt. ltd., New Delhi. 289 p.

Rashid, M. M. (1976). "Bangladesher Sabji" 1st Edn., Bangla Academy, Dhaka Bangladesh. 119-136 pp.

Rashid, M.A., M.S. Ahmed, N.S. Mondol, and M.A. Ahad. (1985). Screening of eggplant germplasm against bacterial wilt in Bangladesh. *Bangladesh Horti.* **13**(1 &2) : 40-44.

Rashid, M. (1993). Sabjee Bighan. Published by Bangla Academy, Dhaka.137-144 pp.

Rashid, M. M. (2000). A Guidebook of Plant Pathology. Dept. of Plant Pathology. HSTU. Dinajpur. 58pp.

Rashid, M.A. (2000). Screening and evaluation of brinial varieties against Bacterial wilt disease. Ann. Rept. (2000-2001). Horticulture research center. Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 2.

Rashid, M. A. (2001). Screening and evaluation of brinial varieties against root-knot disease. Ann. Rept. (2000-2001). Horticulture research center. Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 1.

Rashid, M.A. (2002). Screening and evaluation of brinial varieties against Bacterial wilt disease. Ann. Rept. (2001-2002). Horticulture research center. Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 2.

Rashid, M. A. (2002). Screening and evaluation of brinial varieties against root-knot disease. Ann. Rept. (2001-2002). Horticulture research center. Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 1.

Reddy, P.P. (1986). Analysis of crop losses in certain vegetables due to *Meloidogyne incognita. Int. Nematol.Net.Newsl.***3**(4):3-5.

Reddy, K.M and Sadashiva, A.T. (2001). Evaluation of eggplant (*Solanum melongena* L.) lines for bacterial wilt resistance. *Capsicum-and-Eggplant-Newsletter.* **20** : 117-119

Roberts, D. A. and Boothroyd, C. W. (1972). Fundamentals of Plant Pathology, Toppan Company Limited, Tokyo, Japan. 239-343 pp.

Saxena, S. K., and Singha, S.K. (1984). Interactions between *Meloidogyne incognita* and *Pseudomonas solanacearum* on brinjal. *Indian J. Nematol.* 14:1-5.

Saxena, S. K., and Singh, S.P. (1985). Reaction of different vegetables to root-knot nematode *Meloidogyne incognita* and their effect of the morphometrics of nematode. *Indian J. Nematol.* **15** (1) : 33-35.

Shetty, K.G.H. and Ravichandra, N.G. (1988). Evaluation of brinjal (*Solanum melongena* L.) germplasm resistance against *Meloidogyne javanica* and race-1, race-2 and race-3 of *M. incognita*. *Indian-Journal-of-Nematology.* **18**(2) : 165-174.

Sharma, J. P. and Prasad, V. S. R. K.(1995). Differential reaction and source of resistance to wilt caused by *Pseudomonas solanacearum* in brinjal (*Solanum melongena*). *Indian-Journal-of-Agricultural-Sciences.* **65**(9) : 686-690.

Sharma, J. P. (2000). Evaluation of resistance to wilt caused by *Pseudomonas solanacearum* in brinjal (*Solanum melongena*). *Indian-Journal-of-Agricultural-Sciences.* 186-187pp.

Sherf, A. F. and MacNab, A. A. (1985). Vegetable Disease and Their Control. 2nd edn. John Wiley, New York.

Singh, R. S. and Sitaramaiah, (1994). Plant Pathogens, The Nematodes. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. India. 175-177 pp.

Singh, B. (1995). Bacterial wilt of Potato: A new record in India. *Indian Phytopathol.*45.

Singh, R. S., Singh, D. and Singh, H. V. (1997). Effect of fungal antagonists on the growth o chickpea plants and wilt by *Fusarium oxysporum f. sp. ciceri. Plant Dis. Res.* **12**(2): 103-107 pp.

Singh, P.K. and Gopalakrishnan T.R. (1998). Evaluation of brinjal genotypes for yield and bacterial wilt resistance. *Journal-of-Applied-Biology.* **8**(1) : 70-74.

Sultana, N. Rahman, M. A. and Rashid, M. A. (2003). Screening and evaluation of brinial varieties against root-knot disease. Ann. Rept. (2003-2004). Plant Pathol. Div., Bangladesh Agricultur Research Institute (BARI), Joydebpur, Gazipur. pp. 2-3.

Swanepoel, A.E. (1990). The effect of temperature on the development of wilting and on progeny tuber infection of potatoes inoculated with South African strains of biovar 2 and 3 of *Pseudomonas solanacearum*. *Potato Res*. **33**:287-190.

