INVESTIGATION ON NURSERY AND FIELD DISEASES OF ROSE (*Rosa* spp.) IN SELECTED AREAS OF BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled **"Investigation and Survey on Nursery and Field Diseases of Rose (*Rosa* spp.) in Bangladesh"** submitted to the department of Plant Pathology, faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-bangla nagar, Dhaka-1207, in partial fulfillment of the requirements for the degree of **Master of Science (MS) in PLANT PATHOLOGY**, embodies the result of a piece of bona fide research work carried out by **Suraiya Tahmida Chhanda**, Registration No.: **12-05163,** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June, 2019

Place: Dhaka, Bangladesh

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DEDICATED TO
MY ALL BELOVED

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ABSTRACT

Three experiments were conducted for investigation and survey on diseases of rose during January 2018 to April 2019. Six nurseries of Savar and Agargaon were investigated for nursery diseases. Field investigation was conducted in Jashore, Dhaka and Manikganj districts of Bangladesh. Eighteen villages from 4 Unions of Jhikorgacha Upazila of Jashore district, two villages from Savar upazila of Dhaka and two villages from Singair upazila of Manikganj were selected for investigation. The disease incidence and severity were recorded under natural epiphytic conditions. Eleven diseases were recorded and identified in field conditions viz. leaf spot, black spot, leaf blight, flower blight, powdery mildew, mosaic, dieback, stem dry rot, dry brown spot, foot rot, and rust disease. The major mycoflora associated with these diseases were *Pestalotia guepinii., Alternaria* spp., *Botrytis cinerea, Penicillium* sp., *Cercospora* sp. *Cladosporium* sp., *Epicoccum purpurescens, Nigrospora sp., Curvularia lunata* and *Podosphaera pannosa* (*Oidium* sp.). However, the powdery mildew disease caused by *Podosphaera pannosa* (*Oidium* sp.) became major disease in recent years in Jashore. The incidence and severity of diseases of rose varied significantly among the locations. Depending on the disease incidence and severity, the major diseases of rose were black spot, leaf spot, leaf blight, flower rot and powdery mildew. In leaf spot disease, the highest disease incidence and severity were recorded in Panisara (43.33%) and Singair (11 %), respectively. In case of black spot disease of rose the highest disease incidence and severity were recorded in Singair that were 86.33% and 25.00%, respectively. The highest leaf blight incidence was 61.67% recorded in Kulia and the highest severity was observed in Singair which was 9%. In flower blight disease, both highest disease incidence and disease severity was recorded in Godkhali which were 95% and 33.33%, respectively. The both highest disease incidence and disease severity of powdery mildew were recorded in Godkhali which were 98.33% and 30%, respectively. Three diseases viz. dry brown spot, stem dry rot and foot rot of rose was recorded in Jashore. Apart from this, a survey was carried out on the socio-economic status of rose farmers and problem related rose cultivation in Bangladesh. Altogether, 63 farmers were interviewed in Jashore, Dhaka and Manikganj district of Bangladesh. This study revealed that the highest percent of farmers came from the age group of 30 to 40 years and had secondary level of education. Most of the farmers express their opinion about positive relationship among insect pest, disease and weed infestation in the rose field.

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LIST OF ABBREVIATIONS

Full word	Abbreviations
Agro-Ecological Zone	AEZ
And others	*et al.*
Bangladesh Bureau of Statistics	BBS
Centimeter	cm
Coefficient of Variance	CV
Degree Celsius	°C
Etcetera	etc.
Gram	g
Kilogram	Kg
Least Significant Difference	LSD
Meter	m
Millimeter	mm
Percentage	%
Videlicet (namely)	viz.
Disease incidence	DI
Disease severity	DS
Hectare	ha
Kilogram per hectare	Kg/ha
Cost per bigha per year	Cost/bigha/year
Production per bigha	Production/bigha
Taka per bigha	Tk/bigha
Asia Farming Rose Cultivation Information Guide	AFRCIG
International Floriculture Trade Statistics	IFTS

CHAPTER I

INTRODUCTION

Flowers have gained an important position in society in present day. Flowers are used in the manufacturing of green tea, perfumes, essential oils and many other products (Dadlani, 2003). The flower market is an ever growing market in the world. Nowadays, floricultural production ranks 4th behind petroleum, coffee, and bananas in export earnings (BCMAFF, 2003). There are more than 90 countries which are active in world floriculture (IFTS, 2004). In the present world flowers become important not only for its aesthetic social value, but also for its economic contribution (Aditya, 1992). The floral industry is one of the major industries in many developing and underdeveloped countries. Bangladesh is not an exception.

Bangladesh is one of the largest flower growing countries in South-East Asia. In Bangladesh, large-scale commercial production started from mid eighties in Jhikargacha upazila of Jashore district (Sultana, 2003). Later it speeded largely in Jashore, Savar, Chuandanga, Mymensingh and Gazipur which turned to be the major flower production belt in Bangladesh. Cultivation of flower is reported to give 3-5 times and 1.5-2 times more returns than obtained from rice and vegetable cultivation, respectively (Dadlani, 2003).

At present, 10,000 hectares of land covers flower cultivation taking the lead by Jashore district. More than 5,000 resilient farmers are growing flower and foliage in the country and about 150,000 people are directly or indirectly involved in floriculture business as their sole livelihood (Chowdhury, 2010). Approximately 8,000 farmers are involved in flower cultivation and 2000 to 3000 farmers in ornamental plants on commercial basis. About 100,000 to 120,000 people are directly or indirectly involved in floriculture industry for their livelihoods. The employment generation for both men and women are increasing with the increase in area at about 15.79% per year under floriculture industry. The area coverage under commercial flower cultivation is approximately 10,000 hectares of land while commercial nurseries have covered approximately 2,000 to 2,500 hectares of land (Momin, 2006). Different flowers including marigold, tuberose, rose, gladiolus, gerbera and chrysanthemum are grown commercially. The country earned USD 1,530.22 from exports of cut flowers in the fiscal year 2015-2016 (The Financial Express, Sep-2016). Flower society of Godkhali (Jashore) reported that flower of about USD 54 crores are produced in Godkhali, Jashore alone every year and the total flower business amount stands at USD 100 crores. Gross margins of flower per hectare were Tk.1,359,824.20 (Rakibuzzaman *et al.*, 2018). Among all flowers cultivated in Bangladesh, rose has a great importance. People usually use flowers in all their ceremonies like wedding, birthday and marriage day greetings, religious offerings and sometimes in social, political and historical occasions.

Rose (*Rosa* spp.) is a woody perennial flowering plant of the genus *Rosa,* in the family Rosaceae. There are over 200 species and more than 18000 cultivars of roses (Gudin, 2000). The spiny bushes are not so impressive. Rose is an economically important horticulture crop cultivated throughout the world and is generally referred as king of flowers (Boskabady *et al.*, 2011). Rose can be grouped into 3 classifications according to their growth characteristics. They are bush roses, shrub roses and climbing roses (AFRCIG, 2018).

Rose has great value in perfume industry. Rose syrup is mostly made from an extract of rose petals. Rose hips are occasionally used in jam, jelly and marmalade for high vitamin C content. Its rose herbal tea is used in the treatment of cold and cough. Rose cultivation is now a profitable enterprise to the farmers, but the socioeconomic data and information of this flower are very scarce in Bangladesh. There is a shifting tendency towards sourcing floricultural products from developing countries like Bangladesh, India and Pakistan (Yasin *et al*., 2016). This is due to the increasing labour and energy costs in Europe. *Rosa* spp. are cultivated throughout the country as garden plant. Roses provide high revenue to farmers and increase employment opportunities (Mari *et al*., 2007). It is commercially and aplenty grown at Godkhali in Jashore, Kaligonj, Maheshpur and Nepa in Jhenaidah, Jibonnagar in Chuadanga, Savar in Dhaka and in Manikgonj, Gazipur, Bogra, Rangpur and Chittagong districts (Haque *et al.*, 2013). The major production is concentrated at Godkhali in Jashore which covered about 60% of total flower production. The area of flower production in Bangladesh at present is rather small. Now around 10000 ha areas are under flower cultivation. The area under commercial rose cultivation is 111 ha producing around 2423 tones with an average yield of 21.92 ton/ha. Every day farmers trade of around Tk. 2 lakh in the local market. Among the cut flower rose contributes the maximum. In the FY 2012-2013, cultivation of Rose occupied an area of 189 acres which expanded to 281 acres within FY 2013-14 (BBS, 2015).

Although rose cultivation was observed as profitable crop, there are several constraints to its production. The constraints are- lack of scientific knowledge and modern technology of flower cultivation, weak networks, insufficient stock of fertilizer and pesticides, stealing, flower damage by animals, and spoilage, disease and insects infestation including different biotic and abiotic disorders. Rose crop is subjected to a number of insect pest and fungal diseases (Gullino and Garibaldi, 2005). Diseases are an important reason for losses in agricultural crop commodities. It is estimated that world faces nearly 13% losses in agriculture produce because of plant diseases (Fletcher *et al*., 2006). More than 80% plants diseases are caused by nasty fungal pathogenic microbes. Therefore, fungal diseases cause a severe reduction in production and subsequently lower economic return to grower (Riaz *et al*., 2007). The Rose plants are affected by fungal diseases along with bacteria, virus, nematodes and pests. The common fungal diseases are *Alternaria* leaf spot, black mold, black spot, botrytis blight, brown canker, cane blight, canker, *Cercospora* leaf spot, common stem canker, crown canker, downy mildew, fungal canker, graft canker, powdery mildew, rust, *Septoria* leaf spot, anthracnose and *Verticillium* wilt. Some abiotic disorders of rose are nutrient deficiencies, nutrient excesses, pesticidal and herbicidal damages, winter injury, sunburn etc. (Shamsi *et al.*,

2013). In Bangladesh, the most common diseases of this plant is *Botrytis* blight (*Botrytis cinera*), Cercospora leaf spot (*Cercospora puderi*), rose mosaic (*Rose mosaic virus*), black spot (*Diplocarpon rosae*), die-back (*Botryodiplodia theobromae*), *Alternaria* leaf spot (*Alternaria alternata*) and stem canker (*Crytosporella umbrina*). In the world, at least 48 fungal species are reported, that are capable of causing rose diseases (Islam *et al.*, 2010).

These diseases can be classified as fungal disease, bacterial disease, viral disease, nemic disease and nutritional disorders. The seedling and nursery diseases are crown gall (*Agrobacterium tumifaciens*), black spot (*Diplocarpon rosae, Marssonina rosae*), rose mosaic (*Rose mosaic virus*). Field diseases can be grouped as fungal, bacterial, viral and nemic diseases. Fungal diseases are black spot (*Diplocarpon rosae, Marssonina rosae*), powdery mildew (*Sphaerotheca pannosa, Podoaphaera pannosa*), downey mildew (*Peronospora sparsa*), rust (*Pragmidium mucronatum*), anthracnose (*Sphaceloma rosarum*), grey mold (*Botrytis cinerea*), *Verticillium* wilt (*Verticillium dahlia*), sooty mold (*Alternaria spp.*), canker (*Coniothyrum spp., Cryptosporella umbrina*), *Alternaria* leaf spot (*Alternaria spp*), *Cercospora* leaf spot (*Cercospora spp*) and *Septoria* leaf spot (*Septoria spp*). Bacterial diseases are bacterial leaf spot (*Pseudomonus syringae pv. mors-prunorum*), crown gall (*Agrobacterium tumifaciens*) and hairy root (*Agrobacterium rhizogens*). The Viral diseases are rose mosaic [*Rose mosaic virus* (RMV)], rose rosette / witch's broom [*Rose rosette virus* (RRV)], Rose streak [*Rose streak virus* (RSV)] and strawberry latent [*Strawberry latent ringspot virus* (SLRV)]. Some Nemic diseases are dagger (*Xiphinema spp., Xiphinema diversicaudatum*), lesion (*Pratylenchus penetrans, Pratylenchus vainus*), ring (*Criconemella axesta*), root knot (*Meloidogyne hapla*), spiral (*Helicotylenchus nannus, Rotylenchus spp.*) and stunt (*Tylenchorhynchus spp.*). And some of miscellaneous diseases and disorders are rose flower proliferation, rose spring dwarf, rose wilt, nitrogenous deficiency disorder and excessesive nitrogenous disorder (Yasin *et al*., 2016).

Among these deadly diseases black spot is more acute in Bangladesh. Black spot caused by the fungus *Diplocarpon rosae* (imperfect stage *Marssonina rosae*), is one of the most common and persistent diseases of rose (Dobbs, 1984; Horst, 1990). It is the most serious disease of roses that reduces the number of flowers, marketable value of flowers, plant vigour and the life of plant (Xue *et al.*, 1998). The black spot fungus overwinters as mycelia or spores in infected canes and leaves. In the spring, overwintering mycelia or spores cause primary (initial) infections on new shoots and leaves. Within about two weeks after primary infections, fruiting structures form within lesions and produce spores which cause secondary infections throughout the growing season (Stephen *et al*., 2007). Spore bearing structures are called acervuli (Yonghao, 2016).

Powedery mildew (*Podosphaera pannosa*) is worldwide one of the most important diseases on indoor and outdoor grown plants. The fungus is an obligate parasite (Sivaplana, 1993; Sivaplana, 1994). Powdery mildew can cause complete defoliation of plant. Epidemics can be expected any time during the growing season when the rainfall is low or absent. The days are warm, dry and the nights are cool and damp. In the spring,

new shoots of garden roses are dwarfed, distorted and covered with a whitish gray mildew growth. These mildew growth over expanding leaves are first appears on the upper surface of the leaves (Ronald, 2010).

In leaf spot of rose, different mycoflora are associated. They can be divided as *Alternaria* leaf spot, *Cercospora* leaf spot and Bacterial leaf spot. A preliminary account of a severe leaf spot disease of Rose associated with an undetermined species of *Alternaria* (Rao, 1964). On the basis of morphology and host-specificity it was designated as *A. tenuis* var. *rosicola*. The fungus was found doing much damage to the foliage of Rose and severe defoliation. It also caused blossom blight. The disease was mainly occurred during the rainy and winter seasons (June to December) but disappeared in summer season due to prevailing high temperatures. The disease is highly favoured by high humidity and moderate temperatures often becoming destructive inciting severe type of defoliation (Horst, 1990).

The *Cercospora* leaf spot of rose is caused by *Cercospora rosicola* (*Mycosphaerella rosicola*, sexual stage) (Davis, 1938). *Cercospora* leaf spot also causes severe leaf loss in heavily infected plants. Symptoms are circular spots, usually 2-4 mm in diameter, but some can be as large as 10 mm in diameter. The spots are characterized by the appearance of numerous tiny maroon to purple oval leaf spots that are scattered randomly across the leaf surface (Hagan and Mullen, 2000). As the disease progresses, the spot will grow larger. Later, the center of these spots turn tan to almost gray in color while the margin of the spot remains maroon to dark purple. Heavily spotted leaves turn yellow and are prematurely shed. Typically, leaf loss begins at the base of the canes and gradually spreads upwards through the canopy towards the shoot tips. Lesions are primarily found on leaves but can also be found on other parts of the plant. Growth of shrub roses is heavily defoliated by *Cercospora* leaf spot disease (Hagan *et al*., 2005).

Bacterial leaf spot on rose usually caused by *Pseudomonas syringe* and *Xanthomonas campestris*, which can infect a wide range of Rosacea family. The symptoms of bacterial leaf spot was dark brown, sunken spots appear on leaves, flower stalks, and calyx parts. Flower buds may die without opening. Black streaks appear on 1 year old stems (Pscheidt and Rodriguez, 2018). Spots form between leaf veins mostly giving rise to angular or square-shaped dead spots bordered by leaf veins. Chlorosis of leaves occurs when many spots form and leaflet drop can be common (Greenheart, 2019).

Flower blight disease caused by *Botrytis cinerea*. *Botrytis cinerea* is a destructive pathogen of roses grown as cut flowers (Hammer and Evensen, 1996; Tatagiba and Elad 1998). The pathogen colonizes petals causing lesions that reduce both yield and quality (Volpin and Elad, 1991). During periods of cool and wet weather, Botrytis blight frequently develops on roses. The disease may affect flowers which may not open. Sometimes the disease is observed as small flecks on infected petals. At the base of infected flowers, sunken, grayish-black spots (lesions) may be found on the stems and the lesions may continue down the cane. Damage is often associated with wounds where flowers have been cut or the plants have been pruned. The fungus forms oval, one-celled

conidia (spores) which form in a cluster. The pathogen also forms sclerotia (infectious propagules) which appear as black, flattened or slightly raised structures on the plant surface (Digital Diagonostics, 2019). Sclerotia are collectively considered the most important survival structures of *Botrytis cinerea* (Coley, 1980) and important initial inoculum for Botrytis blight epidemics (Sutton, 1990).

Six fungal species were associated with leaf blight symptom of *Rosa spp*. The fungi were *Alternaria alternata, Aspergillus flavus, Cladosporium cladosporioides, Penicillium* sp., *Pestalotia guepinii* and *Trichoderma viride* (Ghosh and Shamsi, 2014). Circular black spots are the main symptom of rose leaf blight. These spots develop only on the upper surface of leaves. Rose leaf blight differs from other leaf spot diseases in that the edges of the spots are irregular and jagged. Spots are most often surrounded by a mottled yellow discoloration. Advanced infections produce elevated reddish-purple blemishes on the rose's newest stems. Rose leaf spot eventually causes premature leaf drop and stunted growth (Home Guides, 2019).

Anthracnose is a fungal disease caused by *Sphaceloma rosarum* which affects many plants, including roses (Cheewangkoon *et al*., 2009). Anthracnose can be recognized by the grayish-brown sunken spots that develop on the plant. Initially, lesions are small, round, reddish-purple spots. The centers of the spots eventually turn gray or white, with red margins. Tissue may drop out or crack in the center of the spots, giving infected leaves a shot-hole appearance. Lesions can also develop on petioles and stems. The fungus produces microscopic spore-bearing structures in the lesions (Griep, 2015).

Several fungi are capable of causing stem canker and dieback of roses. The responsible fungus is *Coniothyrium* spp. Brown cankers begin as spots ranging in color from yellow to purple, depending on the causal fungus. The developing cankers become sunken, forming wrinkled or cracked lesions that are tan to black. Canker margins are brown to reddish purple. Cankers often enlarge until the stem is girdled. Once the stem is girdled, the foliage above the canker wilts and dies. Cankers that form at the graft union usually result in plant death (Randy, 2013). Small black pycnidia can be seen in the cankered area (Pscheidt and Rodriguez, 2018).

Rose rust disease is caused by *Phragmidium mucronatum*. It forms small orange pustules (aecia) appear early in spring on both leaf surfaces. Later, the pustules enlarge and become more numerous on lower leaf surfaces. Mottled and chlorotic areas may develop on upper leaf surfaces opposite the spots (uredinia) on the lower surfaces. In late summer and fall, the small pustules turn black (telia) and contain the winter spore stages of the rust. The stems occasionally are infected (Pscheidt and Rodriguez, 2018). The teliospores overwintered in black pustules on dead leaves and stems, germinate and produce basidiospores as the part of their disease cycle. The basidiospores are carried by air currents and infect nearby young rose leaves and stems (RHS, 2019).

Rose mosaic disease is one of the most economically important diseases of roses. It is generally associated with mixed infections of viruses that belong to two taxa named

Ilarvirus and *Nepovirus*. Within the genus *Ilarvirus*, the most common are *Prunus necrotic ringspot virus* (PNRSV) and *Apple mosaic virus* (ApMV) (Paret *et al.*, 2014). The symptoms associated with rose mosaic are highly variable and depend primarily upon the rose cultivar, virus complex, and the environment (Manners, 1985). Some of the more common foliar symptoms include chlorotic line patterns, ring spots, yellow vein banding and puckering, severe distortion of leaves, mild mottling of the leaves, mottling symptoms, and intense yellow spot. Infected plants have decreased vigour, reduced blossom quality and quantity, reductions in transplant survival rates, early autumn leaf drop, and are more susceptible to winter-kill (Cochran, 1972, 1982 & 1984; Secor *et al*., 1977; Thomas 1982 & 1984). The major source of rose mosaic virus disease transmission occurs through the budding or grafting of infected buds or scions onto healthy plants (Manners, 1985).

Considering above fatcs and points this research work is designed to achieve the following objectives:

1. To detect and identify the nursery and field diseases of Rose in selected areas of Bangladesh;
2. To measure the incidence and severity of diseases of Rose in selected areas of Bangladesh; and
3. To survey on socio-economic status of Rose growers and disease problems related to rose cultivation in selected areas of Bangladesh.

CHAPTER II

REVIEW OF LITERATURE

Rose is one of the most important flowers among all flowers cultivated in Bangladesh. Many diseases attack in this flower. Very few research works directly has been carried out in this area in Bangladesh. There is also a very limited significant research works on diseases of Rose plant in the South Asia. However, research works are found regarding diseases of rose plants in the world. The literatures on diseases of rose and their pathogens are accumulated in this section. This chapter is to review the previous studies that are related to the present study. The review of some related studies are described below:

2.1. Flower Cultivation in Bangladesh

According to Rakibuzzaman *et al*. (2018), the country earned USD 1,530.22 from exports of cut flowers in the fiscal year 2015-2016 (The Financial Express, Sep-2016). Flower society of Godkhali (Jashore) reported that flower of about USD 54 crores are produced in Godkhali alone every year and the total business amount stands at USD 100 crores. Gross margins of flower per hectare were Tk.1,359,824.20.

Chowdhury (2010**)** reported that, 10,000 hectares of land covers flower cultivation taking the lead by Jashore district. More than 5,000 resilient farmers are growing flower and foliage in the country and about 150,000 people are directly or indirectly involved in floriculture business as their sole livelihood.

Momin (2006) reported that approximately 8,000 farmers are involved in flower cultivation and 2000 to 3000 farmers in ornamental plants on commercial basis. About 100,000 to 120,000 people are directly or indirectly involved in floriculture industry for their livelihoods. The employment generation for both men and women are increasing with the increase in area at about 15.79% per year under floriculture industry. The area coverage under commercial flower cultivation is approximately 10,000 hectares of land while commercial nurseries have covered approximately 2,000 to 2,500 hectares of land. Different flowers including marigold, tuberose, rose, gladiolus, gerbera and chrysanthemum are grown commercially.

Dadlani (2003) stated that flowers have gained an important position in society in present day. People utilize flowers in different ways and different purpose. Flowers are extremely popular at weddings as well as many religious and other functions. In most countries, flowers are only grown for local use, as their short life. Flowers are not just a part of the plant but they are a form of expressions. The aroma of the flowers is unique from one flower to another and Floriculture is the field of agriculture which deals with flowers and such products. In addition to this, flowers are produced and exported many countries for various purposes. The reason could be different from one country to

another and the flowers are used in the manufacturing of green tea, perfumes, essential oils and many other products. He also reported that it speeded largely in Jashore, Savar, Chuandanga, Mymensingh and Gazipur which turned to be the major flower production belt in Bangladesh. Cultivation of flower is reported to give 3-5 times and 1.5-2 times more returns than obtained from rice and vegetable cultivation, respectively.

Sultana (2003) reported that Bangladesh is one of the largest flower growing countries in South-East Salsa. The scope, land, parent stocks, labour, and other natural resources are available and contrtibute towards making Banglades an exporter with great opportunities. In Bangladesh, floriculture brought into limelight by some innovative farmers in late seventies with tuberose on a small-scale basis. Large-scale commercial production started from mid-eighties in Jhikargacha upazila of Jashore district**.**

According to BCMAFF (2003), the flower market is an ever growing market in the world, which helps in exporting and earns revenue. Nowadays, floricultural production ranks 4th behind petroleum, coffee, and bananas in export earnings.

Aditya (1992) reported that flowers became important not only for its aesthetic social value, but also for its economic contribution. The floral industry is one of the major industries in many developing and underdeveloped countries.

2.2. Cultivation of Rose (*Rosa* spp.)

According to the AFRCIG (2018), Rose can be grouped into 3 classifications according to their growth characteristics. They are bush roses, shrub roses and climbing roses. Basically bush roses are self supporting and bear flowers at the top of the plants. Plant height may reach up to 6 feet. Hybrid teas, Hybrid perpetuals, *Floribunda* roses, *Grandiflora* roses, *Polyantha* roses, Miniature roses and tree or standard roses belong to this category. Shrub roses belong to a non-specific class of wild species, hybrids and cultivar that develop large, dense growth needing little maintenance and they are hard in nature. Species and old fashioned roses generally bloom only once per season. Climbing rose plants are extremely vigorous plants with long branches thar require support or training. These branches can be trained to a trellis or fence or allowed to sprawl as a bank cover. Canes may range in size from 5 feet to 20 plus feet depending on the type of rose cultivar and how they are supported. Ever blooming climbers, rambler roses, large-flowered climbers and trailing roses belongs to this category.

Yasin *et al*. (2016) stated that, Rose cultivation is now a profitable enterprise to the farmers, but the socioeconomic data and information of this flower are very scarce in Bangladesh. There is a shifting tendency towards sourcing floricultural products from developing countries like Bangladesh, India and Pakistan.

According to BBS (2015), the major production of Rose is concentrated at Godkhali in Jashore which covered about 60% of total flower production. The area of flower production in Bangladesh at present is rather small. Now around 10000 ha are under

flower cultivation. The area under Rose cultivation is 111 ha producing around 2423 tones with an average yield of 21.92 ton/ha. Every day farmers trade of around Tk. 2 lakh in the local market. Among the cut flower rose contributes the maximum. In the FY 2012-2013, cultivation of Rose occupied an area of 189 acres which expanded to 281 acres within FY 2013-14.

According to Banglapedia (2014), the varieties of rose have played an important role in the production are *Rosa rugosa, R. mundi, R. centifolia, R. canina, R. damascena, R. gallica* etc. In Bangladesh some local varieties have been raised, such as 'Fatema Sattar', 'Shibly', 'Rahela Hamid', 'Piyaree', 'Bhasani', Sher-e-Bangla', '1952', and 'Jayanti. Roses have acquired cultural significance in many societies.

Haque *et al*. (2013) stated that Rose is commercially and aplenty grown at Godkhali in Jashore, Kaligonj, Maheshpur and Nepa in Jhenaidah, Jibonnagar in Chuadanga, Savar in Dhaka and in Manikgonj, Gazipur,, Bogra, Rangpur and Chittagong districts.

Boskabady *et al*. (2011) said that Rose is an economically important horticulture crop cultivated throughout the world and is generally referred as king of flowers and the spiny bushes are not so impressive.

Mari *et al*. (2007) stated that *Rosa* spp. are cultivated throughout the country as garden plant. Roses provide high revenue to farmers and increase employment opportunities.

Fletcher *et al*. (2006) reported that diseases are an important reason for losses in agricultural crop commodities. It is estimated that world faces nearly 13% losses in agriculture produce because of plant diseases caused by a number of pathogens.

According to Gullino *et al*. (2005) the constraints of Rose cultivation are- lack of scientific knowledge and modern technology of flower cultivation, weak networks, insufficient stock of fertilizer and pesticides, stealing, flower damage by animals, and spoilage, disease and insects infestation including different biotic and abiotic disorders. Rose crop is subjected to a number of insect pest and fungal diseases. The management of rose diseases requires frequent use of fungicides that adversely affect the environment and raise costs of production.

Gudin (2000) stated that, Rose (*Rosa sp*.) is a woody perennial flowering plant of the genus *Rosa*, in the family Rosaceae. There are over 200 species and more than 18000 cultivars of roses.

2.3. Diseases of Rose (*Rosa* spp.)

Yasin *et al*. (2016) classified the rose diseases as nursery diseases and field diseases. These types of diseases again sub classified to fungal disease, bacterial disease, viral disease, nemic disease and nutritional disorders. The seedling and nursery diseases are crown gall (*Agrobacterium tumifaciens*), black spot (*Diplocarpon rosae, Marssonina*

rosae), rose mosaic (*Rose mosaic virus*). Field diseases can be grouped as fungal, bacterial, viral and nemic diseases. Fungal diseases are black spot (*Diplocarpon rosae, Marssonina rosae*), powdery mildew (*Sphaerotheca pannosa, Podoaphaera pannosa*), downey mildew (*Peronospora sparsa*), rust (*Pragmidium mucronatum*), anthracnose (*Sphaceloma rosarum*), grey mold (*Botrytis cinerea*), Verticillium wilt (*Verticillium dahlia*), sooty mold (*Alternaria spp.*), canker (*Coniothyrum spp., Cryptosporella umbrina*), *Alternaria* leaf spot (*Alternaria spp.*), *Cercospora* leaf spot (*Cercospora spp.*) and *Septoria* leaf spot (*Septoria spp.*). Bacterial diseases are bacterial leaf spot (*Pseudomonus syringae pv. mors-prunorum*), crown gall (*Agrobacterium tumifaciens*) and hairy root (*Agrobacterium rhizogens*). The Viral diseases are rose mosaic (*Rose mosaic virus* RMV), rose rosette / witch's broom (*Rose rosette virus* RRV), rose streak (*Rose streak virus* RSV) and strawberry latent (*Strawberry latent ringspot virus* SLRV). Some Nemic diseases are dagger (*Xiphinema spp., Xiphinema diversicaudatum*), lesion (*Pratylenchus penetrans, Pratylenchus vainus*), ring (*Criconemella axesta*), root knot (*Meloidogyne hapla*), spiral (*Helicotylenchus nannus, Rotylenchus spp*.) and stunt (*Tylenchorhynchus spp*.). And some of miscellaneous diseases and disorders are rose flower proliferation, rose spring dwarf, rose wilt, nitrogenous deficiency disorder and excessesive nitrogenous disorder.

Shamsi *et al.* (2013) reported that the rose plants are affected by fungal diseases along with bacteria, virus, nematodes and pests. The fungal diseases are *Alternaria* leaf spot, black mold, black spot, botrytis blight, brown canker, cane blight, canker, *Cercospora* leaf spot, common stem canker, crown canker, downy mildew, fungal canker, graft canker, powdery mildew, rust, *Septoria* leaf spot, anthracnose and *Verticillium* wilt. Some abiotic disorders such as nutrient deficiencies, nutrient excesses, pesticidal and herbicidal damages, winter injury, sunburn etc.

Islam *et al*. (2010) reported that in Bangladesh, the most common diseases of this plant are botrytis blight (*Botrytis cinera*), *Cercospora* leaf spot (*Cercospora puderi*), rose mosaic (*Rose mosaic virus*), black spot (*Diplocarpon rosae*), die-back (*Botryodiplodia theobromae*), *Alternaria* leaf spot (*Alternaria alternata*) and stem canker (*Crytosporella umbrina*). In the world, at least 48 fungal species are reported, that are capable of causing rose diseases.

Riaz *et al*. (2007) reported that more than 80% plants diseases are caused by nasty fungal pathogenic microbes. Therefore fungal diseases cause a severe reduction in production and subsequently lower economic return to grower.

2.3.1. Black Spot Disease of Rose

Pscheidt and Rodriguez (2018) discussed about the symptoms of black spot disease. Symptoms on the leaves are recognized as black, nearly circular spots occur on the upper leaf surfaces habing characteristic feathery or fringed margins. The spots can coalesce but often remain distinct. These spots are often surrounded by yellow halos. Infections can result in extensive yellowing of leaflets or entire leaves. Yellowed leaves drop

prematurely, especially on susceptible cultivers. Lower leaves are usually infected first, followed by middle and upper leaves. Excessive defoliation reduces stem length and size and the number and quality of leaves and blossoms. Plants that defoliate by mid-season are weakend, have reduced flower bud set, poor flower quality and are susceptible to environmental stresses and particularly winter injury. Symptoms can also develop on canes. They usually appears as raised purple-red bloches on immature wood of first-year canes which later become blackened with age and develop a blistered appearance. The branches of the plants are rarely killed by lesions on the canes. Inconspicuous, purple-red bloches and spots may results from infection of petiols, peduncles, leaves, stipules, sepals and fruits. The pathogen survives in the winter in these lesions and cankered spots. Cankers serve as a means for survival of the fungus as over-wintering. These are important source of inoculum for new infections in the spring. This deadly fungus cans also over-winteres in dead, fallen leaves and plant debrises.

Yonghao (2016) stated that rose leaves are most susceptible to blacck spot infection when they are young and actively expanding. At least seven hours of continuous wetness is required for spores to cause infection.spore bearing structures are called acervuli. Infection occurs directly through the cuticle on both sides of the leaves. Temperature from 72° to 86° F favors symptom development. 75° F is the optimum temperature for disease development. Wet weather favors disease development and spred. Summer temperature above 90° can slow the disease and limit the epidemics.

Ghosh and Shamsi (2014) worked on fungal diseases of rose plant in Bangladesh. They found five types of symptom on two varieties of rose plant *viz. Rosa centifolia* (red, pink and white flower) and *R. involucrata*. The symptoms were black spot, leaf spot$_1$ (spot reddish brown, sub circular 2-3 mm in diam.), leaf spot$_2$ (off white centre surrounded by reddish brown border 3-5 mm in diam. sub circular), blight and anthracnose. Their study revealed the presence of 20 species of fungi belonging to 17 genera. The isolated fungi were *Alternaria alternata* (Fr.) Keissler, *Arthrinium saccharicola* Stevenson, *Aspergillus flavus*, Link., *A. niger* van Tiegh., *Botrytis allii* Munn, *Cercospora sp.*, *Cladosporium cladosporioides* (Fresen.) de Vries, *C. oxysporum* Berk. & Curt., two species of *Colletotrichum, Curvularia brakyospora* Boedijn, *Curvularia pallescens* Boedijn, *Fusarium sp.*, *Epicoccum purpurascens* Ehreneb ex Schlecht; Link, Gibberella sp., *Marssonina rosea* (Lib.) Died, *Nigrospora sphaerica* (Sacc.) Masson, *Pestalotiopsis guepinii* (Desm.) Stay. with its two culture types, *Penicillium sp.*, *Rhizopus stolonifer* (Ehrenb. Ex. Fr) Vuill. and *Trichoderma viride* Pers. ex Fries. The frequency (%) of association of *Pestalotia guepinii* was higher than any other fungi. *Pestalotiopsis guepinii* and its two culture types were found to be pathogenic to rose plant.

Stephen *et al*. (2007) observed that the black spot fungus overwinters as mycelia or spores in infected canes and leaves. In the spring, overwintering mycelia or spores cause primary (initial) infections on new shoots and leaves. Within about two weeks after primary infections, fruiting structures form within lesions and produce spores which cause secondary infections throughout the growing season. Spores are mainly spread by splashing water but may become wind borne. The pathogen also can be disseminated

locally by wind blown leaves. Disease development can be influenced by plant architecture. Compact roses or those that develop leaves close to the ground are more prone to infection than roses with an open canopy. Crowed plantings generally have higher humidity within the canopy which favors disease development.

Beckerman (2007) foun, in case of black spot disease, rain or sprinkler irrigation splashes fungal spores from infected leaves that were shed the previous year to the plant's lower leaves. The spores must remain wet for several hours for infection to occur. Symptoms became visible within 72 hours after infecting during warm, wet weather, and a secondary infection cycle can develop within 10 days after the initial infection.

According to Xue *et al*. (1998) black spot is the most serious disease of roses and if not effectively managed it can severely weaken plants and lead to increased susceptibility to winter injury or dieback due to other causes. It reduces the number of flowers, marketable value of flowers, plant vigour and the life of plant.

Walker *et al*. (1996) stated that an integrated disease management apporoach could be used to minimize damage caused by black spot. Though almost all rose varieties are susceptible to black spot disease the first step is to select disease resistant cultivars.

Dobbs (1984) stated that black spot caused by the fungus *Diplocarpon rosae*, is one of the most common and persistent diseases of rose in connecticut and the infected plants have unattractive appearance.

Horst (1983) stated that the name *Marssonina rosae* is applied for the imperfect stage of the fungus while the perfect stage, *D. rosae* is rarely observed.

2.3.2. Powdery Mildew Disease of Rose

Pscheidt and Rodriguez (2018) discussed about powdery mildew disease that the growth are irregular, light green to reddish or whitish grey, slightly raised blister like areas. The young leaves could be severely infected and become curled and irregularly twisted. These leaves are usually covered with large, powdey, whitish grey patches of mildew fungus. The infected leaves become turn reddish purple, then yellow, dry and drop prematurely. On highly susceptible rose cultivers, the buds, young canes, pedancles, throns, flower petals and fruit sepals may become infected and entirely covered with the typical dense flourlike growth. These whith patches on the leaf surface are actually the fungal mycelia that are colonizing and expanding through leaf tissue and asexual conidia. Under compound microscope, mycelia appear as thread like and branching and are composed of masses of hyphae, the vegetative growth of the fungus. Infections are initiated from over wintering mycelium, conidia, or ascospores on fallen leaves, from infected tissue such as buds and canes or can be wind blown as conidia or ascospores from other locations.

Ronald (2010) observed that in the spring, new shoots of garden roses are dwarfed, distorted and covered with a whitish gray mildew growth. These mildew growth over expanding leaves are first appears on the upper surface of the leaves. Powdery mildew can cause complete defoliation under favourable condition. Epidemics can be expected any time during the growing season when the rainfall is low or absent. The days are warm, dry and the nights are cool and damp.

Sivaplana (1993) and in (1994) reported that powedery mildew (*Podosphaera pannosa*) is worldwide one of the most important diseases on indoor and outdoor grown plants. The fungus is an obligate parasite, the use of water can harm the spore.

2.3.3. Leaf Spot Disease of Rose

2.3.3.1. *Alternaria* Leaf Spot

Simmons (2007) observed the morphological characters of *Alternaria alternata*. The morphological characters of *Alternaria alternate* were to develop white colonies and later turned black or golden brown. The conidia were borne singly or in short chains and were obpyriform to obclavate, 10 to 40 × 6.2 to 17.60 µm with 0 to 3 longitudinal and 2 to 6 transverse septa.

Horst (1990) told that on the basis of morphology and host-specificity *Alternaria* sp. was designated as *Alternaria tenuis* var. *rosicola*. The fungus was found doing much damage to the foliage of Rose and severe defoliation. It also caused blossom blight. The disease was mainly occurred during the rainy and winter seasons (June to December) but disappeared in summer season due to prevailing high temperatures. The disease is of great economic importance as it infects many economic and highly prized Rose varieties. The disease is highly favoured by high humidity and moderate temperatures often becoming destructive inciting severe type of defoliation.

Rao (1964) reported from India that a preliminary account of a severe leaf spot disease of rose associated with an undetermined species of *Alternaria*. On the basis of morphology and host-specificity it was designated as *Alternaria tenuis* var. *rosicola*. The fungus was found doing much damage to the foliage of Rose and severe defoliation. It also caused blossom blight. The disease was mainly occurred during the rainy and winter seasons (June to December) but disappeared in summer season due to prevailing high temperatures. The disease is of great economic importance as it infects many economic and highly prized Rose varieties. The disease is highly favoured by high humidity and moderate temperatures often becoming destructive inciting severe type of defoliation.

2.3.3.2. *Cercospora* Leaf Spot

Hagan *et al.* (2005) observed that as the disease progresses, the spot were grows larger. Later, the center of these spots turned tan to almost gray in color while the margin of the spot remains maroon to dark purple. Heavily spotted leaves turned yellow and are prematurely shed. Typically, leaf loss began at the base of the canes and gradually spreads upwards through the canopy towards the shoot tips. The infected part of the leaf

began to die. Lesions were primarily found on leaves but can also be found on other parts of the plant. Leaf spotting and defoliation intensified through the summer and into early fall, particularly during extended periods of wet, cloudy weather. Growth of shrub roses heavily defoliated by *Cercospora* leaf spot was greatly reduced.

Hagan and Mullen (2000) also reported that *Cercospora* leaf spot also causes severe leaf loss in heavily infected plants. Symptoms were circular spots, usually 2-4 mm in diameter, but some can be as large as 10 mm in diameter. The size was variable depending on the species or variety of rose on which the lesions occur. When symptoms began to appear, a small purplish area becomes apparent. The spots were characterized by the appearance of numerous tiny maroon to purple oval leaf spots that were scattered randomly across the leaf surface.

Davis (1938) reported that the *Cercospora* leaf spot of Rose was caused by *Cercospora rosicola (Mycosphaerella rosicola,* sexual stage).

2.3.3.3. Bacterial Leaf Spot

According to Greenheart (2019) spots form between leaf veins mostly giving rise to angular or square-shaped dead spots bordered by leaf veins. Lesions are usually dark brown and often merge to kill large sections of the leaves. Chlorosis of leaves occurs when many spots form and leaflet drop can be common.

Pscheidt and Rodriguez (2018) told that bacterial leaf spot on rose usually caused by the bacteria *Pseudomonas syringe* and *Xanthomonas campestris*, which can infect a wide range of Rosacea family. The symptoms of bacterial leaf spot was dark brown, sunken spots appear on leaves, flower stalks, and calyx parts. Flower buds may die without opening. Black streaks appear on 1 year old stems

2.3.4. Botrytis Blight Disease of Rose

According to the report of "Digital Diagonostics" (2019), during periods of cool and wet weather, *Botrytis* blight frequently develops on roses. The disease may affect flowers which may not open and may become covered with grayish brown fungal growth. Sometimes the disease is observed as small flecks on infected petals. At the base of infected flowers, sunken, grayish-black spots (lesions) may be found on the stems and the lesions may continue down the cane. Damage is often associated with wounds where flowers have been cut or the plants have been pruned. These infections often result in cane blight. The fungus forms oval, one-celled conidia (spores) which form in a cluster. The pathogen also forms sclerotia (infectious propagules) which appear as black, flattened or slightly raised structures on the plant surface

Tatagiba *et al.* (1998) and Hammer and Evensen (1996) told that flower blight disease caused by *Botrytis cinerea*. *Botrytis cinerea* is a destructive pathogen of roses grown as cut flowers.

Volpin and Elad (1991) observed that the pathogen colonizes petals causing lesions that reduce both yield and quality.

Orna *et al.* (1995) found that, *Botrytis* blight in cut rose flowers can be suppressed by gibberellic acid. Spraying of GA_3, with a concentration of 346 mg l^{-1} (1 mM) should required for effective control.

Coley (1980) stated that sclerotia are collectively considered the most important survival structures of *Botrytis cinerea*.

Sutton (1990) discussed that sclerotia are important initial inoculum for Botrytis blight epidemics.

2.3.5. Leaf Blight Disease of Rose

According to "Home Guides" (2019), circular black spots are the main symptom of rose leaf blight. These spots develop only on the upper surface of leaves and range in size from 1/16 to 3/4 inch. Rose leaf blight differs from other leaf spot diseases in that the edges of the spots are irregular and jagged. Spots are most often surrounded by a mottled yellow discoloration. Advanced infections produce elevated reddish-purple blemishes on the rose's newest stems. If left untreated, rose leaf spot eventually causes premature leaf drop and stunted growth.

Ghosh and Shamsi (2014) stated that leaf blight disease is caused by different pathogens. They observed that about six fungal species were associated with blight symptom of *Rosa centifolia* (red flower). The fungi were *Alternaria alternata, Aspergillus flavus, Cladosporium cladosporioides, Penicillium* sp., *Pestalotia guepinii* and *Trichoderma viride*.

2.3.6. Anthracnose Disease of Rose

Griep (2015) observed that anthracnose disease can be recognized by the grayish-brown sunken spots that develop on the plant. This fungal disease may not be as well known as black spot on roses, but it can cause significant spotting on susceptible cultivars. Initially, lesions are small, round, reddish-purple spots. The centers of the spots eventually turn gray or white, with red margins. Tissue may drop out or crack in the center of the spots, giving infected leaves a shot-hole appearance. Lesions can also develop on petioles and stems. The fungus produces microscopic spore-bearing structures in the lesions.

Cheewangkoon *et al.* (2009) stated that anthracnose is a fungal disease caused by *Sphaceloma rosarum*, (sexual morph *Elsinoe)* which affects many plants, including roses. The sexual morph is uncommon in nature, and the frequently observed asexual *Sphaceloma* morph is usually morphologically conserved.

2.3.7. Canker and Die Back Disease of Rose

Pscheidt and Rodriguez (2018) told that small black pycnidia can be seen in the cankered area. Cankers can cause wilt in and kill distal portions of the cane.

Randy (2013) reported that several fungi are capable of causing stem canker and dieback of roses. The responsible fungus was *Coniothyrium* spp. Cankers began as spots ranging in color from yellow to purple, depending on the causal fungus. The developing cankers became sunken, forming wrinkled or cracked lesions that are tan to black. Canker margins were brown to reddish purple. Numerous small, black, wart-like specks embedded within the canker area were fruiting bodies of the causal fungus. Cankers often enlarge until the stem was girdled. Once the stem was girdled, the foliage above the canker wilted and died. Cankers that formed at the graft union usually result in plant death.

According to "Rose Cane Cankers" (1990), penetration and infection occurred chiefly through wounds in the epidermis caused by pruning cuts, thorn abrasions, frost cracks, hail damage, cultivar wounds, insect and rodent injuries, or flower removal. Broken thorns and leaf and thorn scars also serve as entries for infection. In some instances, the canker fungi could invade the uninjured, tender epidermis of new growth or dormant buds. The three most common canker diseases of roses in Illinois were stem blight and canker (also known as common canker), caused bythe fungus *Coniothyrium fuckelii* (teleomorph, *Diaplella coniothyrium*); brand canker, caused by the fungus *Coniothyrium wernsdorffiae*; and brown canker, caused by the fungus *Cryptosporella umbrina* (anamorph, *Diaporthe umbrina*). Brown canker is the most destructive of the three diseases. They observed that the mycelia of the canker fungi overwintered in stems and perhaps also in other infected parts. In late winter or early spring, the mycelium renewed growth and extends the area affected. Fruiting bodies produced in cankered areas mature, rupture the epidermis, and released spores in masses of yellow tendrils. The spores were liberated and spread by splashing or dripping water and wind-blown rain. Lesions were evident within 4 to 15 days after infection, and the dark fruiting bodies soon form within them. Cankers were developed throughout the growing season when conditions are favorable.