Talukdar, M. J. (1974). Plant diseases in Bangladesh. *Bangladesh. J. Agril. Res*. 1(1):71.

Timm, R.W. and Amen, M. (1960). Nematodes Associated with commercial crops in East Pakistan. *Agric Pak.* **11**(3) : 355-363.

Ushamani, P. and Peter. K.V. (1987). Field resistance of brinjal to bacterial wilt. *Agricultural-Research-Journal-of-Kerala*. **25**(1) : 133-135.

Van Gundy, S. D. and Tsao, P. H. (1963): Growth reduction of citrus seedlings by *Fusarium solani* as influenced by the citrus nematode and other soil factors. *Phytopathology*. **53** : 488-89 .

Walker, J.C. (1969). Plant pathology. 3rd Edn. Mc Graw- Hill Book Co., New York. 299 pp.

Winstead, N.N. and A. Kelman. (1960). Resistance to bacterial wilt in eggplant in North Carolina. *Plant Dis. Reptr*. **44**: 432-434.

Yamakawa, K. and Mochizuki, H. (1978). Studies on the use of disease resistance of wild non-tuberous *Solanum* species in breeding of eggplant. Absract No. 1674, 20 th Int.Cong. Hort. Meeting, Sydney, Australia.

Yabuuchi, E., Kosako, Y.and Oyaizu, H.(1992) Propsal of *Burkholdderia* Gen Nov and transfer of seven species of Genus *Pseudomonas* Homology Group II to the new Genus, with the type species *Burkholderia cepacia*. Comb No. *Microbiol. Immun.*36:1251-1275.

Zevan, A.C. and Zhukivsky, P.M. (1975). Dictionary of cultivated plants and their centers of diversity, Wagenigen. P. 219.

APPENDIX

Appendix 1. Analysis of variance of the data on Bacterial wilt incidence on different eggplant varieties

Source of variation	Degrees of freedom	Mean Square			
		Bacterial wilt incidence (%)			
		25 DAT	35 DAT	45 DAT	55 DAT
Replication	2	0.292	0.298	0.167	1.625
Treatment	7	219.76**	592.26**	177.43**	435.61**
Error	14	0.577	0.577	0.357	2.292

** Significant at 0.01 level of probability

Appendix 2. Analysis of variance of the data on Fusarium + Nematode wilt incidence of different eggplant varieties

Source of variation	Degrees of freedom	Mean Square			
		Fusarium + Nematode (%)			
		50 DAT	65 DAT	80 DAT	95 DAT
Replication	2	0.042	0.078	0.125	4.292
Treatment	7	291.143**	317.214**	658.04**	723.76**
Error	14	0.089	0.089	0.220	3.435

** Significant at 0.01 level of probability

Appendix 3. Analysis of variance of the data on Yield contributing characters from wilt infected different eggplant varieties

Source of variation	Degrees of freedom	Shoot height/ plant (cm)	Shoot weight/ plant (g)	Root length (cm)	Root weight (g)	Average Gall number
Replication	2	0.371	0.802	0.125	0.042	0.125
Treatment	7	399.14**	688.299**	40.260**	32.021**	174.613**
Error	14	0.796	1.281	0.216	0.090	0.220

** Significant at 0.01 level of probability

Appendix 4. Analysis of variance of the data on Yield from wilt infected different eggplant varieties

Treatments	Degrees of freedom	Yield (Kg/plot)	Yield (t/ha)
Replication	2	0.125	0.125
Treatment	7	1258.15**	1258.15**
Error	14	1265.0	1265.0

** Significant at 0.01 level of probability

Appendix 5. Nutritive components in 100 gm of edible portion of eggplant

Components	Composition
Calories	24.0
Moisture (%)	92.7
Carbohydrates (g)	4.0
Protein (g)	1.4
Fat (g)	1.3
Oxalic acid (mg)	18.0
Calcium (mg)	18.0
Magnesium g	47.0
Iron (mg)	0.9
Sodium (mg)	3.0
Copper (mg)	0.17
Potassium (mg)	2.0
Sulphar (mg)	44.0
Chlorine (mg)	52.2

Source : Internet (www. Agridept.gov.lk)

Appendix 6. Composition of Potato Dextrose Agar (PDA)

Components	Composition
Potato (Peeled -and sliced)	200g
Dextrose	20g
Agar	20g
Water	1000ml

Appendix 7. Monthly mean of daily maximum, minimum and average temperature, relative humidity, total rainfall and sunshine hours during December/2005 to March/2006