2.3.8. Rust Disease of Rose

According to "RHS" (2019), the teliospores of rust disease of rose overwintered in black pustules on dead leaves and stems, germinate and produce basidiospores as the part of their disease cycle. The basidiospores are carried by air currents and infect nearby young rose leaves and stems. All types of spores germinate within a temperature range of 6° to about 27°C (34° to 81°F), with an optimum range of 15° to 21°C (59° to 70°F). At or above about 28°C (82°F) no infection by urediospores occurs under otherwise favorable conditions and the spores remain viable for only about a week.

Pscheidt and Rodriguez (2018) stated that rose rust pathogen is usually known as *Phragmidium mucronatum*, although other species of *Phragmidium* also occur. It forms small orange pustules (aecia) appear early in spring on both leaf surfaces. Later, the pustules enlarge and become more numerous on lower leaf surfaces. Mottled and chlorotic areas may develop on upper leaf surfaces opposite the spots (uredinia) on the lower surfaces. In late summer and fall, the small pustules turn black (telia) and contain the winter spore stages of the rust. The stems occasionally are infected.

2.3.9. Mosaic Disease of Rose

Paret *et al*. (2014) stated that, mosaic disease of rose is one of the most economically important diseases among viral diseases which affect roses. Rose mosaic disease continues to be a problem in nursery production and landscapes. Rose mosaic disease was generally associated with mixed infections of viruses that belonged to two taxa named *Ilarvirus* and *Nepovirus.* Within the genus *Ilarvirus*, the most common are *Prunus necrotic ringspot virus* (PNRSV) and *Apple mosaic virus* (ApMV). PNRSV had been isolated worldwide.

Porter *et al.* (2012); Manners (1985) reported that the symptoms associated with rose mosaic were highly variable and depended primarily upon the rose cultivar, virus complex, and the environment. They also observed that the major source of rose mosaic virus disease transmission occured through the budding or grafting of infected buds or scions onto healthy plants.

Golino *et al*. (2007) noticed that healthy buds or scions propagated bud on rose mosaic infected rootstock was also resulted in an infected plant. Cuttings from infected plants, as well as budded plants produced from infected scions, had greater chance of infection. Spread of rose mosaic virus disease had been demonstrated on very closely spaced plants through rare natural root grafts.

Cochran (1988); Davidson (1988); Manners (1987) stated that transmission of rose mosaic disease was occurred through aphids, thrips, pruning shears, contaminated soil, and root contact.

Cochran in (1972, 1982 and 1984) and Thomas (1982; 1984) observed that, some of the more common foliar symptoms include chlorotic line patterns, ring spots, yellow vein banding and puckering, severe distortion of leaves, mild mottling of the leaves, mottling symptoms, and intense yellow spot.

Secor *et al*. (1977) noticed that infected plants have decreased vigour, reduced blossom quality and quantity, reductions in transplant survival rates, early autumn leaf drop, and are more susceptible to winter-kill.

CHAPTER III

MATERIALS AND METHOD

3.1.1. Experimental Site

The study was conducted in Jashore, Manikganj and Dhaka districts. The survey on field diseases was conducted in Jhikargacha, Singair, and Savar upazila of Jashore, Manikganj and Dhaka district respectively. However, survey on nursery diseases was conducted in two locations viz. Dhaka city and Savar upazila. Laboratory works were carried out in Plant Disease Clinic of Sher-e-Bangla Agricultural University, Dhaka.

3.1.2. Study and Survey Area

The field investigation and surveys were conducted in the major rose growing region of Jashore, Manikganj and Dhaka districts (Plate 1). Farmer's fields with standing rose garden were selected for survey. Altogether 22 locations under 6 unions and 3 upazilla from 3 districts were intensively surveyed to collect data on diseases of rose in Bangladesh. The details of survey locations are given in Table 1.

Table 1. Details of survey locations for field diseases of Rose

Sl. No.	Name of District	Name of Upazila	Name of Union	Name of Village	Number of Field
01.	Jashore	Jhikorgachha	Godkhali	Godkhali	3
				Patuapara	3
				Sadirali	3
				Belemath	3
				Dhalipara	3
			Panisara	Panisara	3
				Sayedpara	3
				Nilkanthanagar	3
				Kulia	3
				Gaburapur	3
			Navaron	Hariya	3
				Nimtola	3
				Baisa	3
				Sharifpur	3
				Chandpur	3
				Mathuapara	3
			Nirbaskhola	Nirbaskhola	3
				Shiorda	3
2.	Manikganj	Singair	Singair	Singair	3
				Baliadangi	3
3.	Dhaka	Savar	Birulia	Golap Gram	3
				Sadullapur	3
Total	**03**	**03**	**06**	**22**	**66**

Six nurseries from two locations of Dhaka named Agragoan region of Dhaka City and Savar Municipality area were selected for survey on nursery diseases of rose. The details of survey locations for nursery diseases are given in Table 2.

Table 2. Details of survey locations for nursery diseases of Rose

Name of District	Area/Locations	Name of Nursery
Dhaka	Agargoan area	• Green Bangla Nursery • Agargaon Nursery • Sobuj Bangla Nursery
Savar	Municipality area	• Barishal Nursery • Patuakhali Nursery • Labib Nursery

Plate 1. Experimental sites under study

3.1.3. Experimental Period

The experiment was carried out during the period from January 2018 to April 2019. Survey on nursery diseases was conducted in 2018. Moreover, investigation and survey of rose on field disease in Manikganj and Dhaka districts was conducted in 2018. However, details field investigation and survey was conducted in 2019 in Jhikorgacha of Jashore district.

3.1.4. Characteristics of Soil

The Agargoan and Savar regions belong to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. The land was above flood level and sufficient sunshine was available during the experimental period. Organic matter and fertility status were moderate. Located at 90°22′E longitudes and 23°41′N latitude at an altitude of 8.6 meters above the sea level and under the agro-ecological region of "Madhupur Tract" (AEZ NO. 28). The Jashore region occupies extensive low-lying areas between the Ganges river floodplain and the Ganges tidal floodplain. Soils of the area are grey, and dark grey, acidic, heavy clays overlay peat or muck at 25-100 cm. General soil types include mainly peat and non-calcareous dark grey floodplain soils. Organic matter content is medium to high. Fertility level is medium, under the agro-ecological region of "Gopalganj-Khulna Beels" (AEZ NO. 14). For better understanding, the experimental site is shown in the map of AEZ of Bangladesh in Appendix IV.

3.5. Experiments

Following experiments were carried out throughout the study period in order to study the diseases of Rose in Bangladesh:

1. Investigation, identification and measurement of disease incidence and the severity on field diseases of Rose flower at Jashore, Savar and Manikganj district.
2. Investigation, identification and measurement of diseases of Rose in different nurseries of Dhaka District.
3. Survey on socio-economic status of cultivation practices, diseases and problems of Rose in Bangladesh.

3.6. Sampling Size for Measurement of Diseases

The data were collected in different seasons. In case of nursery diseases, twenty plants were considered from each nursery to calculate amount of diseases. However, in case of field diseases thirty plants from each field was considered to measure data on disease incidence and severity.

3.7. Interview of Farmers and Sample Size

In the survey program, three farmers from each location were interviewed under this study. The interview was conducted to get information about diseases of rose in different stages of plant and in different seasons of Bangladesh. The sample size was sixty three as mentioned above. The interview was taken from rose farmers of 21 locations mentioned in Table 1 except Baliadangi of Manikganj.

3.8. Data Collection

Plant Disease Survey Sheet (Appendix. 1) was used to collect information on symptomology of diseases and to record disease incidence and severity data. The surveys were conducted under natural epiphytic condition. Data was collected with three replications. Data were collected by using Plant Disease Survey Sheet on the following parameters:

1. Disease incidence (%)
2. Disease severity (%)

Moreover, the following informations were also recorded during data collection:

1. Symptomological study
2. Infected plant parts
3. Distribution of diseases
4. Status of diseases

In survey, data were collected by interview of the respondents (farmers). The questionnaires (Appendix. 2), the instruments for data collection, were formulated and pre-tested in two districts namely Dhaka and Manikganj prior to beginning the survey. Data and information on rose cultivation were collected by using the questionnaire on the following topics:

1. Land information
2. Cultivation area and time
3. Planting materials
4. Benefit cost ratio
5. Cost involved in pest management
6. Fertilizer application
7. Insect infestation
8. Disease infestation
9. Weed infestation
10. Relationship among insect, disease and weed
11. Action taken against pest infestation
12. Major problems in rose cultivation
13. Suggestion for management of diseases

3.9. Field Inspection and Identification of Disease

Rose plants of the selected farmer's field observed carefully and symptoms of the diseases were recorded in Plant Disease Survey Sheet (Appendix. 1). In each village, three farmer fields were visited to find out present diseased condition of standing crops under natural epiphytic conditions. Different scientific articles on Rose diseases were primarily used for disease identification in field. Survey sheet was used to write details symptoms of plant diseases and also for recording disease incidence and disease severity percentage. Current field condition, present disease status and farmer's opinion has been taken as an important consideration for recording data. Farmers and fields were selected randomly. The overall conditions of the selected fields were taken in consideration. The disease severities were counted on the basis of eye estimation and direct opinion of the

concern farmer. The land area and pesticides that used by the farmers were also taken as an important consideration.

Disease was quantified in three categories such as, Major: where these disease symptoms causes total flower damage and it is impossible to sold them in market to earn money, Medium: where symptoms causes partial damage of flower, the flowers can be sold in market but reduce the market price, Minor: these symptoms never cause any damage or loss of flower parts, only reduce the market value of the flower. Diseased plant samples and soil were collected and examined in the laboratory. Diseased samples were brought to the laboratory to identify the causal organism. The causal organisms then isolated, identified and recorded. The survey was conducted with Plant Disease Survey Sheet prepared by Department of Plant Pathology, Sher-e-Bangla Agricultural University. Data on land area utilization under flower cultivation were also collected by using standard questionnaires to study the economic importance of selected flower in the mentioned region (Annex. 2).

3.10. Sample Collection

Diseased leaves and other infected plant parts exhibited different types of typical symptoms were collected from different rose plants of different rose fields of Dhaka, Manikganj and Jashore for recording field diseases. In some cases, soil was collected and examined in the laboratory. For investigation of the nursery diseases, different nurseries situated at Sher-e-Bangla Nagar and Savar were observed. Then the samples were carried to the Plant Disease Clinic of Sher-e-Bangla Agricultural University in individual snap locked plastic bags. The collected samples were preserved in refrigerator at 4°C before investigation. In the laboratory, the samples were examined for visible symptoms as well as for microscopic examination and isolation of causal organism(s).

3.11. Isolation of Causal organism(s) by Tissue Plating Method

Plant parts showing the typical disease symptoms were cut into small pieces aseptically, washed thoroughly in running tap water. Some samples were surface sterilized with 70% Ethanol for 30 seconds. Then in 1% sodium hypochlorite (NaOCl) for 30 seconds and washed three times in sterile distilled water each for 1 min. Some samples were sterilized with 37.5% Chlorox for 30 seconds washed three times in sterile distilled water each for 1 min. The surface sterilized leaf pieces were then aseptically plated on Blotter paper and Potato Dextrose Agar (PDA) medium and incubated at 25±2 ºC for 6-7 days under 12 hours light and dark conditions. Hyphal tips from the margin of each developing colony were sub-cultured on PDA to get pure culture. Microscopic examinations were carried out to study morphological characteristics. The causal organisms were isolated, identified and recorded. The pathogen was identified from all infected samples (Agrios, 2005).

3.12. Identification of Causal Organism(s)

Identification of causal organisms was done by the following methods:

3.12.1. Identification by Direct Observation (Microscopic Study)

The diseased leaves of medicinal plants were collected and kept in polythene bags and tagged. The samples were then taken to the laboratory. The collected sample was observed under stereoscopic microscope. The temporary slides were prepared from the diseased samples to observe under compound microscope. The causal pathogens were identified according to reference materials and CMI Description (Mathur and Kongsdal, 2003; Riley, 2002; Carlile *et al*., 2001; Ellis, 1971; Booth, 1971).

3.12.2. Identification by Growing on Blotter Paper (Incubation Method)

The diseased leaves, stems, roots were cut into pieces (5 mm diameter) and surface sterilized with 70% Ethanol for 30 seconds. Then in sodium hypochlorite (NaOCl) for 30 seconds and washed three times in sterile distilled water each for 1 min. Then the cut pieces were placed in sterile blotting paper. The plates containing leaf pieces were incubated at room temperature for seven days. When the fungus grew well and sporulated it was observed under stereo microscope, to observe the growth characteristics. The slides were prepared from the pathogenic structures and observed in compound microscope and identified with the help of relevant literature and CMI description (Mathur and Kongsdal, 2003; Riley, 2002; Carlile *et al*., 2001; Ellis, 1971).

3.12.3. Identification by Growing on Culture Medium (Tissue Plating method)

The diseased leaves, stems, roots were cut into pieces (5 mm diameter) and surface sterilized. Some samples were surface sterilized with 70% Ethanol for 30 seconds. Then in 1% sodium hypochlorite (NaOCl) for 30 seconds and washed three times in sterile distilled water each for 1 min. Some samples were sterilized with 37.5% Chlorox for 30 seconds washed three times in sterile distilled water each for 1 min. Then the cut pieces were placed on to acidified PDA medium in petridish. (Mehrota and Aggarwal, 2003). The plates containing leaf pieces were incubated at room temperature for three days. When the fungus grew well and sporulated, the organism was re-cultured by single spore or tip culture method to obtain pure culture. Then slides were prepared from pathogenic structures and observed under microscope and identified with the help of relevant literature and CMI Description (Agrios, 2005; Mathur and Kongsdal, 2003; Barnett and Hunter, 1972; Ellis, 1971; Booth, 1971).

3.12.4. Identification by Symptomological Study (Visual Assessment)

Symptomological study was done for all diseases. The development of symptoms was closely observed to confirm the disease. During survey, the diseased plant parts (leaf, shoot, twig, collar region, root, flower and fruit) were carefully examined visually of by magnifying glass to observe the disease symptom development, sign of the pathogen, source of infection, mode of dissemination and favourable environment. Idea about causal organisms (fungi, bacteria, nematode and virus) was taken from those information (Pernezny *et al*. 2008; Mullen, 2007; Waller *et al*., 1998; Shutleff and Averre, 1997; Putnam, 1995; Hensen and Wick, 1993).

3.13. Measurement of Plant Diseases

Measurement of plant disease was calculated by measuring disease incidence (%) and disease severity (%).

3.13.1. Disease Incidence

The plants under investigation were keenly observed to watch the typical symptoms and sign of the disease concerned. The plants showing typical symptoms by the pathogenic infection were considered as diseased plant. Disease incidence was calculated by the number of proportion of the plant units diseased in relation to the total number of units examined (Agrios, 2005). Plant units mean the leaves, stems, fruits, tubers, rhizomes, bulb etc. that show any symptoms. The disease incidence was calculated using the following formula:

$$\text{Disease Incidence (\%)} = \frac{\text{Plant units diseased} \times 100}{\text{Plant units examined}}$$

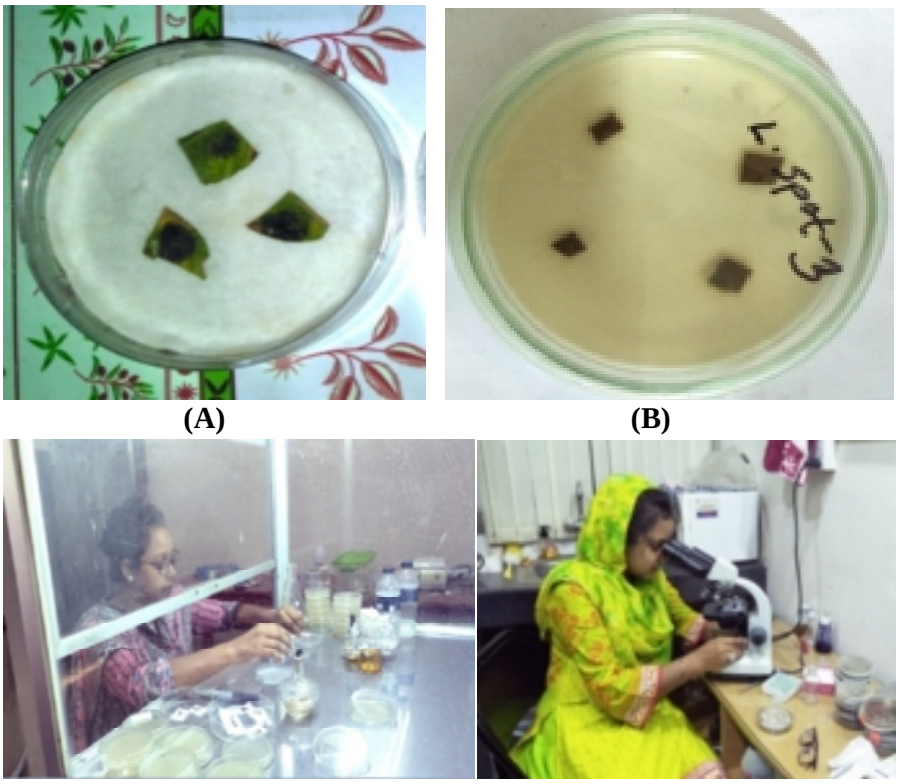
3.13.2. Disease Severity

Disease severity was calculated in the proportion of amount of plant tissues infected in relation to the total amount of tissue examined. Disease severity data were collected on the following parameters (Agrios, 2005).

$$\text{Disease severity (\%)} = \frac{\text{Area of tissues infected} \times 100}{\text{Area of tissues inspected}}$$

3.14. Analysis of Data

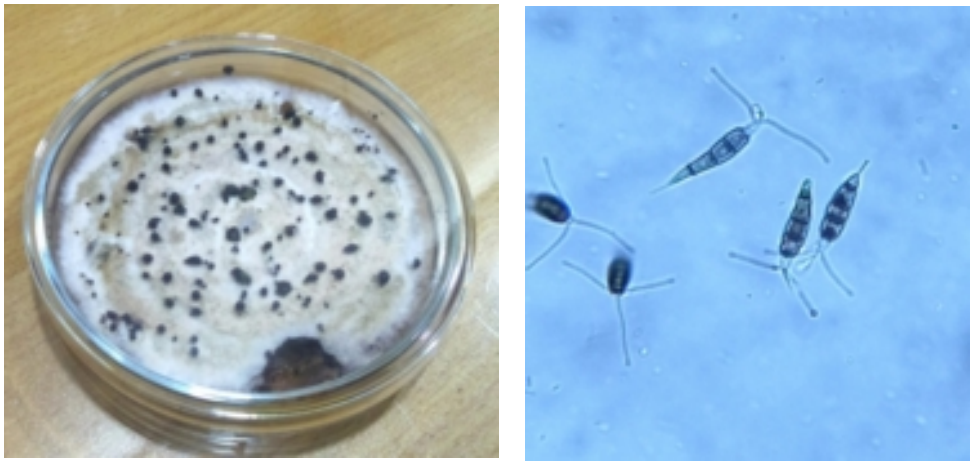
The collected data was analyzed by Statistics 10 computer package program. Analysis of variance (ANOVA) will be used to find out the variation of result from experimental treatments. The mean differences were judged by Least Significant Difference (LSD) at the 5% level of significance.



(A) **(B)**

(C) **(D)**

Plate 2. (A) Incubation of diseased sample in moist Blotter Paper; (B) Incubation of diseased sample in PDA medium; (C) Isolation of causal organisms in laminar airflow cabinet by tissue planting method; (D) Observation of pathogens under compound microscope



(A) **(B)**

Plate 3. (A) Pure culture of causal organism; (B) Identification of causal organism by microscopic study

(A) **(B)**

(C) **(D)**

Plate 4. Investigation and Measurement on diseases in the Rose filed; (A) field disease investigation at Jashore; (B) Interviewing of rose farmer at field; (C) field disease investigation at Savar; (D) Nursery disease investigation at Agargaon, Dhaka

CHAPTER IV

RESULTS

Experiment 1: Investigation, Identification and Measurement of diseases of Rose at Jashore, Savar and Manikganj Districts

4.1. Diseases of Rose

4.1.1 Leaf Spot Diseases of Rose

During the field investigation, four types of leaf spot were recorded.

A. Symptomological Study

In leaf $spot_{1,}$ the spots were light brown to orange in color, irregular in shape, surrounded by dark brown to black thin margin. The spots are generally occurring on the margin of the leaves, visible in both upper and lower surfaces. Gradually the leaf surface is covered with numerous spots and the leaf become rotten and dry. The spot size is getting gradually learger. Spots became coalesces and turned into blighted condition within few days (Plate. 5-A).

In leaf $spot_{2,}$ light brown to ash color spots, nearly circular to irregular in shape, surrounded by dark brown to black thin margin. The spots are initially small, blackish in color and numerous in numbers. They appears on the whole leaf and only be seen on the upper surface of the leaf. Firstly they become coalesces from the leaf margin and gradually make the leaf blighted (Plate. 5-B).

In leaf $spot_{3,}$ numerous black coloured circular to irregular spots are found on the leaves. They appear scattertedly upon the whole leaf. Spots generally found on the upper surface of leaf. Spot size is comoperatively small. The spots have no center and no margin surrounding it (Plate. 5-C).

In leaf $spot_{4,}$ the spots are purple to brown in color, round or nearly round in shape, numerous in numbers. Spots are seen on the upper surface of the leaves. They have a tiny centre, light brown to whitish in color surrounded by dark margins (Plate. 5-D). Only Cercospora was isolated from this leaf spot.

B. Identification of Causal Organisms

The identified mycoflora associated with leaf spot diseases of Rose were *Pestalotia guepinii., Alternaria alternata, Alternaria* sp., *Botrytis cinerea, Penicillium* sp., *Cercospora* sp. *Cladosporium* sp., *Epicoccum purpurescens, Nigrospora oryzae, Aspergillus niger* (black), *Aspergillus flavus* (green), *Aspergillus ochraceous* (brown), *Aspergillus sydewii* (yellow) and *Aspergillus terreus*. In case of *Alternaria alternata* and *Alternaria sp.,* the mycelium was septated, branched, hyaline in tender age. The conidiophore was simple, septated, short, colored and beard conidia at the top. Conidia

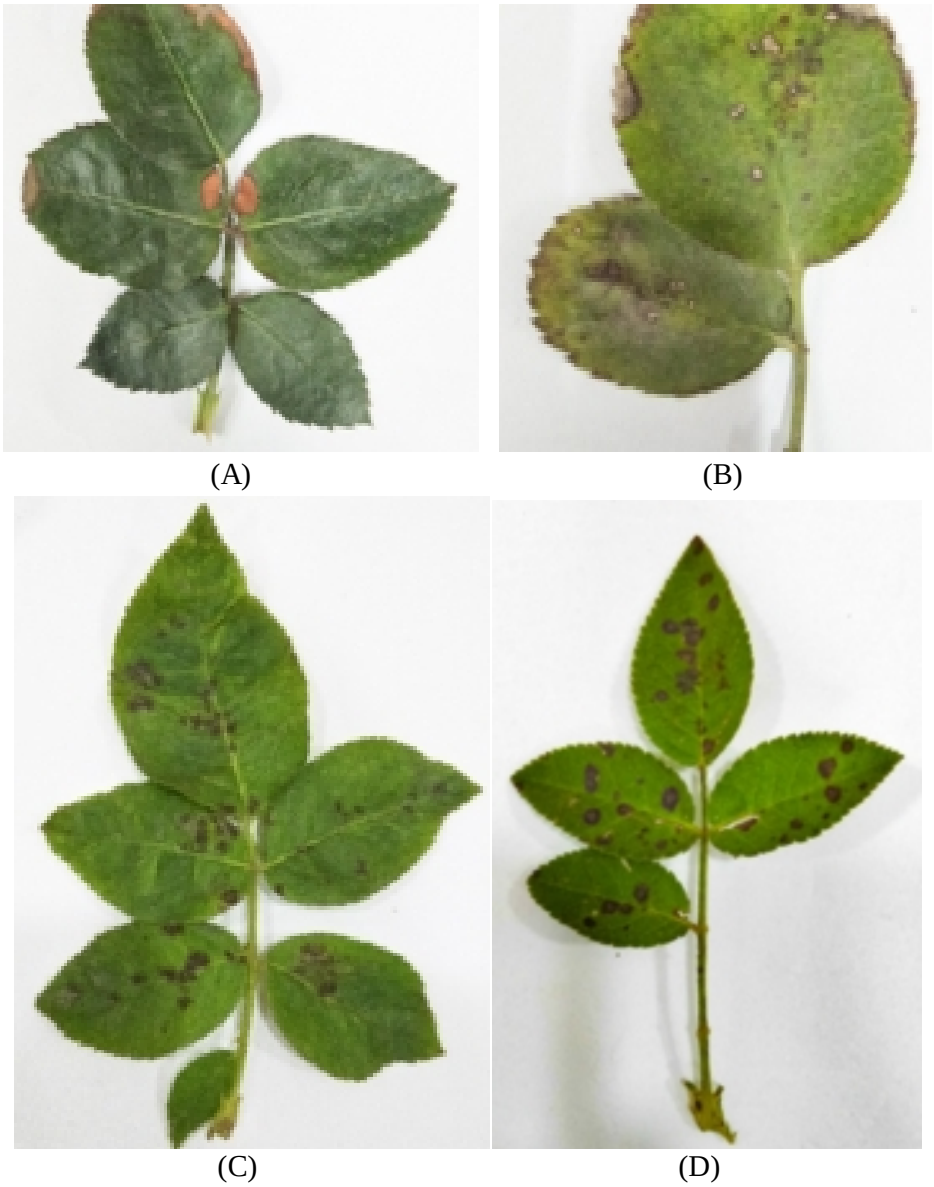
were dark, both short and long beaked, multicelled and muriform (both longitudinal and transverse septum was present), borne at the tip of conidiophores singly or in short chains. The conidia contained 4-8 transverse septa and few longitudinal septa. Conidial shape was elliptical to obclavate or ovoid which were pointed at distal end (Plate 4.B-C). The pure culture of *Alternaria* sp. was prepared. In the culture the colonies of *Alternaria* are moderately slow growing and produce blackish culture on PDA medium within 10 days (Plate 5. C-D).

In case of *Pestalotia guepinii*, the mycelium was septated, branched, hyaline in tender age. The conidia were light brown in color, 4-5 celled, fusiform conidia with a hyaline basal cell. Conidia had apical appendages. The appendages were trisetulated (three setulae or apical appendages were present). The pure culture of *Pestalotia guepinii* was slow growing, initially produced whitish culture on PDA medium (Plate 6. A-B). After on an average 30 days, deep blackish, ink like spores were produced on the culture. In case of *Botrytis cinerea,* Fuzzy gray mass of spores were observed. Thread like branched hyphal structures were found with brown tree like conodiophore which are long and smooth. Globose conidia were found in numerous numbers which were hyaline and non septate. Pure culture of *Botrytis cinerea* was made (Plate 6. E-F). The fungus was moderately fast growing. It produced whitish cottony colony on PDA culture medium within 8 days.

In case of *Penicillium* sp., the mycelium was hyaline, branched and septate. The conidiophores were arised from the mycelium, septate, branched near the apex and penicilate (brush like structure). Conidiophores contained sterigmata which beared the long conidial chain. The pure culture of *Penicillium* sp. was fast growing, initially produced deep greenish to blakish culture on PDA medium within 7 days (Plate 7. A-B). In case of *Cercospora* sp., the mycelium was septate, branched and light brown in color. The tuft of conidiophores was observed. The conidiophores were unbranched, short to medium in size, and geniculated (a significant notch on the tip of the conidiophores). The pure culture was deep brown to black in color produced on the PDA media (Plate 7. C-D).

In case of *Cladosporium* sp., the mycelium was hyaline, branched and septate. Spores were ellipsoidal to cylindrical and pigmented with colors of light brown. pure culture of *Cladosporium* sp. was moderately fast growing, produced deep greenish to blakish culture on PDA medium (Plate 8. A-B). *Epicoccum purpurescens* produced light to dark colored conidia were warted and spherical to globose in shape. Sporets had been found to contain up to 9 cells. The pure culture of *Epicoccum purpurescens* was fast growing, initially produced whitish compact culture on PDA medium in a umbrella shaped pattern (Plate 8. C-D). Later it converted to bright orange colored colonies after 30 days of incubation. In case of *Nigrospora oryzae*, the mycelium was light brown in color, septation was not clearly visible. The distinctive black spores were present, looked like spherical shaped. They initially produced whishish and fluffy mycelium on the PDA media. After maturation, it turned in dark black colored culture (Plate 8. E-F).

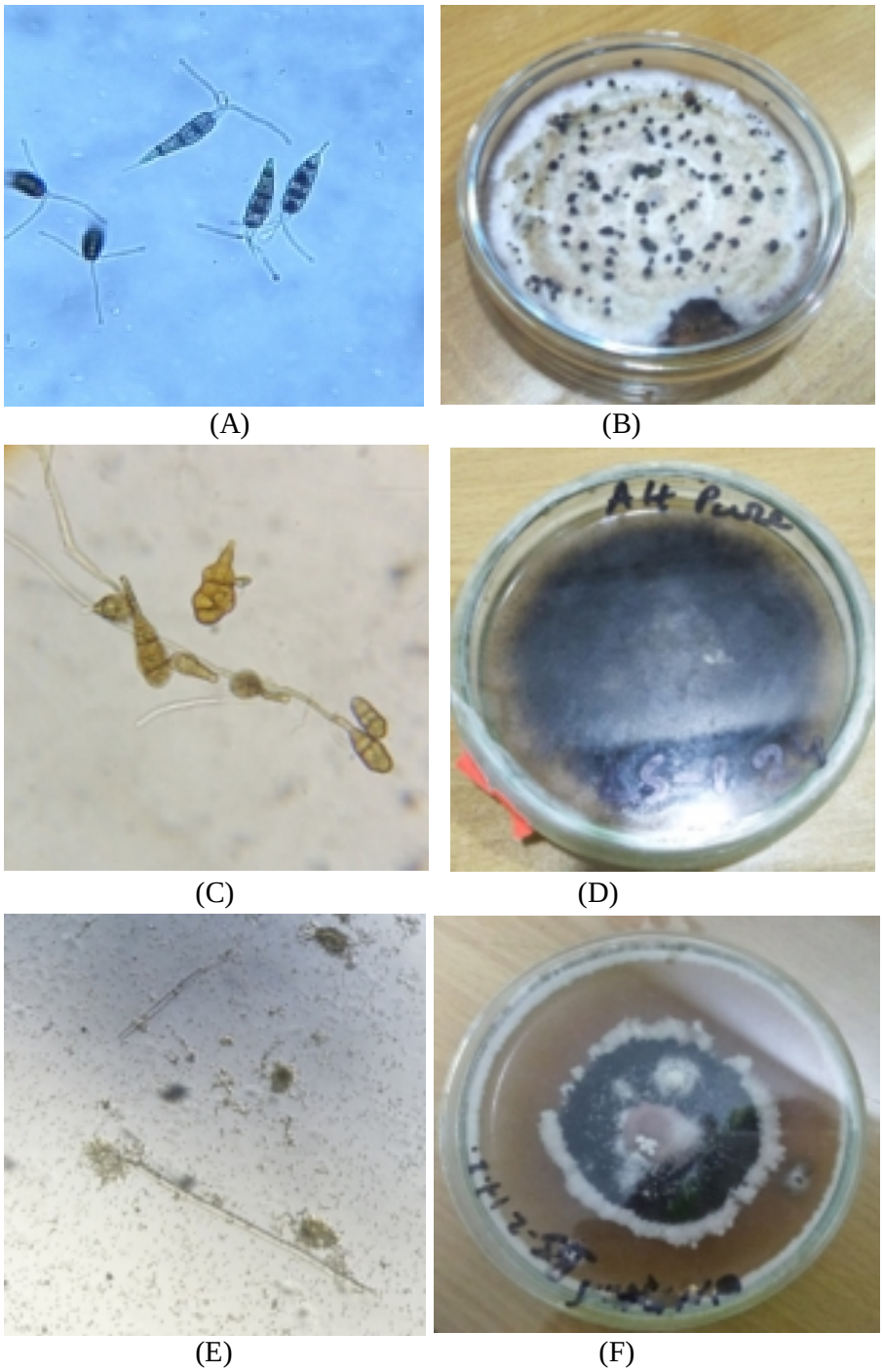
In case of *Aspergillus sp*., the mycelium was hyaline, septed and branched. The conidiophores were long, erect, arised singly from the somatic hyphae (foot cell), unbranched, asepted, hyaline and slender. It contained globose head like structures (vesicle) which was formed on the tip of the conidiophores. The conidia were small, rounded and dark colored (Plate 9. A, C, E). *Aspergillus sp*. produced various colored of conidia. The pure culture of *Aspergillus niger* was initially white, later converted to black. *Aspergillus flavus* produced green colored culture, *Aspergillus ochraceous* produced brown colored culture ((Plate 8. 9, D, F), *Aspergillus sydewii* produced yellow colored culture and *Aspergillus terreus* produced pale greenish to whitish colored culture on PDA media (Plate 10. B, D).



(A) (B)

(C) (D)

Plate 5. Leaf Spot diseases of Rose; (A) Leaf spot$_1$ disease; (B) Leaf spot$_2$ disease; (C) Leaf spot$_3$ disease; (D) *Cercospora* leaf spot

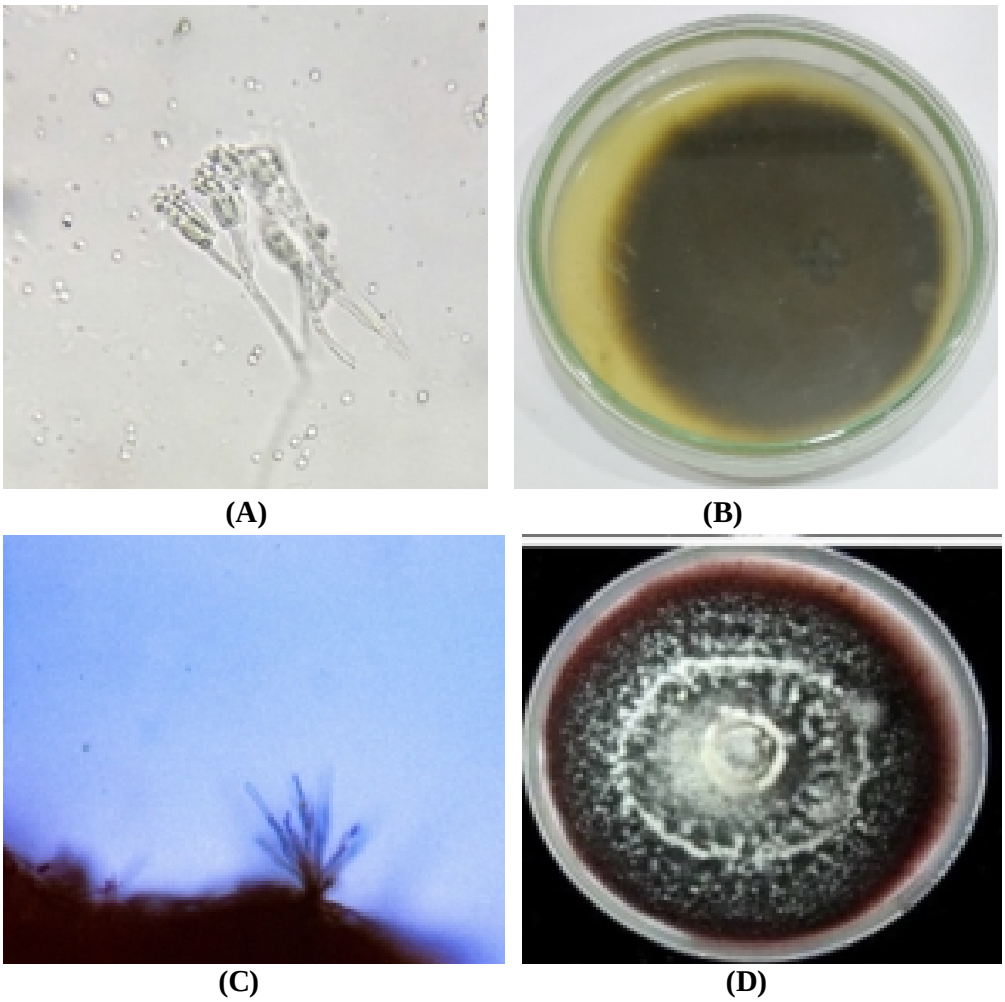


(A) (B)

(C) (D)

(E) (F)

Plate 6. Microorganisms and Pure culture isolated from Leaf spot diseases of Rose; (A) Conidia of *Pestalotia guepinii*. (10×40); (B) Pure culture of *Pestalotia guepinii*; (C) Germinating Conidia of *Alternaria sp*. with mycelia (10×40); (D) Pure culture of *Alternaria sp.*; (E) *Botrytis cinerea* with conidia; (F) Pure culture of *Botrytis cinerea*



(A) **(B)**

(C) **(D)**

Plate 7. Mycoflora and Pure culture isolated from Leaf spot diseases of Rose; (A) microscopic structure of *Penicillium sp.* (10×40); (B) pure culture of *Penicillium sp.*; (C) conidiophores of *Cercospora sp.* (D) pure culture of *Cercospora sp.*

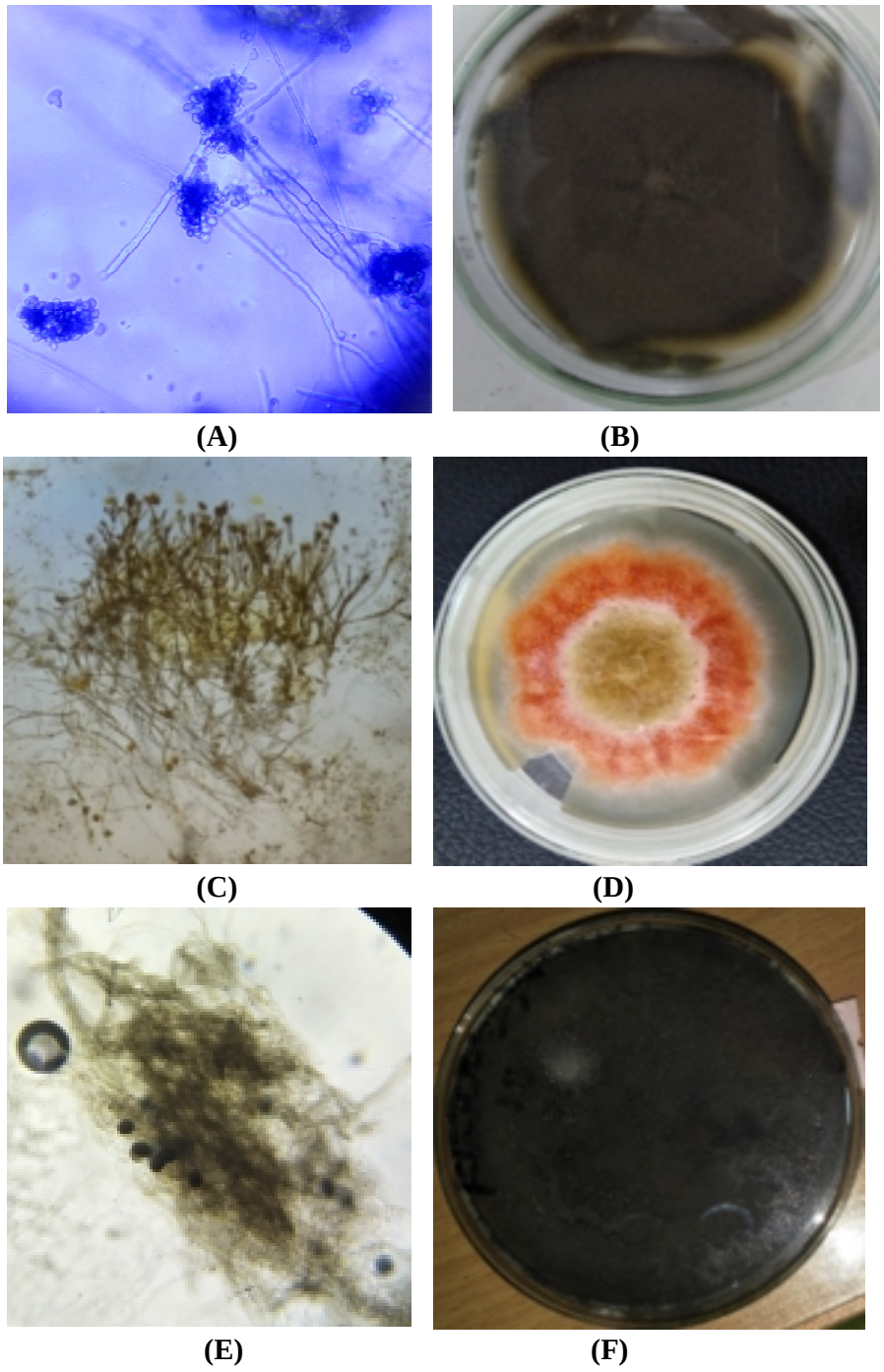
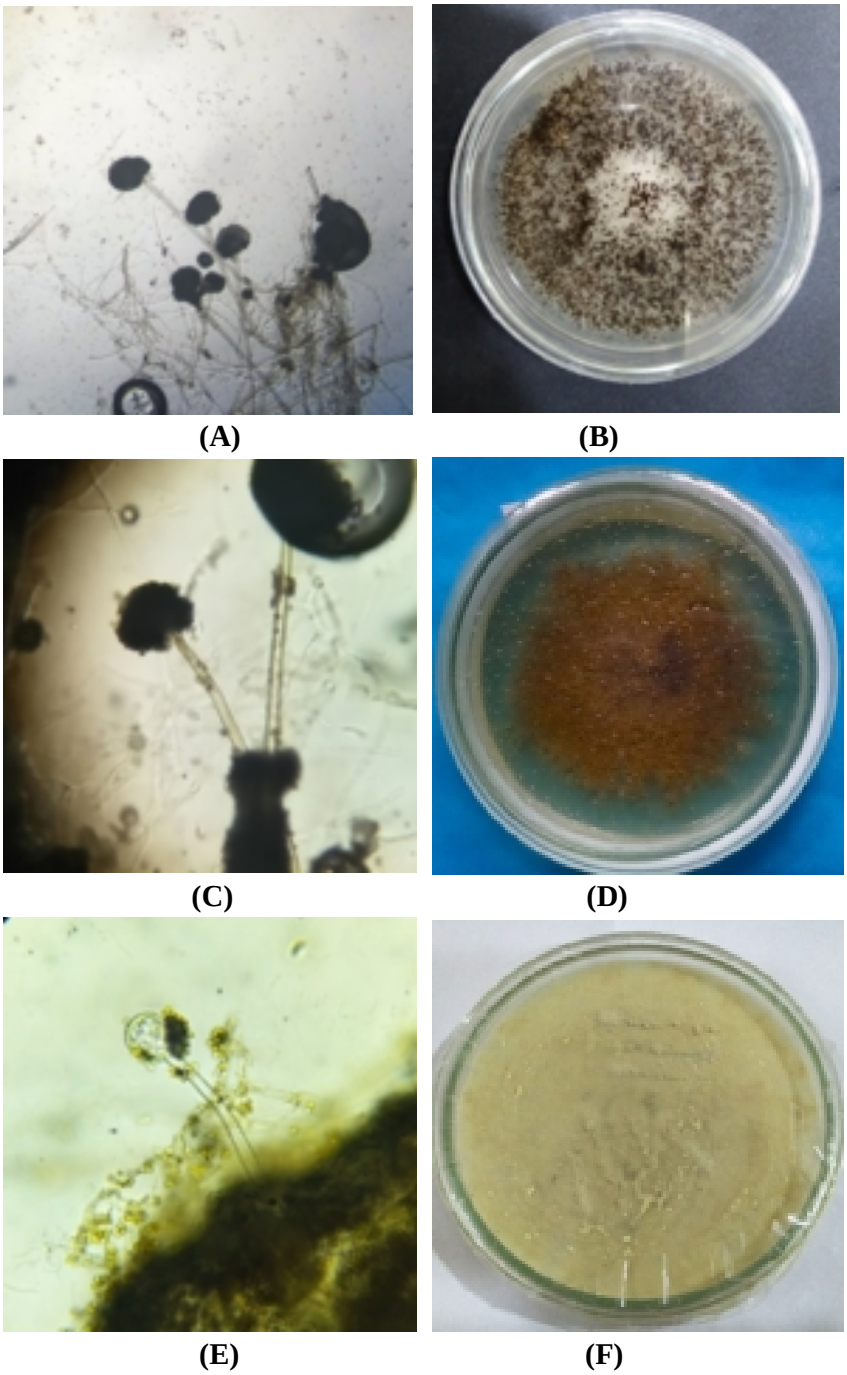


Plate 8. Causal organisms and Pure culture of Leaf spot diseases of Rose; (A) microscopic structure of *Cladosporium sp.* (10×40); (B) pure culture of *Cladosporium sp.* (C) *Epicoccum purpurescens* with mycelium (10×40); (D) pure culture of *Epicoccum purpurescens*; (E) microscopic structure of *Nigrospora oryzae*; (F) pure culture of *Nigrospora oryzae*

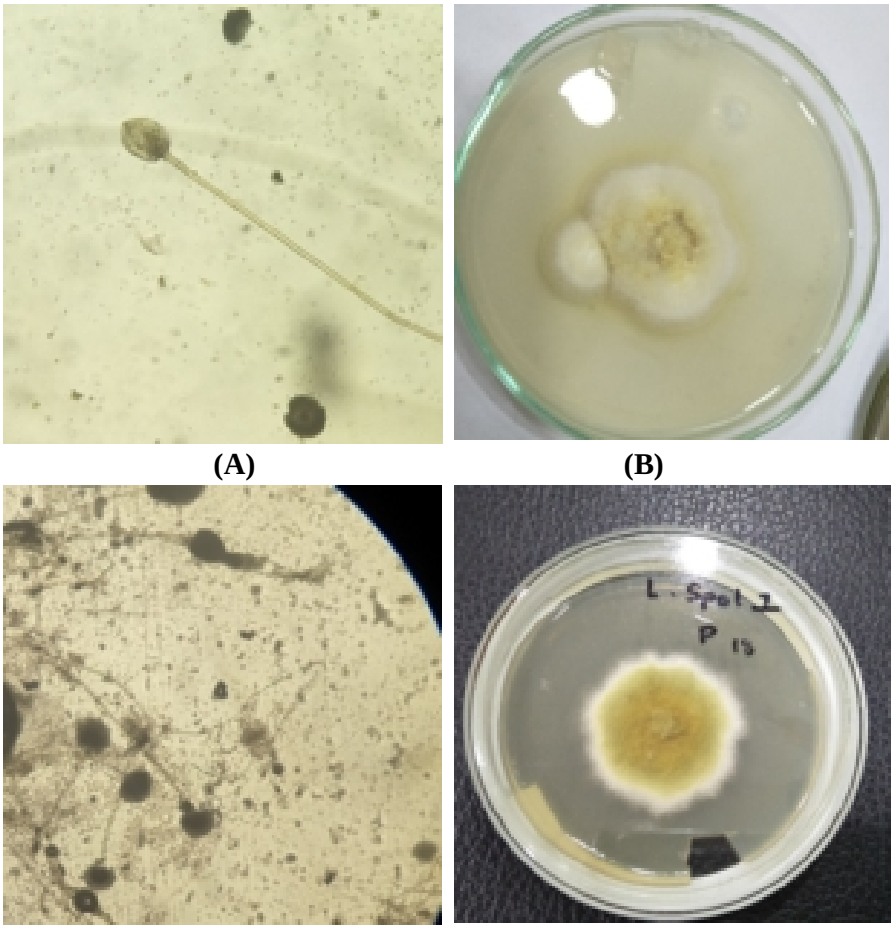


(A) **(B)**

(C) **(D)**

(E) **(F)**

Plate 9. Fungi associated with Leaf spot diseases of Rose with their pure culture; (A) microscopic structure of *Aspergillus niger* (10×40); (B) pure culture of *Aspergillus niger* (C) microscopic structure of *Aspergillus flavus* (10×40); (D) pure culture of *Aspergillus flavus*; (E) microscopic structure of *Aspergillus ochraceous*; (F) pure culture of *Aspergillus ochraceous*



(A) **(B)**

(C) **(D)**

Plate 10. Fungi associated with Leaf spot diseases of Rose with their pure culture; (A) microscopic structure of *Aspergillus sydewii* (10×40); (B) pure culture of *Aspergillus sydewii*; (C) microscopic structure of *Aspergillus terreus* (10×40); (D) pure culture of *Aspergillus terreus*

C. Incidence and Severity of the Disease

Incidence of leaf spots disease of Rose varied significantly among the locations in Jashore, Manikganj and Dhaka, and that ranged from 3.00 to 43.33 % (Table 3). The highest disease incidence was recorded in Panisara (43.33%) and no disease was found in Nimtola. In case of disease severity, similar results were observed. Severity of leaf spot also varied significantly. The highest disease severity was observed in Singair which is 11 %.