Month	**Temperature(°C)			**Relative Humidity (%)	*Rainfall (mm)	*Sunshine (hrs)
	Max.	min.	Ave			
December	27.1	15.7	21.4	64.0	Trace	212.5
January	25.3	18.2	21.8	67.6	00	195.2
February	31.3	19.4	25.33	61.3	00	225.5
March	33.2	22.0	27.6	48.5	Trace	220.4

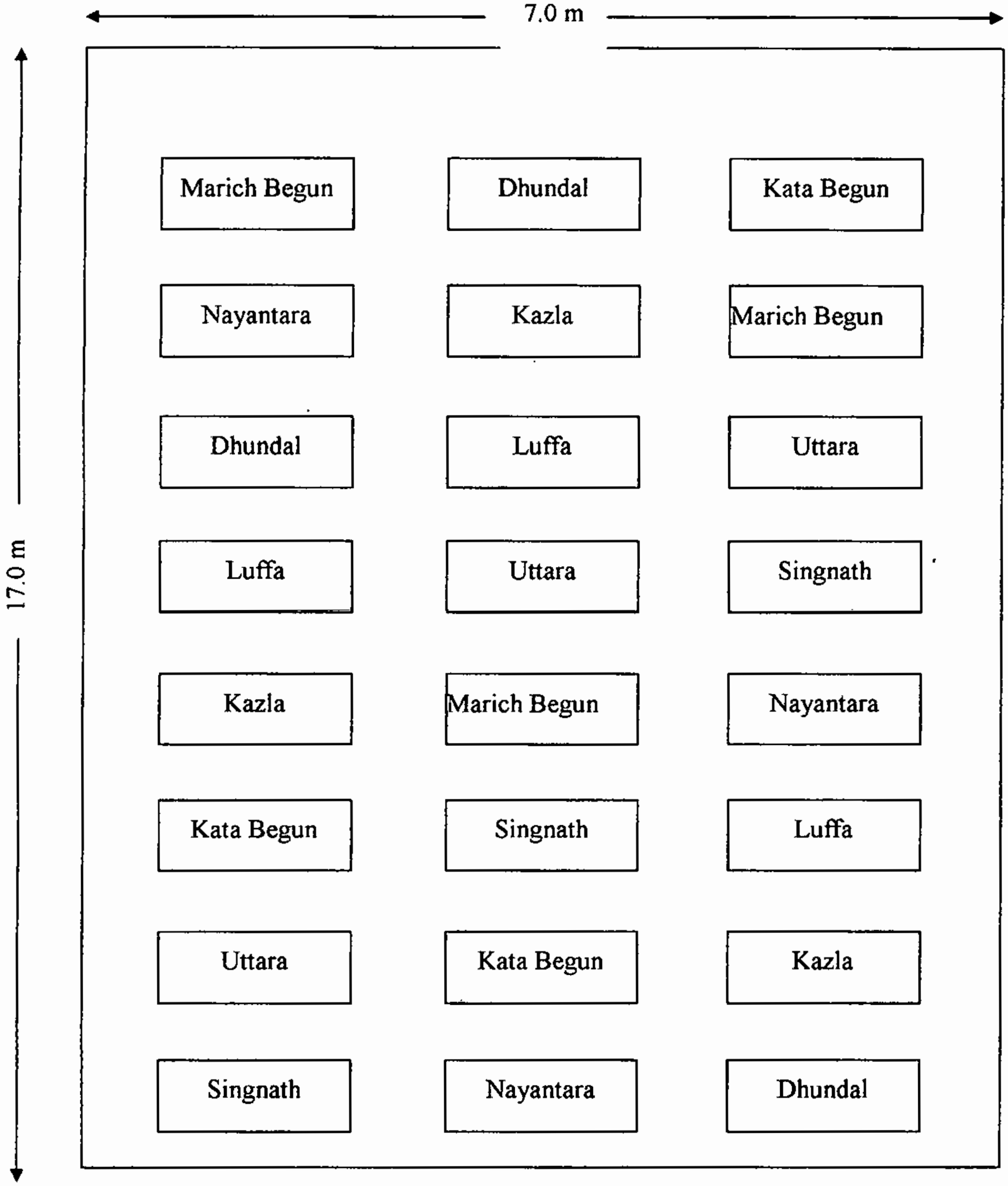
Source: Station name: PBO, Dhaka, Station no: 41923, Surface synoptic data card, Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dhaka-1207.

*= Monthly total

* *= Monthly average

Appendix 8. Layout of the experimental field (RBD)

Plot Size	: 3.0m ×1.0m
Distance between	
Plot to plot	: 1.0 m
Block to Block	: 1.0 m



Layout of the experiment