Table 3. Incidence and severity of leaf spot diseases of Rose in Jashore, Dhaka and Manikganj districts in field condition

Location		Amount of Disease	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	6.67 h-j	0.83 d-f
	Patuapara	35.67 bc	6.00 bc
	Sadirali	12.33 f-j	1.00 d-f
	Belemath	33.33 b-d	2.00 d-f
	Dhalipara	7.33 h-j	0.83 d-f
	Panisara	**43.33 ab**	3.67 c-e
	Sayedpara	3.00 ij	0.73 ef
	Nilkonthonagar	32.33 b-d	4.33 b-d
	Kulia	23.33 c-h	1.33 d-f
	Gaburapur	28.33 b-g	1.67 d-f
	Hariya	11.33 g-j	1.33 d-f
	Nimtola	**0.00 j**	**0.00 f**
	Baisha	6.67 h-j	0.50 ef
	Sarifpur	38.33 bc	1.33 d-f
	Chandpur	61.67 a	2.33 d-f
	Mathuapara	25.00 b-h	1.33 d-f
	Nirbaskhola	31.67 b-e	2.00 d-f
	Shiorda	20.00 c-i	3.67 c-e
Dhaka Savar	Golap Gram	13.67 e-j	1.3 d-f
	Sadullapur	16.00 d-j	2.00 d-f
Manikganj Singair	Singair	33.67 b-d	**11.00 a**
	Baliadangi	30.00 b-f	7.67 ab
CV		48.03	82.97
LSD		18.480	3.5358
Level of Significange		**	**

Figures with similar letters of a column do not differ significantly.

** Means significant at the 0.01 probability level.

4.1.2. Black Spot Disease of Rose

A. Symptomological Study

The spots were black, nearly circular or unevenly circular in size, occur on the upper leaf surfaces. They have characteristic feathery or fringed margins. Some spots had small, irregular light brown center, some other had not any center. Gradually the leaf surface is covered with numerous such spots and turning the leaf yellowish first. The spots are getting larger day by day. Spots became coalesces and turned into blighted condition within few days (Plate 11.).

Plate 11. Black Spot of Rose

B. Mycoflora Associated with Black Spot Disease of Rose

The identified mycoflora from black spot disease of Rose were *Pestalotia guepinii, Alternaria* sp., *Penicillium* sp., *Rhizoctonia solani, Aspergillus niger, Aspergillus flavus* and *Chaetomium* sp.

In case of *Pestalotia guepinii,* the mycelium was septated, branched, hyaline in tender age. The conidia were light brown in color, 4-5 celled, fusiform conidia with a hyaline basal cell. Conidia had apical appendages. The appendages were trisetulated (three setulae or apical appendages were present). The pure culture of *Pestalotia guepinii* was slow growing, initially produced whitish culture on PDA medium (Plate 12. A-B). After on an average 30 days, deep blackish, ink like spores were produced on the culture.

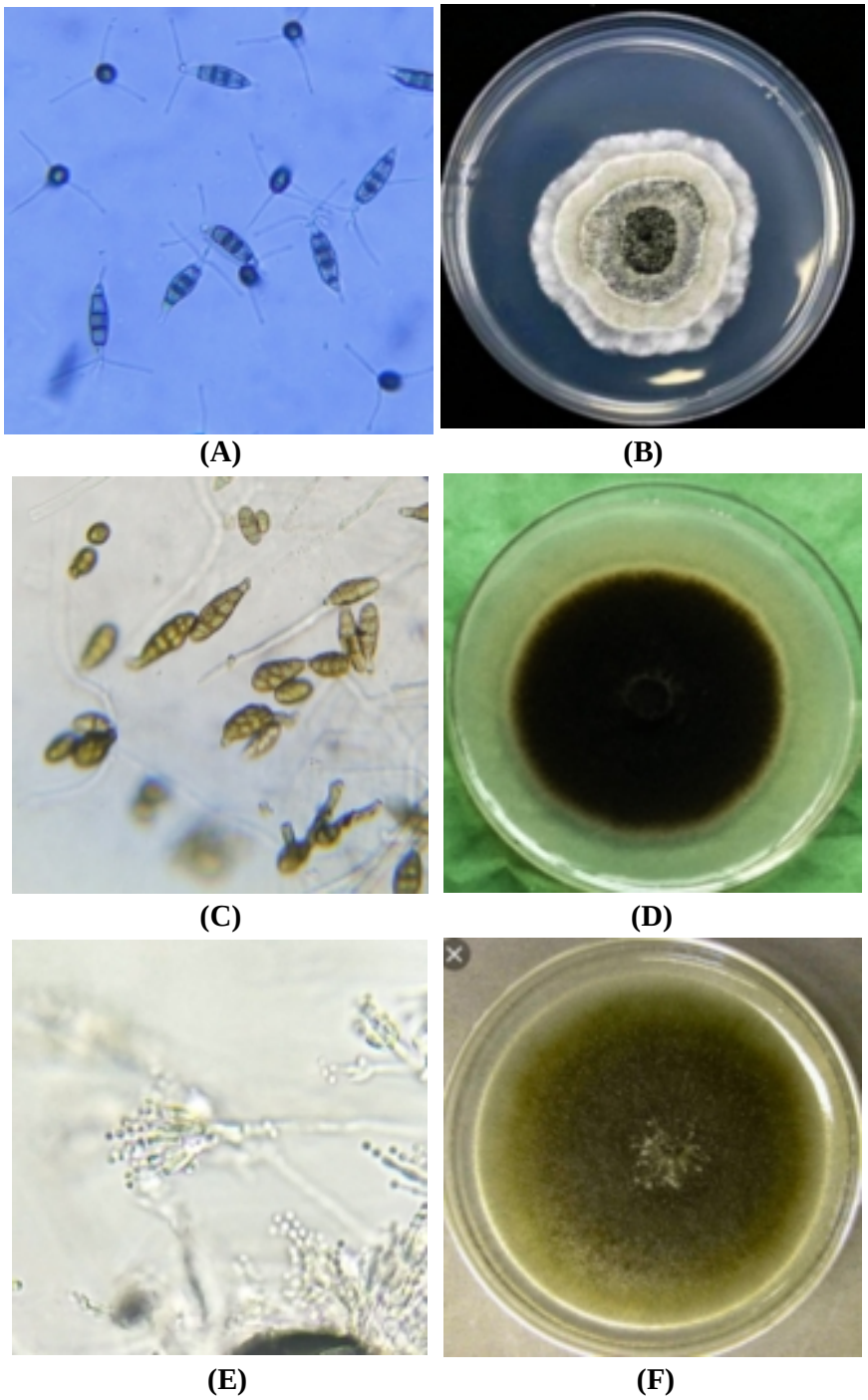
In case of *Penicillium sp.,* the mycelium was hyaline, branched and septate. The conidiophores were arised from the mycelium, septate, branched near the apex, penicilate (brush like structure). Conidiophores contained sterigmata which beared the long conidial chain. The pure culture of *Penicillium sp* was fast growing, initially produced deep greenish to blakish culture on PDA medium within 7 days (Plate 12. E-F).

In case of *Alternaria spp.*, the mycelium was septated, branched and hyaline in tender age. The conidiophore was simple, septated, short, colored and beard conidia at the top. Conidia were dark, short beaked, multicelled and muriform (both longitudinal and transverse septum was present), borne at the tip of conidiophores singly or in short chains. The conidia contained 4-8 transverse septa and few longitudinal septa. Conidia shape were elliptical to obclavate or ovoid which were pointed at distal end. The pure culture of *Alternaria* sp. was prepared (Plate 12. C-D). In the culture the colonies of *Alternaria* are moderately slow growing and produce blackish culture on PDA medium within 10 days.

In case of *Aspergillus sp.,* the mycelium was hyaline, septed and branched. The conidiophores were long, erect, arised singly from the somatic hyphae (foot cell), unbranched, asepted, hyaline and slender. It contained globose head like structures (vesicle) which was formed on the tip of the conidiophores. The conidia were small, rounded, dark colored. *Aspergillus sp.* produced various colored of conidia. The pure culture of *Aspergillus niger* was initially white, later converted to black. *Aspergillus flavus* produced green colored culture on PDA media.

In case of *Rhizoctonia solani*, the mycelium was light brown, septed, branched, constrictions were present at the basal regions. They had perpendicular branching (the fungi had a characteristic of 90 degree branching) (Plate 13. A). The pure culture of *Rhizoctonia solani* was prepared from disease sample (Plate 13. B). In pure culture, the colonies were moderately fast growing and produced white culture with dark brown to black sclerotia on PDA medium within 7 days which were visible with naked eyes.

In case of *Chaetomium sp.* setae were coiled and brown ascospores subglobose to lemon-shaped, had superficial, ostiolar perithecia and covered in hairs. Mycelia had grown in conglomerate masses that resemble ropes (Plate 13. C-D).

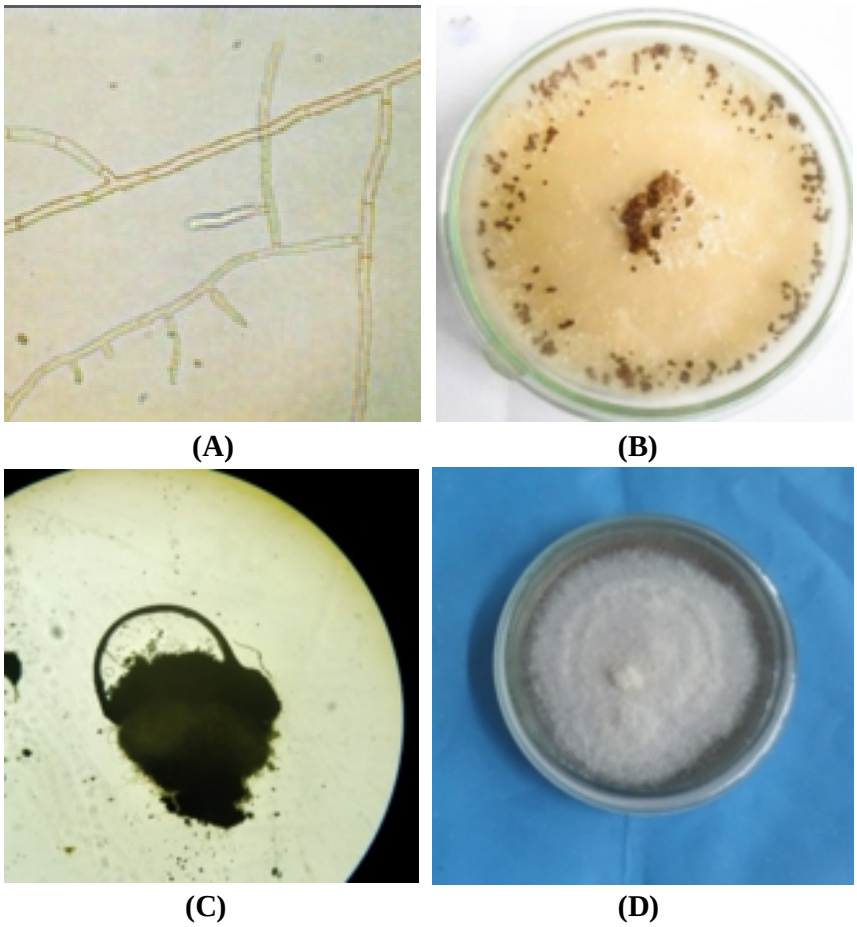


(A) **(B)**

(C) **(D)**

(E) **(F)**

Plate 12. Causal organisms and Pure culture of Black spot of Rose; (A) Conidia of *Pestalotia guepinii* (10×40); (B) Pure culture of *Pestalotia guepinii*; (C) Conidia of *Alternaria alternata* with mycelia (10×40); (D) Pure culture of *Alternaria sp.*; (E) Microscopic structure of *Penicillium sp.* (10×40); (F) Pure culture of *Penicillium sp.*



(A) **(B)**

(C) **(D)**

Plate 13. Causal organisms and Pure culture of Black spot of Rose; (A) Mycelium of *Rhizoctonia solani* (10×40); (B) Pure culture of *Rhizoctonia solani*; (C) Microscopic structure of *Chaetomium sp.*; (D) Pure culture of *Chaetomium sp*.

C. Incidence and Severity of the Disease

Incidence of black spot disease of Rose varied significantly among the locations that ranged from 4.67 to 86.33% (Table 4). The both highest disease incidence and disease severity were recorded in Singair (86.33% and 25.00%, respectively). No disease was found in Patuapara, Panisara, Hariya, Sarifpur and Mathuapara villages.

Table 4. Incidence and severity of black spot disease of Rose in Jashore, Dhaka and Manikganj in field condition

Location		Amount of Disease	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	27.00 d	2.00 cd
	Patuapara	**0.00 i**	**0.00 d**
	Sadirali	11.33 f-i	1.67 d
	Belemath	0.00 i	0.00 d
	Dhalipara	12.33 e-h	0.83 d
	Panisara	**0.00 i**	**0.00 d**
	Sayedpara	7.33 g-i	0.70 d
	Nilkonthonagar	4.67 hi	0.10 d
	Kulia	12.67 e-h	1.00 d
	Gaburapur	10.33 f-i	0.40 d
	Hariya	**0.00 i**	**0.00 d**
	Nimtola	54.00 b	4.67 c
	Baisha	23.33 de	2.67 cd
	Sarifpur	**0.00 i**	**0.00 d**
	Chandpur	17.33 d-g	1.67 d
	Mathuapara	**0.00 i**	**0.00 d**
	Nirbaskhola	19.00 d-g	1.67 d
	Shiorda	40.00 c	1.67 d
Dhaka Savar	Golap Gram	22.00 d-f	2.33 cd
	Sadullapur	17.00 d-g	1.67 d
Manikganj Singair	Singair	**86.33 a**	**25.00 a**
	Baliadangi	63.67 b	13.67 b
CV		36.74	65.69
LSD		11.785	2.9867
Level of Significange		**	**

Figures with similar letters of a column do not differ significantly.

** means significant at the 0.01 probability level.

4.1.3. Leaf Blight Diseases of Rose

During field investigation, three types of leaf blight disease of rose were recorded. The symptoms of leaf $blight_1$, leaf $blight_2$, and leaf $blight_3$ are given below.

A. Symptomological Study

In leaf $blight_1$, the blighted area of infected leaves were greenish brown, irregular in shape, occur on the both upper and lower leaf surfaces. The blighting of the leaf was started from the margin of the leaves and gradually moved towards the center irregularly. The blighted area had very thin dark brown margin (Plate 14-A).

In leaf $blight_2$, the blighted area of infected leaves were dark brown, irregular in shape, occur on the both upper and lower leaf surfaces. The blighting of the leaf was started from the margin of the leaves irregularly. The blighted area had no margin (Plate 14-B).

In leaf $blight_3$, the leaves were started to blighting from the lower part and gradually move to the upper part of the leaf. The blighted area of infected leaves were dark brown to black, irregular in shape, occur on the both upper and lower leaf surfaces. The blighted area had a blakish center. Blighted area is irregular in shape. The peripheral region of the blight was dark to light brown in color, relatively lighter than the center. The blighted area had no prominent margin (Plate 14-C).

(A) **(B)**

(C)

Plate 14. Leaf blight diseases of Rose; (A) Leaf blight$_1$ disease; (B) Leaf blight $_2$ disease; (C) Leaf blight $_3$ disease

B. Fungi Associated with Leaf Blight Diseases of Rose

The identified fungi from leaf blight disease of Rose were *Pestalotia guepinii, Alternaria* sp., *Botrytis cinerea., Aspergillus flavus* (green), *Aspergillus sydewii* (yellow), and one unknown fungus of ascomycotina.

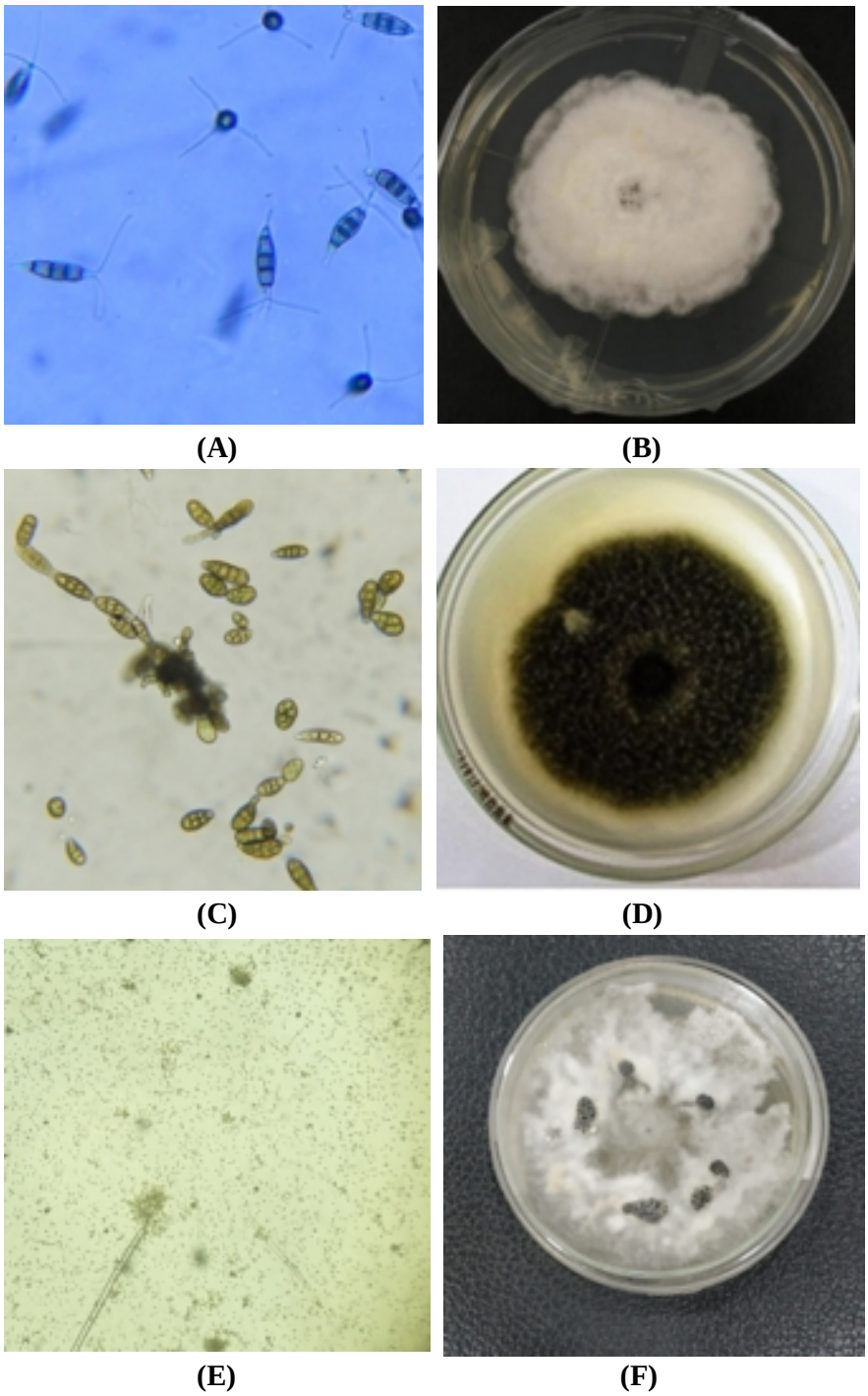
In case of *Alternaria* sp., the mycelium was septated, branched, hyaline in tender age. The conidiophore was simple, septated, short, colored and beard conidia at the top. Conidia were dark, both short and long beaked, multicelled and muriform (both longitudinal and transverse septum was present), borne at the tip of conidiophores singly or in short chains. The conidia contained 4-8 transverse septa and few longitudinal septa. The shape of conidia was elliptical to obclavate or ovoid which were pointed at distal end. The pure culture of *Alternaria* sp. was prepared. In the culture the colonies of *Alternaria* are moderately slow growing and produce blackish culture on PDA medium within 10 days (Plate 15. C-D).

In case of *Pestalotia guepinii.,* the mycelium was septated, branched, hyaline in tender age. The conidia were light brown in color, 4-5 celled, fusiform conidia with a hyaline basal cell. Conidia had apical appendages. The appendages were trisetulated (three setulae or apical appendages were present). The pure culture of *Pestalotia guepinii* was slow growing, initially produced whitish culture on PDA medium. After on an average 30 days, deep blackish, ink like spores were produced on the culture (Plate 15. A-B).

In case of *Botrytis cinerea*, Fuzzy gray mass of spores were observed. Threadlike branched hyphal structures were found with brown tree like conodiophore which are long and smooth. Globose conidia were found in numerous numbers which were hyaline and non septate. Pure culture of *Botrytis* was made. The fungus was moderately fast growing. It produced whitish cottony colony on PDA culture medium within 8 days (Plate 15. E-F).

In case of *Aspergillus sp.*, the mycelium was hyaline, septed, branched. The conidiophores were long, erect, arised singly from the somatic hyphae (foot cell), unbranched, asepted, hyaline and slender. It contained globose head like structures (vesicle) which was formed on the tip of the conidiophores. The conidia were small, rounded, dark colored. *Aspergillus sp.* produced various colored of conidia. The pure culture of *Aspergillus flavus* produced green colored culture, and *Aspergillus sydewii* produced yellow colored culture on PDA media (Plate 16. A-B).

One unknown fungi was identified and named unknown fungi of ascomycotina. This fungus has hyaline mycelium with prominent ascus. The ascus contained approximately 12 cells which hyaline in color (Plate 16. C-D).

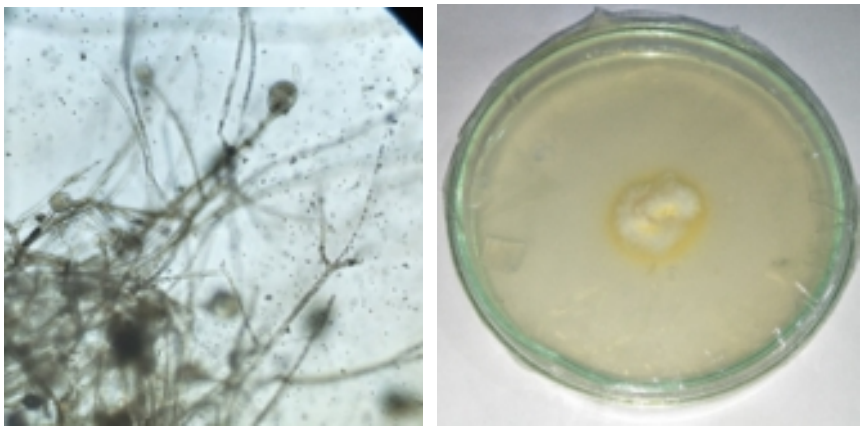


(A) **(B)**

(C) **(D)**

(E) **(F)**

Plate 15. Fungi associated with Leaf blight diseases of Rose; (A) Conidia of *Pestalotia guepinii.* (10×40); (B) Young culture of *Pestalotia guepinii*; (C) Chain of Conidia of *Alternaria sp*. (10×40); (D) Pure culture of *Alternaria sp*.; (E) Microscopic structure of *Botrytis sp*. (10×40); (F) Pure culture of *Botrytis sp.*



(A) **(B)**

Plate 16. Fungi associated with Leaf blight diseases of Rose; (A) Microscopic structure of *Aspergillus sydewii* (10×40); (B) Young culture of *Aspergillus sydewii*

C. Incidence and Severity of the Disease

Incidence of leaf blight diseases of Rose varied significantly among the locations of Jashore, Manikgang and Savar, that ranged from 12.33 to 61.67% (Table 5). The highest disease incidence was recorded in Kulia (61.67%) and the lowest disease incidence was 12.33% in Sayedpara village. In case of disease severity, similar results were observed. Severity of leaf blight also varied significantly. The highest disease severity was observed in Singair which is 9.00%. Moreover, in Sayedpara village of Jashore, the lowest disease severity was observed which is 1.07%.

Table 5. Incidence and severity of leaf blight disease of rose in Jashore, Dhaka and Manikganj in field condition

Location		Amount of Disease	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	34.33 a-d	5.00 a-c
	Patuapara	45.67 a-c	4.00 a-c
	Sadirali	58.33 ab	3.67 bc
	Belemath	42.00 a-d	5.00 a-c
	Dhalipara	58.333 ab	6.00 a-c
	Panisara	58.000 ab	7.17 ab
	Sayedpara	**12.33 d**	**1.07 c**
	Nilkonthonagar	37.00 a-d	2.00 bc
	Kulia	**61.67 a**	7.00 ab
	Gaburapur	43.00 a-d	5.00 a-c
	Hariya	15.33 cd	2.00 bc
	Nimtola	12.67 d	0.83 c
	Baisha	15.33 cd	1.17 c
	Sarifpur	35.00 ad	2.00 bc
	Chandpur	28.67 b-d	1.67 c
	Mathuapara	36.00 a-d	2.67 c
	Nirbaskhola	29.33 b-d	1.67 c
	Shiorda	14.33 d	1.67 c
Dhaka Savar	Golap Gram	14.33 d	1.33 c
	Sadullapur	13.00 d	1.00 c
Manikganj Singair	Singair	32.33 a-d	**9.00 a**
	Baliadangi	25.00 cd	4.33 a-c
CV		57.01	92.04
LSD		30.83	5.19
Level of Significange		*	*

Figures with similar letters of a column do not differ significantly.
* Means significant at the 0.05 probability level

4.1.4. Flower Blight Disease of Rose

A. Symptomological Study

Both flowers and blooming flower buds were affected by flower blight disese. The outer petals of the flowers started blighting first. In some cases blighting was occurded from the center of the flower. The blighted petals were black in color, became shriveled. In some cases, the upper portion of the petal became greenish and had numerous black spots. The sepals were also affected. Blighting occurred due to using flower caps which sometimes injured the petals and started to blight. The blighted area had no margins. Heavely blighted flowers became brown and dry and seemed as deformed flowers (Plate 17).

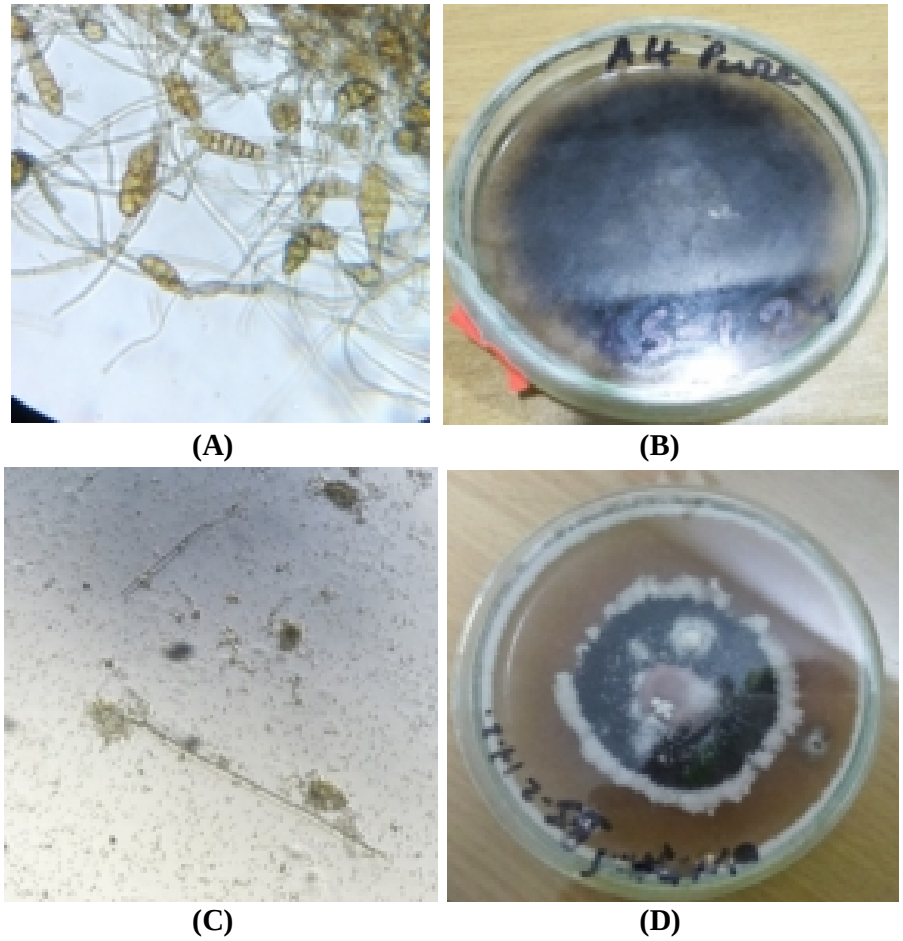
Plate 17. Flower blight disease of Rose

B. Identification of Causal Organisms

The identified causal organisms of Flower blight disease of Rose were *Alternaria* sp. and *Botrytis cinerea.* In case of *Alternaria sp.*, the mycelium was septated, branched, hyaline in tender age. The conidiophore was simple, septated, short, colored and beard conidia at the top. Conidia were dark, beakless, short and long beaked, multicelled and muriform (both longitudinal and transverse septum was present), borne at the tip of conidiophores singly or in short chains. The conidia contained 4-8 transverse septa and few longitudinal septa. The shape of conidia was elliptical to obclavate or ovoid which were pointed at distal end (Plate 18. B-C). The pure culture of *Alternaria* sp. was prepared. In the culture the colonies of *Alternaria* are moderately slow growing and produce blackish culture on PDA medium within 10 days (Plate 18. A-B).

In case of *Botrytis cinerea*, fuzzy gray mass of spores were observed. Thread like branched hyphal structures were found with brown tree like conodiophore which are

long and smooth. Globose conidia were found in numerous numbers which were hyaline and non septate. Pure culture of *Botrytis* was made. The fungus was moderately fast growing. It produced whitish cottony colony on PDA culture medium within 8 days (Plate 18. C-D).



(A) **(B)**

(C) **(D)**

Plate 18. Causal organisms and Pure culture of flower blight of Rose; (A) Conidia of *Alternaria sp*. with mycelium (10×40); (B) Pure culture of *Alternaria sp*.; (C) Microscopic structure of *Botrytis sp*. (10×40); (D) Pure culture of *Botrytis sp*.

C. Incidence and Severity of the Disease

Incidence of flower blight diseae of Rose varied significantly among the locations of Jashore, Manikgang and Savar. The highest disease incidence was recorded in Godkhali (95%) that is statistically identical with Panisara (93.33%). In case of disease severity, similar results were observed. Severity of flower blight also varied significantly. The highest disease severity was observed in Godkhali which is 33.33% followed by Singair (19%) and Baliadangi (8.33%). No disease was observed in Sadirali, Dhalipara and Baisha villages of Jashore (Table 6).

Table 6. Incidence and severity of flower blight disease of rose in Jashore, Dhaka and Manikganj in field condition

Location		**Amount of Disease**	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	**95.00 a**	**33.33 a**
	Patuapara	9.67 g-i	1.00 de
	Sadirali	**0.00 i**	**0.00 e**
	Belemath	16.00 f-h	2.33 de
	Dhalipara	**0.00i**	**0.00 e**
	Panisara	93.33 a	9.00 c
	Sayedpara	6.00 hi	1.17 de
	Nilkonthonagar	30.00 ef	2.67 d
	Kulia	13.67 g-i	1.33 de
	Gaburapur	20.33 fg	1.67 de
	Hariya	6.33 g-i	1.40 de
	Nimtola	18.33 f-h	2.67 d
	Baisha	**0.00 i**	**0.00 e**
	Sarifpur	36.67 de	2.50 de
	Chandpur	48.67 cd	1.67 de
	Mathuapara	20.00 f-h	2.00 de
	Nirbaskhola	29.33 ef	1.33 de
	Shiorda	30.00 ef	2.33 de
Dhaka Savar	Golap Gram	10.33 g-i	0.67 de
	Sadullapur	13.33 g-i	1.17 de
Manikganj Singair	Singair	70.67 b	19.00 b
	Baliadangi	52.67 c	8.33 c
CV		30.60	35.09
LSD		14.22	2.51
Level of Significange		**	**

Figures with similar letters of a column do not differ significantly.

** Means significant at the 0.01 probability level.

4.1.5. Powdery Mildew Disease of Rose

A. Symptomological Study

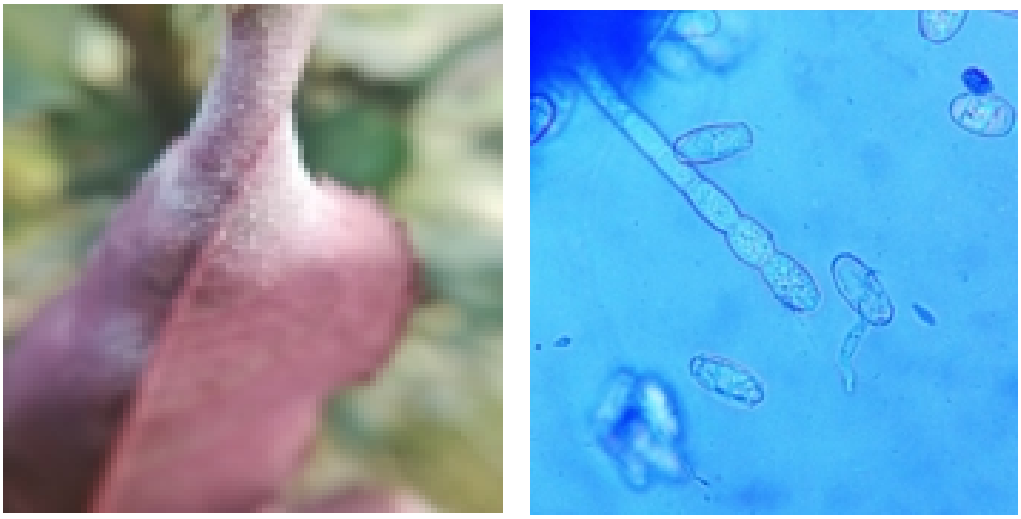
A white, powdery fungal growth on the leaves and shoots was noticed. It affected mainly lower side of the leaves (Plate 19. A). In some cases, both leaf surfaces were affected. Along with leaves the fungus affected flower stalks, stems, calyces and petals. Heavily infected flower buds were failed to open properly. The heavily infected young leaves were curled and distorted. Mildew growth on stems and flower stalks was usually thicker and more mat-like than that on the leaves (Plate 19. B). The mildew growth on all parts had been turned browner as it ages. Sometimes, rotting start in powdery mildew infected areas.

(A) **(B)**

Plate 19. Powdery mildew disease of Rose (A. infected leaf; B. infected flower bud)

B. Identification of Causal Organism

The identified causal organism of powdery mildew diaease of Rose was *Podosphaera pannosa* (*Oidium* sp.). a member of the Ascomycete fungi (Plate 20. B). It is an obligate fungi i.e. it can not live without living host. A semi-permenent slide was made from the fresh sample. The oidia of the fungus are oval shaped, hyaline, formed chains. Each chain contained 3-5 cells, arised from septate stalk (Plate 20. B).



(A) **(B)**

Plate 20. (A) Infected leaf with powdery masses of powdery mildew disease; (B) Conidial chain of *Podosphaera pannosa* (*Oidium* sp.).

C. Incidence and Severity of the Disease

Incidence of powdery mildew disease of Rose varied significantly among the locations that ranged from 7.67 to 98.33% (Table 7). The both highest disease incidence and disease severity were recorded in Godkhali (98.33% and 30.00% respectively) followed by Dhalipara (96.67% and 26.67% respectively) and No disease was recorded in Sayedpara, Kulia, Nimtola, Baisha, Chandpur, Mathuapara, Nirbaskhola, Shiorda, Singair, Baliadangi, Golap Gram and Sadullapur.

Table 7. Incidence and severity of Powdery Mildew disease of rose in Jashore, Dhaka and Manikganj in field condition

Location		Amount of Disease	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	**98.33 a**	**30.00 a**
	Patuapara	90.00 ab	20.00 b
	Sadirali	7.67 fg	1.33 d
	Belemath	69.00 c	8.00 c
	Dhalipara	96.67 a	26.67 a
	Panisara	83.33 b	18.33 b
	Sayedpara	**0.00 g**	**0.00 d**
	Nilkonthonagar	19.33 ef	2.00 d
	Kulia	0.00 g	0.00 d
	Gaburapur	27.33 e	2.67 cd
	Hariya	22.67 e	2.50 d
	Nimtola	0.00 g	0.00 d
	Baisha	0.00 g	0.00 d
	Sarifpur	48.33 d	2.33 d
	Chandpur	0.00 g	0.00 d
	Mathuapara	0.00 g	0.00 d
	Nirbaskhola	0.00 g	0.00 d
	Shiorda	0.00 g	0.00 d
Dhaka Savar	Golap Gram	0.00 g	0.00 d
	Sadullapur	0.00 g	0.00 d
Manikganj Singair	Singair	0.00 g	0.00 d
	Baliadangi	0.00 g	0.00 d
CV		29.75	62.75
LSD		12.536	5.3504
Level of Significange		**	**

Figures with similar letters of a column do not differ significantly.

** Means significant at the 0.01 probability level.

4.1.6. Mosaic Diseases of Rose

A. Symptomological Study

The symptoms were highly variable. The leaf symptom was a pattern of light and dark green areas including yellow patches that gave a mosaic effect in infected leaves (Plate 21). Chlorotic line patterns (zigzag pattern), vein-banding and mottles in leaves were also observed in some leaves. The mosaic symptoms were seen in all growth stage of rose. It was more common on new leaves. Severely infected leaves became curled and completely yellow. Infected plants were less vigorous than healthy plants and were more sensitive to winter injury.

Plate 21. Mosaic disease of Rose

B. Identification of Causal Organism

No organism was identified from this disease. Most possibly any kind of virus is responsible for the disease.

C. Incidence and Severity of the Disease

Incidence of mosaic of Rose varied significantly among the locations of Jashore, Manikgang and Savar, that ranged from 5.67 to 40.33% (Table 8). The highest disease incidence was recorded in Chandpur (40.33%) followed by Sarifpur (37%) and the highest disease severity was observed in Singair which is 8.33% followed by Nilkonthonagar (3.67%). Moreover, No disease was observed in Belemath, Dhalipara, Nimtola and Baisha villages.

Table 8. Incidence and severity of mosaic disease of rose in Jashore, Dhaka and Manikganj in field condition

Location		Amount of Disease	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	28.33 a-e	2.67 b-e
	Patuapara	25.00 a-e	2.67 b-e
	Sadirali	26.67 a-e	1.33 c-e
	Belemath	0.00 g	0.00 e
	Dhalipara	0.00 g	0.00 e
	Panisara	25.00 a-e	1.33 c-e
	Sayedpara	5.67 fg	0.50 de
	Nilkonthonagar	30.67 a-d	3.67 bc
	Kulia	34.33 ab	2.00 b-e
	Gaburapur	39.00 a	2.67 b-e
	Hariya	16.67 b-g	0.33 e
	Nimtola	0.00 g	0.00 e
	Baisha	0.00 g	0.00 e
	Sarifpur	37.00 a	3.07 b-d
	Chandpur	**40.33 a**	1.33 c-e
	Mathuapara	11.67 efg	1.33 c-e
	Nirbaskhola	23.33 a-f	1.17 c-e
	Shiorda	15.00 c-g	1.50 c-e
Dhaka Savar	Golap Gram	12.00 d-g	1.50 c-e
	Sadullapur	11.67 e-g	1.17 c-e
Manikganj Singair	Singair	34.33 ab	**8.33 a**
	Baliadangi	32.33 a-c	4.67 b
CV		55.65	86.86
LSD		18.715	2.6824
Level of Significange		**	**

Figures with similar letters of a column do not differ significantly.
** Means significant at the 0.01 probability level.

4.1.7. Dieback Disease of Rose

A. Symptomological Study

The infected stems were black to brown in color and dry. Browning and dieback of a pruning stub was noticed which then progresses further down the branch. In severe cases, the whole plant became died (Plate 22). No organism was identified from this disease.

Plate 22. Dieback disease of Rose

B. Incidence and Severity of the Disease

Incidence of dieback disease of Rose varied significantly among the locations ranged from 3.00 to 68.33% (Table 9). The both highest disease incidence and disease severity were recorded in Nimtola (68.33% and 4.67%, respectively) and no disease was found in Godkhali, Sadirali, Kulia, Gaburapur, Chandpur, Mathuapara, Shiorda, Golap Gram and Sadullapur villages.

Table 9. Incidence and severity of die back disease of rose in Jashore, Dhaka and Manikganj in field condition

Location		Amount of Disease	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	0.00 g	0.00 e
	Patuapara	7.33 d-f	1.33 bc
	Sadirali	0.00 g	0.00 e
	Belemath	9.67 c-e	1.00 cd
	Dhalipara	6.67 d-f	0.67 c-e
	Panisara	40.00 b	2.00 b
	Sayedpara	5.67 ef	0.63 c-e
	Nilkonthonagar	**3.00 fg**	**0.33 de**
	Kulia	0.00 g	0.00 e
	Gaburapur	0.00 g	0.00 e
	Hariya	6.67 d-f	0.60 c-e
	Nimtola	**68.33 a**	**4.67 a**
	Baisha	9.33 de	1.00 cd
	Sarifpur	11.00 cd	0.57 de
	Chandpur	0.00 g	0.00 e
	Mathuapara	0.00 g	0.00 e
	Nirbaskhola	7.67 d-f	1.00 cd
	Shiorda	0.00 g	0.00 e
Dhaka Savar	Golap Gram	14.33 c	2.00 b
	Sadullapur	8.33 de	1.00 cd
Manikganj Singair	Singair	0.00 g	0.00 e
	Baliadangi	0.00 g	0.00 e
CV		33.23	58.83
LSD		4.9280	0.7402
Level of Significange		**	**

Figures with similar letters of a column do not differ significantly.
** Means significant at the 0.01 probability level.

4.1.8. Stem Dry Rot Disease of Rose

A. Symptomological Study

Yellowish to brown spots were found on the stem. The spot became coalesced and formed canker. The developing cankers became sunken, forming wrinkled or cracked lesions that were tan to dark brown. Canker margins were brown to orangish. The infected stems were partially or completely girdle the cane. Complete girdling resulted in dieback and poor growth of the plant parts above the affected areas. The foliage above the canker wilted and died (Plate 23). No organism was identified from this disease.

Plate 23. Stem dry rot disease of Rose

B. Incidence and Severity of the Disease

Incidence of stem dry rot disease of Rose was found in limited locations only at Patuapara, Belemath and Nilkonthonagar at Jashore, and that ranged from 2.67 to 10.67% (Table 10). The both highest disease incidence and disease severity was recorded in Patuapara (10.67% and 1.67%) followed by Belemath (3% and 0.33%) and Nilkonthonagar (2.67% and 0.33%, respectively). No disease was recorded at Godkhali, Sadirali, Belemath, Dhalipara, Panisara, Sayedpara, Kulia, Gaburapur, Hariya, Nimtola, Sarifpur, Chandpur, Mathuapara, Nirbaskhola, Shiorda, Singair, Baliadangi, Golap Gram and Sadullapur.

Table 10. Incidence and severity of stem dry rot disease of rose in Jashore, Dhaka and Manikganj in field condition

Location		Amount of Disease	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	0.00 c	0.00 c
	Patuapara	**10.67 a**	**1.67 a**
	Sadirali	0.00 c	0.00 c
	Belemath	**3.00 b**	**0.33 b**
	Dhalipara	0.00 c	0.00 c
	Panisara	0.00 c	0.00 c
	Sayedpara	0.00 c	0.00 c
	Nilkonthonagar	**2.67 b**	**0.33 b**
	Kulia	0.00 c	0.00 c
	Gaburapur	0.00 c	0.00 c
	Hariya	0.00 c	0.00 c
	Nimtola	0.00 c	0.00 c
	Baisha	0.00 c	0.00 c
	Sarifpur	0.00 c	0.00 c
	Chandpur	0.00 c	0.00 c
	Mathuapara	0.00 c	0.00 c
	Nirbaskhola	0.00 c	0.00 c
	Shiorda	0.00 c	0.00 c
Dhaka Savar	Singair	0.00 c	0.00 c
	Baliadangi	0.00 c	0.00 c
Manikganj Singair	Golap Gram	0.00 c	0.00 c
	Sadullapur	0.00 c	0.00 c
CV		145.94	141.58
LSD		1.7853	0.2474
Level of Significange		**	**

Figures with similar letters of a column do not differ significantly.
** Means significant at the 0.01 probability level.

4.1.9. Dry Brown Spot Disease of Rose

A. Symptomological Study

There were numerous brown spots on the stems. The spots were irregular in shape, brown to light brown in color, surrounded by dark brown, thin margin. They were mostly found on older lower stems. Some were also found on upper stems (Plate 24). No organism was identified from this disease.

B. Incidence and Severity of the Disease

Incidence of dry brown spot disease of rose was found only in Patuapara, Panisara and Shiorda at Jashore, and that ranged from 14.67 to 41.00% (Table 11). The highest disease incidence was recorded in Shiorda (41%) followed by Panisara (38.33%) and Patuapara (14.67%)**.** In case of disease severity, similar results were observed. The highest disease severity was observed in Panisara which is 4%. In Patuapara and Shiorda, lowest disease severity was recorded (1.17%). In the rest of the locations, no disease was observed.

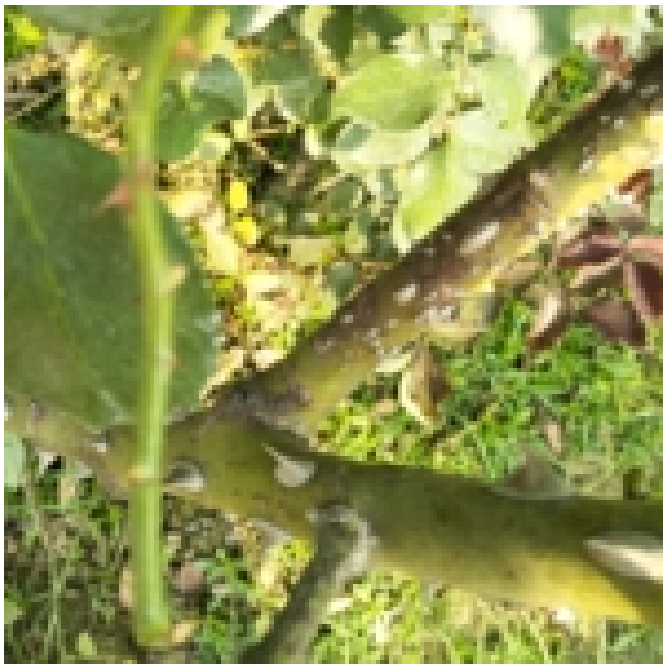


Plate 24. Dry brown spot disease of Rose

Table 11. Incidence and severity of Dry brown spot disease of rose in Jashore, Dhaka and Manikganj in field condition

Location		Amount of Disease	
District and Upazilla	**Village**	**Disease Incidence (%)**	**Disease Severity (%)**
Jashore Jhikargacha	Godkhali	0.00 c	0.00 c
	Patuapara	**14.67 b**	**1.17 b**
	Sadirali	0.00 c	0.00 c
	Belemath	0.00 c	0.00 c
	Dhalipara	0.00 c	0.00 c
	Panisara	**38.33 a**	**4.00 a**
	Sayedpara	0.00 c	0.00 c
	Nilkonthonagar	0.00 c	0.00 c
	Kulia	0.00 c	0.00 c
	Gaburapur	0.00 c	0.00 c
	Hariya	0.00 c	0.00 c
	Nimtola	0.00 c	0.00 c
	Baisha	0.00 c	0.00 c
	Sarifpur	0.00 c	0.00 c
	Chandpur	0.00 c	0.00 c
	Mathuapara	0.00 c	0.00 c
	Nirbaskhola	0.00 c	0.00 c
	Shiorda	**41.00 a**	**1.17 b**
Dhaka Savar	Singair	0.00 c	0.00 c
	Baliadangi	0.00 c	0.00 c
Manikganj Singair	Golap Gram	0.00 c	0.00 c
	Sadullapur	0.00 c	0.00 c
CV		75.80	109.71
LSD		5.3364	0.5204
Level of Significange		**	**

Figures with similar letters of a column do not differ significantly.
** Means significant at the 0.01 probability level.

4.1.10. Foot Rot Disease of Rose

A. Symptomological Study

The lower part of the main stem which stayed adjacent to soil level was mostly attacked by foot rot disease. A prominent gall was formed at the soil level of the plants. The shape of the gall was uneven, and hardened into a dark, woody mass. The stems were started to rot and form black color. The rotten portion was water soaked and the entire plants were died (Plate 25).

Plate 25. Crown Gall and Foot rot diaease of Rose

B. Identification of Causal Organism

The identified causal organisms of foot rot disease of Rose were *Fusarium oxysporum*. The microconidia of *Fusarium oxysporum* were small, oval shaped, single or bicelled and hyaline. The macroconidia were multicelled with 3-4 septation were observed under microscope, which were sickle shaped with knotched base at one end (Plate 26-B). The pure culture (Plate 26.C-D) of *Fusarium* was prepared. In the culture, the colonies were moderately fast growing and produced from white to reddish orange colored culture on PDA medium within 7 days.

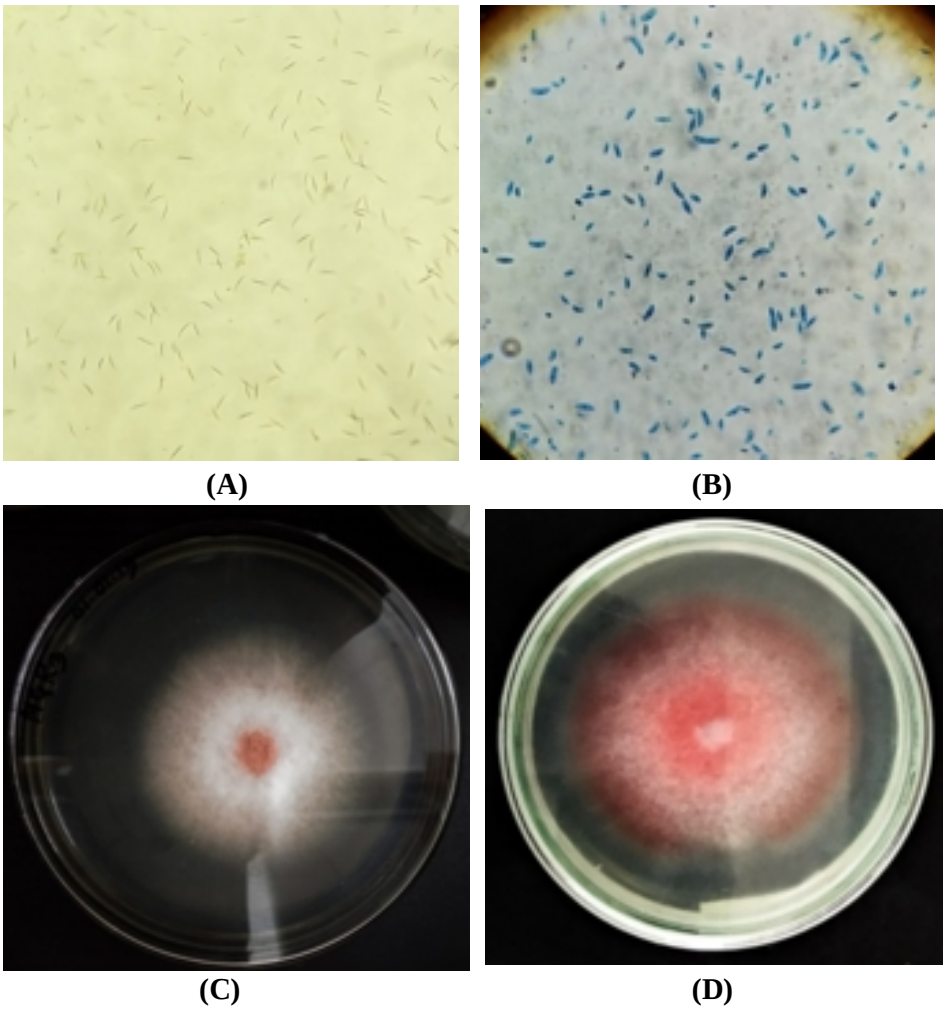


Plate 26. Causal organisms and Pure culture of Foot rot disease of Rose; (A) Macro Conidia of *Fusarium oxysporum* in magnification of (10×10); (B) Macro Conidia of *Fusarium oxysporum* in magnification of (10×40); (C) Young culture of *Fusarium oxysporum*; (D) Mature pure culture of *Fusarium oxysporum*

C. Incidence and Severity of the Disease

Incidence of foot rot disease of Rose was found in only at Gaburapur, at Jashore, and that ranged from 0.33 to 8.33%. The disease incidence and disease severity were recorded in Gaburapur was 8.33% and 0.33% respectively. No disease was found in other locations.

4.1.11. Rust Disease of Rose

A. Symptomological Study

The leaves were containing numerous reddish to orangish rusty spots. Spots were on the top of the leaves. On some leaves the spots coalesced and formed bigger spots, irregular, brownish in color, gave the leaves rusty appearance. The spots were formed within vein and veinlet. On the advance stage of the disease, the leaf became yellowing and blighted followed by eventual leaf death (Plate 27). No organism was identified from this disease.

Plate 27. Rust disease of Rose

B. Incidence and Severity of the Disease

Rust disease of Rose was found only in Sarifpur, Jashore. Disease incidence ranged from 3.33 to 35%. The disease incidence and disease severity were recorded only in Sarifpur village of Jhikargacha was 35.00% and 3.33%, respectively. In other locations, this disease was absent during survey period.

Experiment 2: Diseases of Rose in Different Nurseries of Dhaka

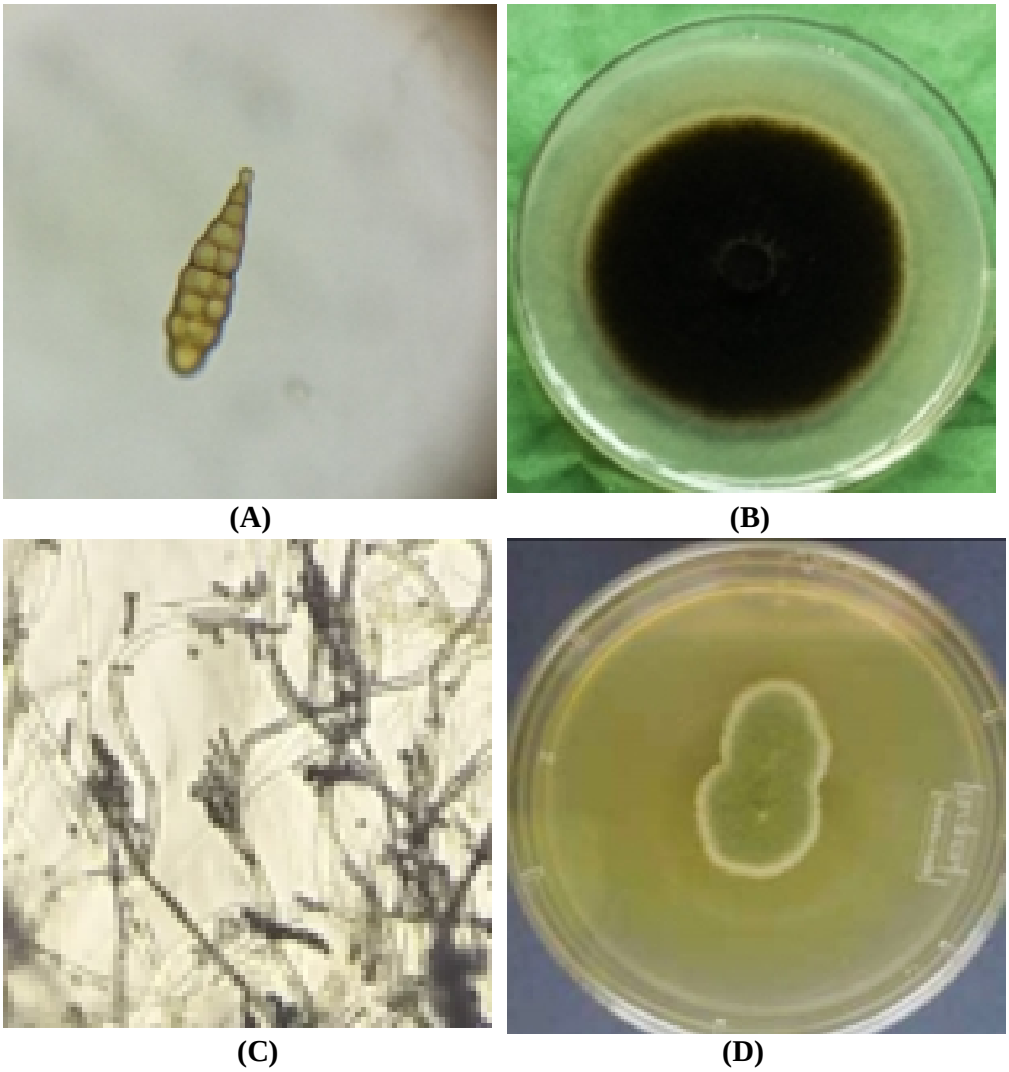
4.2.1. Black Spot Disease of Rose

A. Mycoflora Associated with Black Spot Disease

In nursery, the identified mycoflora associated with black spot disease of Rose were *Alternaria* sp. (Plate 28.A-B), *Penicillium* sp. (Plate 28.C-D), *Aspergillus niger* (black), *Aspergillus flavus* (green), and *Aspergillus ochraceous* (brown).

B. Incidence and Severity of the Disease

Disease incidence of black spot of Rose at Savar and Agargaon were 17.33% and 17.00%, respectively. However, disease severity were 1.90% and 1.33% in Savar and Agargaon, respectively (Table 12).



(A) **(B)**

(C) **(D)**

Plate 28. Causal organisms and Pure culture of Black spot of Rose; (A) Single Conidia of *Alternaria sp*. (10×40); (B) Pure culture of *Alternaria sp*.; (C) Microscopic structure of *Penicillium sp*. (10×40); (D) Pure culture of *Penicillium sp.*

4.2.2. Leaf Spot Disease of Rose

A. Symptomological Study

Numerous, small to medium sized, black colored, roundish shaped spots were present on the upper side of the leaves. They were situated scatteredly upon the leaves. No margin or yellow halo was present in the spots (Plate 29).

B. Identification of Microfungi Associated with Leaf Spot Disease

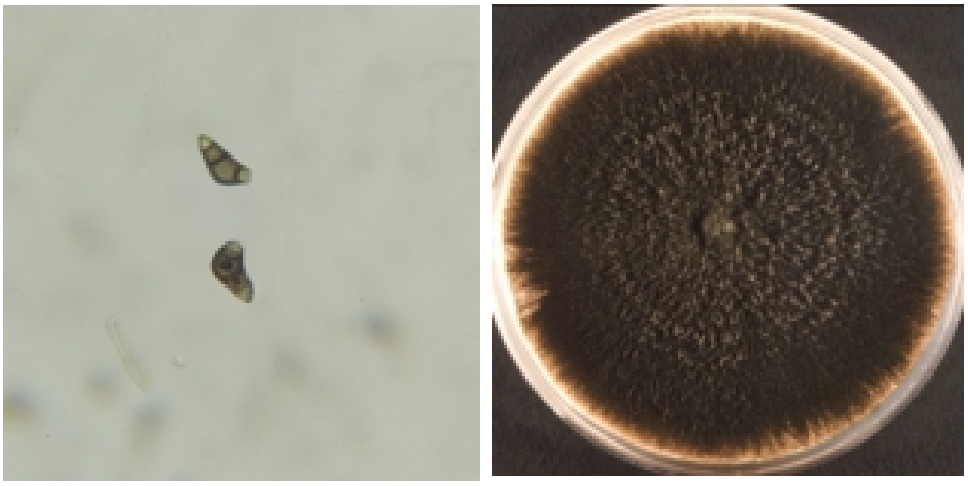
In nursery, the identified microfungi from leaf spot disease of Rose were *Alternaria sp., Penicillium sp., Rhizoctonia sp., Aspergillus niger* (black), *Aspergillus flavus* (green),

Aspergillus ochraceous (brown), and *Curvularia* sp. In *Curvularia sp*., the mycelium was septate, branched, light brown in color. The conidia were septate, 3-5 celled, more or less fusiformed, ends are blunts. The conidia were curved at the middle and the middle cells were larger than the end cells, light brown in color (Plate 30.A). The pure culture of *Curvularia sp.* was initially white, in mature stage turned blakish in color on PDA medium (Plate 30.B).

C. Incidence and Severity of the Disease

Disease incidence of leaf spot at Savar and Agargaon were 21.00% and 11.33% and the disease severity were 1.40% and 1.23%, respectively (Table 12).

Plate 29. Leaf spot disease of Rose in nursery



(A) **(B)**

Plate 30. Causal organisms and Pure culture of Leaf spot of Rose; (A) Conidia of *Curvularia sp.* (10×40); (B) Pure culture of *Curvularia sp.*

4.2.3. Leaf Blight Disease of Rose

A. Symptomological Study

The blighted area of infected leaves were dark brown, irregular in shape, occur on the both upper and lower leaf surfaces. The blighting of the leaf was started from any portion of the leaves irregularly. The blighted area had thin dark brown margin (Plate 31).

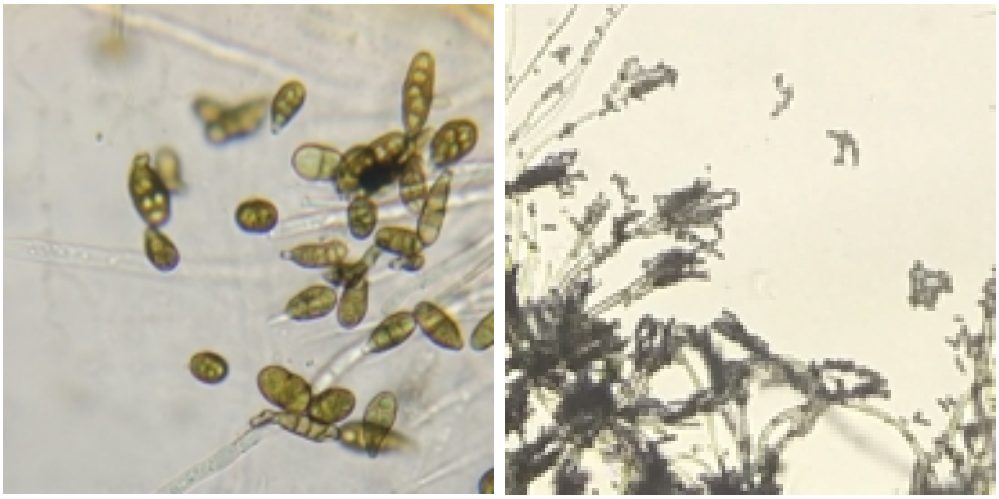
B. Identification of Causal Organism

In nursery, the identified mycoflora from leaf blight disease of Rose were *Alternaria* sp. (Plate 32.A), and *Penicillium* sp. (Plate 32.B).

C. Incidence and Severity of the Disease

Disease Incidence of leaf blight of Rose at Savar and Agargaon were 16.60% and 11.00% and the disease severity were 1.33% and 1.17%, respectively (Table 12).

Plate 31. Leaf blight disease of Rose in nursery



(A) **(B)**

Plate 32. Mycoflora associated with leaf blight disease of Rose; (A) Conidia of *Alternaria* sp. with mycelia (10×40); (B) Microscopic structure of *Penicillium* sp. (10×40)

4.2.4. Flower Rot Disease of Rose

A. Identification of Causal Organisms

In nursery, the identified causal organisms of flower rot disease of Rose were *Alternaria* sp. and *Botrytis cinerea.*

C. Incidence and Severity of the Disease

Disease incidence of flower rot of Rose at Savar and Agargaon were 4.67% and 10.67% and the disease severity were 0.50% and 0.67%, respectively (Table 12).

4.2.5. Mosaic Disease of Rose

A. Incidence and Severity of the Disease

Disease incidence of mosaic disease of Rose at Savar and Agargaon were 9% and 19% and the disease severity were 0.67% and 1.83%, respectively (Table 12).

Table 12. Incidence and severity of different diseases of rose in nursery at Dhaka

Location	Leaf Spot		Leaf Blight		Black Spot		Mosaic		Flower Rot	
	DI %	DS%	DI %	DS%	DI %	DS%	DI %	DS%	DI %	DS%
Savar	21.00 a	1.40 a	16.6 a	1.33 a	17.33 a	1.90 a	9.00 b	0.67 b	4.67 a	0.50 a
Agargaon	11.33 a	1.23 a	11.00 a	1.17 a	17.00 a	1.33 a	19.00 a	1.83 a	10.67 a	0.67 a
CV	42.03	30.54	20.66	43.20	28.04	22.44	18.21	16.33	40.20	34.99
LSD	23.87	1.41	10.04	1.90	16.91	1.27	8.96	0.72	10.83	0.72
Level of Signific.	*	*	*	*	*	*	*	*	*	*

Figures with similar letters of a column do not differ significantly.
* Means significant at the 0.05 probability level.
DI- Disease Incidence; DS- Disease Severity

Experiment 3: Survey on Socio-Economic Status, Cultivation Practices, Diseases and Other Problems Related to Rose Cultivation at Jashore, Savar and Manikganj Districts

The study was done through a pre tested questionnaires and interviews. Physical field visits were also conducted to make a real picture of the diseases of Rose. The data collecting from the fields were analyzed statistically. The results obtained from the studies conducted in the survey areas are presented below sequentially in various forms and thus discussed as to extract the findings systematically in line with the objective of the research work.

A. Survey on Socio-Economic Status of Rose Farmers

4.3.1. Gender of the Farmers

In the survey program, 54 rose farmers were participated in Jashore, 6 farmers were participated in in Savar, Dhaka and 3 rose growers were participated in the field survey at Manikganj. Among them, most (93.89%) of the rose farmers were male and 6.35% were female (Table 13).

Table 13. Gender of the Rose flower farmers

District	Gender	No. of the respondent	Response (%)
Jashore	Male	50	79.36
	Female	4	6.35
Dhaka	Male	6	9.52
	Female	0	0
Manikganj	Male	3	4.76
	Female	0	0
Total		**63**	**100.0**

4.3.2. Age of Rose Farmers

Majority of the rose farmers (42.86%) were 30 to 40 years old (Table 14). 20.63% farmers were below 20 years old and 15.87% farmers were above 50 years old. Around 19% rose growers age were between 40 to 50 years.

Table 14. Age of the farmers engaged in Rose flower cultivation

Ages (years)	No. of respondent	% Response
<30	13	20.63
30-40	27	42.86
40-50	12	19.05
>50	10	15.87
Total	**63 [N=63]**	**100.0**

4.3.3. Education of the Rose Flower Farmers

Education level of rose growers from class One to HSC was 74.60%. Among the education level of farmers, Class IV to SSC was ranked first (33.33%) followed by Class 1-5 (22.22%). About one ninth of the total farmers were illiterate (Table 15). Among the respondent, 9.52% completed Degree and 4.76% completed Masters. From this finding it was revealed that the intensive training about Rose cultivation and its diseases should be adapted to the illiterate and lower educated Rose farmers.

Table 15. Education level and their percentage of the Rose flower farmers

Education level	No. of respondent	% Response
Illiterate	7	11.11
Class 1-5	14	22.22
Class 6- SSC	21	33.33
HSC	12	19.05
Degree	6	9.52
Masters	3	4.76
Total	**63**	**100.0**

4.3.4. Land Utilization under Rose Cultivation

Land utilization by farmers under rose cultivation ranges from 2 to 10 bigha was 73.02% (Table 16). 47.62% farmers cultivate rose in between 6-10 bigha lands. However, around one fourth farmers cultivate rose from 2 to 5 bigha lands. 17.46% farmers cultivate rose in below 2 bigha lands. Around 10% farmers cultivate rose in more then 10 bigha lands.

Table 16. Land utilization under Rose flower cultivation

Land utilization (Bigha)	No. of respondent	% Response
<2	11	17.46
2-5	16	25.40
6-10	30	47.62
10<	6	9.52
Total	**63**	**100**

4.3.5. Farmers' Opinion on the Land Utilization Pattern for Rose Cultivation [N=63]

According to the farmers opinion, on an average total land area owned of 63 farmers was 1.62 ha, of which average cultivable land under total land owned was 1.48 ha. The average land under Rose flower cultivation was 0.54 ha. From these findings, it was revealed that a large portion of the cultivable lands of the farmers was engaged under Rose flower cultivation (Table 17).

Table 17. Farmers' opinion on the land utilization pattern for Rose cultivation

Land utilization pattern	Average Land size	
	Bigha	**Hectare**
Total land area owned	12.17	1.62
Cultivable land under total land owned	11.11	1.48
Land area under Rose flower cultivation	4.09	0.54

*1 hectare = 7.5 bigha

4.3.6. Duration (year) engaged in Rose flower cultivation

The farmers were engaged in Rose cultivation was more than 15 years. Out of 63 farmers, most of them were cultivating Rose ranging 6 to 15 years (60.32%), among them farmers engaged in rose cultivation from 6 to 10 years ranked first (38.10%) (Table 18).

Table 18. Duration (year) engaged in Rose flower cultivation

Duration (year)	No. of respondent	% Response
<5	15	23.81
6-10	24	38.10
11-15	14	22.22
15<	10	15.87
Total	**63**	**100**

4.3.7. Plant Age Status of the Surveyed Field

In most of the fields (47.62 %), plant age was between 5 to 10 years which is ranked first in the table. A few (17.46%) field were observed with less than 5 year old plants. 11-15 years aged plants were observed in 25.40% field and 9.52% plants were observed as more than 15 years aged (Table 19).

Table 19. Plant age status of Rose at Jashore

Plant age (year)	No. of Field	% Field
<5	11	17.46
5-10	30	47.62
11-15	16	25.40
15<	6	9.52
Total	**63**	**100**

B. Survey on Production Technology Used by Rose Farmers

4.3.8. Source of Planting Materials Used by Rose Farmers for Cultivation

Farmers were collecting planting materials of rose from very limited sources. Out of 63 farmers, most of them were collecting planting materials of Rose from nursery, importers and dealers (80.96%). The importers and dealers import rose planting materials mostly from India of different hybrid varieties such as Mirinda, Irani rose etc. Among all sources, farmers collected seedlings mostly from nursery (36.51%) quality hybrid rose varieties were found less in numbers comperatively in lower price than imported seedlings and some farmers collected there rose seedlings from importers (30.16%) where they found rich quality hybrid roses (Table 20).

Table 20. Farmers' opinion on the source of planting materials (seedlings) used for Rose cultivation

Source of Rose planting materials	Response	
	No. of respondent [N=63]	% Response
1. Nursery	23	36.51
2. Directly from importer	19	30.16
3. Personal propagation	3	4.76
4. Local market	4	6.35
5. Dealer	9	14.29
6. Others	5	7.94
Total	**63**	**100**

4.3.9. Fertilizer Application on Rose Fields

Total amount of Cow dung is applied once during land preparation @ 10,000kg/ha with Urea, TSP, MOP, Zinc and Zypsum @ 40 kg/ha, 45 kg/ha, 35 kg/ha, 12 kg/ha and 20 kg/ha respectively as basal dose. P and K are applied again with N, Boron, Zypsum and Zinc as top dressing after prunning @ 20 days interval. When flowering starts, rest of NPK, Boron, Zypsum and Zinc are applied @ 185, 110, 100, 8, 14 and 85 kg/ha @ 2 weeks interval respectively (Table 21).

Table 21. Fertilizer application on Rose fields

Manure/ Fertilizer	Dose per ha (Kg)	Basal Dose per ha (Kg)	Top dressing (Kg/ha)	
			First*	Second**
Cow dung	10,000	Entire amount	-	-
Urea	300	40	75	185
TSP	350	45	95	110
MOP	200	35	65	100
Boron	20	-	12	8
Zinc	35	12	9	14
Zypsum	150	20	45	85

* After prunning @ 20 days interval.

**When flowing starts @ 2 weeks interval.

4.3.10. Cost Involved in Pest Management of Rose Cultivation

According to the farmers opinion total cost involved for pest management of Rose is around 30,000 taka per year per bigha. 12000 taka is for disease management and the rest is for insects and weeds. Insect and weed management needs 8000 taka and 5000 taka per year per bigha. 5000 taka is needed for other pest management (Table 22).

Table 22. Cost involved in pest management of Rose cultivation

Cost/Bigha/Year (Tk.)			Other pest control cost Tk/Bigha/Year
Disease	Insects	Weeds	5000
12,000	8,000	5,000	
Total 30,000			

4.3.11. Buyer of Rose from Farmers

Among the 63 farmers, 55.56% reported that they sell the flowers through middle man. Least (3.17%) number of farmers can sell on the other ways. Some (36.51%) of the farmers can sell directly too (Table 23).

Table 23. Buyer of Rose from farmers

Buyer	No. of respondent [N=63]	% Response
Directly	23	36.51
Middle man	35	**55.56**
Others	2	3.17
Total	**63**	**100.0**

4.3.12. Cost Involved and Benefit Cost Analysis for Rose Production/bigha

Cost of production of rose was more or less same of all farmers. Farmers who cultivated as open cultivation in field comperatively had less cost than who practiced shade culture. Though the open culture had less cost for production, there produced less quality flower sticks, more diseases infested and farmers got less market price than these which produced in shade culture. In shade culture, there produced comperatively high quality flowers, less infested by diseases, comperatively easy for managements and farmers got more market price. On average 7,14,800 tk/bigha was involved in shade culture during first year of planting (Table 24).

Table 24. Cost Involvement in Rose Cultivation (Bigha/year)

Cost involvement	1st year Tk/Bigha	2nd year Tk/Bigha	5th year Tk/Bigha	10th year Tk/Bigha
Land preparation	30,000	-	-	-
Shade preparation	4,00,000	-	-	-
Planting Materials	1,60,000	-	-	-
Weeding	36,000	36,000	36,000	28,800
Irrigation	20,000	20,000	20,000	15,000
Pesticide	30,000	30,000	25,000	20,000
Picking and Packaging	28,800	43,200	86,400	72,000
Other cost	10,000	10,000	10,000	10,000
Total cost	**7,14,800**	**1,39,200**	**1,77,300**	**1,45,800**

[Planting Materials : 1 plants/m^2, 1333 plants/bigha, 120tk/plant ; Weeding : 1 times/month, 10 persons/month, 300 Tk/person (in first year), 1 times/month, 8 persons/month, 300 Tk/person (in tenth year); Picking and packaging 1st year: 2 times/month , 4 person/times, 300tk/person, 2nd year: 3 times/month, 4 person/times, 300tk/person, 5th year: 6 times/month , 4 person/times, 300tk/person, 10th year: 5 times/month , 4 person/times, 300tk/person]

4.3.13. Benefit Cost Ratio of Rose Cultivation (Bigha/year)

The cost was varied year to year. Generally they kept the Rose plants in the field up to 15 to 16 years. After that they replanted the seedlings. The production of flower sticks was varied and depended upon different factors. The flower sticks productions was lower initially and gradually increased with time. Generally rose plants gave higher and quality sticks upto 10 years. After that the production was decreased. About on average 1,27,968 sticks/year/bigha was produced in first year, 2,55,936 sticks/year/bigha was produced in 5th year and 1,91,952 sticks/year/bigha was produced in tenth year. In the peak season farmers got about 10 Tk/stick, in off peak they got about 4 Tk/stick and on average 7 Tk/stick. On some special days and occassions such as international mother language day, victory day, valentines day the demand of flowers was high and farmers get more price of flowers. They got upto 15 Tk/stick on these occasions. On average the Net profit cames from rose cultivation was about 39,73,512 Tk/Bigha/10 years (Table 25).

Table 25. Benefit Cost analysis of Rose (Bigha/year)

Cultivation Year	Production (Sticks/year)	Price (Tk/stick)	Total cost Tk (Bigha/year)	Total Income Tk (Bigha/year)	Net profit Tk (Bigha/year)
1st	1,27,968	Peak: 10 off Peak: 4 Average: 7	7,14,800	8,95,776	1,80,976
2nd	1,59,960	Peak: 10 off Peak: 4 Average: 7	1,39,200	11,19,720	9,80,520
5th	2,55,936	Peak: 10 off Peak:4 Average: 7	1,77,400	17,91,552	16,14,152
10th	1,91,952	Peak: 10 off Peak: 4 Average: 7	145,800	13,43,664	11,97,864
Total			**11,77,200**	**51,50,712**	**39,73,512**

C. Survey on Farmers Opinion on Diseases of Rose

4.3.14. Incidence of Diseases in the Rose Field

Considering the opinion expressed by the farmers, the incidence of diseases of Rose in field were Leaf spot, Leaf blight, Flower Rot, Mosaic, Die back and Canker, Black Spot, Anthracnose, Powdery Mildew, Foot rot, Leaf Curl, Dry Brown Spot, Stem Dry Rot, Rust, Wilt and Gall. Among these diseases Flower Rot, Leaf Spot, Leaf Blight, Mosaic, Powdery Mildew, Die back and Black Spot ranked first to seventh position as per

opinion by the 96.83%, 90.48%, 76.19%, 60.32%, 52.38%, 49.21%, and 36.51% of 63 farmers. More or less all stages of the Rose flower were attacked by the diseases, where the dominating disease such as leaf spot, leaf blight and Mosaic caused infections at seedling, vegetative and flowering stages, whereas Flower Rot, Powdery Mildew and Black Spot at vegetative and flowering stages of the Rose plants in the field. The infestation intensity of the maximum diseases was low to medium expressed by the most of the farmers. On the other hand, flower rot caused damage with high intensity expressed by the 96.83% farmers (Table 26).

Table 26. Farmers' response on the incidence of disease infections in the Rose field

Name of disease	No. of respondent N=63]	% Response	Stage of crop infected	Infection intensity (%)			
				High	Medium	Low	Total
1. Leaf spot	57	90.48	Seedling, vegetative, flowering stage	12.28	54.89	29.82	100.0
2. Leaf blight	48	76.19	Seedling, vegetative, flowering stage	14.58	68.75	35.42	100.0
3. Flower Rot	61	96.83	Vegetative and flowering stage	18.03	59.02	22.95	100.0
4. Mosaic	38	60.32	Seedling, vegetative, flowering stage	7.89	26.32	65.79	100.0
5. Die back	31	49.21	Vegetative and flowering stage	9.68	29.03	61.29	100.0
6. Black Spot	23	36.51	Vegetative and flowering stage	39.13	26.09	34.78	100.0
7.Anthracnose	7	11.11	Vegetative and flowering stage	-	14.29	85.71	100.0
8. Powdery Mildew	33	52.38	Vegetative and flowering stage	63.64	30.30	9.09	100.0
9. Foot rot	5	7.94	Vegetative and flowering stage	-	40.00	60.00	100.0
10. Leaf Curl	19	30.16	Seedling, vegetative, flowering stage	15.79	47.36	36.84	100.0
11. Dry Brown Spot	12	19.05	Vegetative and flowering stage	25.00	41.67	33.33	100.0
12. Stem Dry Rot	4	6.35	Vegetative and flowering stage	50.00	25.00	25.0	100.0
13. Rust	3	4.76	Vegetative and flowering stage	-	33.33	66.67	100.0
14. Wilt	8	12.70	Seedling, vegetative, flowering stage	-	25.00	75.00	100.0
15. Gall	11	17.46	Vegetative and flowering stage	9.09	36.36	54.55	100.0

4.3.15. Relationship among Insect Pest, Disease and Weed Infestation in Rose field

At Jashore, Savar and Manikganj most of the farmers (88.89 %) expressed their opinion that there were positive relationship among insect pest, disease and weed infestation in the field, whereas only 11.11% farmers expressed their negative opinion (Table 27).

Table 27. Farmers' opinion on the relationship among insect pests, diseases and weed infestation in the Rose field

Types of response	Response on the relationship	
	No. of respondents	% Response
Yes	56	88.89
No	7	11.11
Total	**63**	**100**

4.3.16. Degree of Relationship among Insect Pests, Diseases and Weed Infestation in the Rose Field

There was a positive and high degree of relationship among insect pest and disease incidence with weed infestation as well as disease infection with the incidence of insect vector in the Rose field (Table 28). This result indicates insect infestation and disease infection become high when weed infestation become high expressed by the 52.83% farmers, i.e., insect infestation and disease infection increased with the increase of the weed infestation. But in Manikganj the farmers have negative review on this. Similarly, disease infection become high when insect vector populations become high expressed by the 25.40% farmers, i.e., disease infection was increased with the increase of the vector population. The minimum number of farmers in all three aspects (36.51%) did not reply about the degree of relationship between disease infection and vector population. From this finding it was revealed that weed infestation enhanced the insect pest population and disease incidence; similarly, insect vector also enhanced the incidence of disease infection in the Rose field. Thrips and Red Spider Mites are the major pest of Rose and act as vectors. Some other pests such as Mealy bug, Aphid, leaf miner, White fly, Caterpillars, sawfly etc are also damaged rose.

Table 28. Farmers' response on the degree of relationship among insect pest, disease and weed infestation in the Rose field

Relationship	Degree of relationship	No. of respondents [N=63]	% Response
Insect infestation high when weed infestation	High	33	52.83
	Medium	17	26.98
	Low	7	11.11
	Don't Know	6	9.52
	Total	**63**	**100**
Disease infestation high when weed infestation	High	31	49.21
	Medium	14	22.22
	Low	10	15.87
	Don't Know	8	12.70
	Total	**63**	**100**
Disease infestation high when vector insect	High	16	25.40
	Medium	25	39.68
	Low	13	20.63
	Don't Know	9	14.29
	Total	**63**	**100**

4.3.17. Probable Sources of Pests and Diseases of Rose

The probable sources of diseases were from imported seedlings, air borne, soil borne, local planting materials, use of imbalanced fertilizer, through irrigation water (Table 29). Among these local planting materials was ranked first which played role as source of pest and disease infestation on Rose expressed by the maximum (57.14%) farmers participated in the program. Second most important source was the soil borne expressed by the maximum (23.81%) farmers.

Table 29. Farmers response on the probable sources of Rose disease

Probable sources	Response	
	No. of respondents [N=63]	% Response
1. Air borne	12	19.05
2. Imported seedlings	13	20.63
3. Soil borne	15	23.81
4. Local planting materials	36	57.14
5. Use of imbalanced fertilizer	3	4.76
6. Through irrigation water	2	3.17
7. Other sources (if any)	5	7.94

4.3.18. Probable Ways of Spreading of Rose Disease

Farmer's response on the probable ways of dissemination of Rose diseases is presented in Table 30. Affected seedlings and Insects were the most important ways those were ranked first and second respectively expressed by the maximum (76.19% and 57.14%, respectively) farmers. Other important ways of spread of rose pests and disease were

weeds, wind, grasses, and rain splashing expressed by the 30.16%, 52.38% and 46.03% farmers. Irrigation water, Crop debrises and manure, interculture with other crops were also played role as probable ways in spreading rose pests and disease. Few farmers were interculture Rose with Thuja, Chilli, Brinjal, Marigold etc. (Table 30).

Table 30. Farmer's response on the probable ways of spread of Rose disease

Probable ways of spread of Rose disease	No. of respondents [N=63]	% Response
1. Affected seedlings	48	76.19
2. Infested soils	24	38.10
3. Weed and Grasses	19	30.16
4. Insects	36	57.14
5. Wind	33	52.38
6. Irrigation water	11	17.46
7. Crop debrises and Manure	16	25.40
8. Rain splashing	29	46.03
9. Spreads through human being	8	12.70
10. Spreads through interculture with other crops	5	7.94

4.3.19. Measures Taken to Control Diseases and Pest of Rose in the Field

At Jashore, Savar and Manikganj, among 63 farmers, majority (60.32%) of them said that they took any measures to control diseases and pest of Rose in the field. A small portion (22.22%) of the farmers did not reply the matter, i.e., whether they took any measures or not to control Rose diseases and pests in the field (Table 31).

Table 31. Farmers' response on measures taken to control disease of Rose in the field

Types of response	Response on the measures taken to control pests	
	No. of respondents	% Response
Yes	38	60.32
No	11	17.46
Not replied	14	22.22
Total	**63**	**100**

4.3.20. Types of Measures Taken to Control Disease of Rose in the Field

Among 63 farmers at Jashore, Savar and Manikganj, majority (52.38%) of them had taken both preventive and curative measures to control diseases of Rose in the field. Whereas 42.86% farmers said that they took preventive measures and 22.22% farmers took curative measures for the control Rose diseases in the field (Table 32).

Table 32. Farmers' response on the types of measures taken to control disease of Rose in the field

Types of measures	Response (%) on the types of measures taken	
	No. of respondent [N=63]	% Response [100%]
1. Preventive	27	42.86
2. Curative	14	22.22
3. Both	33	52.38

4.3.21. Disease Control in Rose Fields

At Jashore, Savar and Manikganj, among different methods applied for the management of Rose pests and diseases in the field, all of the farmers applied pesticides to control insect pests, diseases and weeds (100%); i.e., application of pesticides was the most widely used method to control Rose pests and diseases in the field (Table 33). They consider it the better management practices for disease and pest control. Considering the farmers' opinion, the better management practices for disease control in Rose were the spraying of fungicides such as Dithane M-45, Tilt, Mancozeb, Acrobat MZ, Amamectin benzoid, Abamectin etc. The concentration was used about 2ml/L of water in case of liquid fungicide and insecticide (Amamectin benzoid, Abamectin) and for Mancozeb they used 3gm/L water as spray. Half of the farmers respond that, control cultivation under poly shade is also very effective to avoid and manage diseases of rose.

Table 33. Farmers' response on the methods of disease control applied in the Rose field

Methods of disease control	Response on the methods applied	
	Diseases	
	Nos. [N=63]	% Response
1. Use of pesticides	63	100
2. Cultivation of imported hybrid Rose seedlings	29	46.03
3. Cultural practices (control cultivation)	31	49.21
4. IPM method	9	14.29
5. Others (if any)	6	9.52

4.3.22. Farmers Response on Receiving Assistance and Service for Controlling Diseases of Rose

Most of the farmers responded positive about receiving assistance and other services from different sources. 33.33 % of the farmers said that the field level officers visit the fields regularly and observe the disease development. 7.93% farmers reported to have suggestions from the experts about different diseases. 36.51% of the 63 farmers mentioned that the field level officers (SAAO) often sit in meetings about their problems. 4.74% farmers have given no opinion (Table 34).

Table 34. Farmers response on receiving assistance and service for controlling diseases of Rose

Assistance and service	No. of respondent [N=63]	% Response
1.Visit of Extension Officers	21	33.33
2. Experts suggestion	5	7.93
3. Field day	7	11.11
4. Field demosntration	4	6.35
5. Meeting with the field level officers (SAAO)	23	36.51
6. No opinion	3	4.74
Total	**63**	**100.0**

4.3.23. Major Diseases of Rose

According to their opinion the major diseases of rose were Leaf spot, Leaf blight, Flower Rot, Mosaic, Die back and Canker, Black Spot, Anthracnose, Powdery Mildew, Foot rot, Leaf Curl, Dry Brown Spot, Stem Dry Rot, Rust, Wilt and Gall (Table 35). Among these diseases Flower Rot, leaf spot, leaf blight, Mosaic, Powdery Mildew, Die back and Black Spot ranked first to seventh expressed by the 96.83%, 90.48%, 76.19%, 60.32%, 52.38%, 49.21%, and 36.51% of 63 farmers. At Savar, Major diseases were Black Spot, Leaf blight, Leaf Spot, Flower Rot, Leaf curl and Mosaic expressed by the 6 farmers and in Manikganj major diseases were Black Spot, Leaf blight, Leaf Spot, Flower Rot, Leaf curl, Mosaic and foot rot expressed by the 3 farmers. Other important diseases were Anthracnose, Foot rot, Dry Brown Spot, Stem Dry Rot, Rust, Wilt, Gall, etc at Jashore (Table 40) and Die back and Canker, Anthracnose, Wilt, Gall etc. at Savar and Manikganj.

Table 35. Farmers' response on the major diseases of Rose

Name of diseases of Rose	Farmers' response on the major diseases	
	No.of respondent [N= 63]	% Response
1. Leaf spot	57	90.48
2. Leaf blight	48	76.19
3. Flower Rot	61	96.83
4. Mosaic	38	60.32
5. Die back and Canker	31	49.21
6. Black Spot	23	36.51
7. Anthracnose	7	11.11
8. Powdery Mildew	33	52.38
9. Foot rot	5	7.94
10. Leaf Curl	19	30.16
11. Dry Brown Spot	12	19.05
12. Stem Dry Rot	4	6.35
13. Rust	3	4.76
14. Wilt	8	12.70
15. Gall	11	17.46

4.3.24. Farmers Suggestions for Better Managements of Diseases of Rose

Some operations should be involved for better management of disease of Rose like use of healthy planting materials, effective use of insecticides & pesticides, proper inter-culture operation, regular field visit, more research and use of disease resistant variety. Most (84.13%) of the farmers responded were positive about effective use of insecticides & pesticides for better management of disease of Rose. About 61.90% farmers suggested about use of healthy planting materials and least (11.11%) number of farmers emphasized on more research (Table 36). 17

Table 36. Farmer's suggetions for better managments of diseases of Rose

Suggestions	No. of respondent [N=63]	% Response
1. Use of healthy planting materials	39	61.90
2. Effective use of insecticides & pesticides	53	84.13
3. Proper inter-culture operation	13	20.63
4. Regular field visits	21	33.33
5. More research on disease management	7	11.11
6. Use of disease resistant variety	8	12.70

CHAPTER V

DISCUSSION

Investigation and survey of field and nursery diseases on Rose was conducted at three districts of Bangladesh. The locations were Jhikorgacha upazila of Jashore, Savar and Sadar upazila of Dhaka and Singair upazila of Manikgang district. Disease samples were collected from investigated areas and pathogens were isolated from those samples. Disease incidence and severity were also recorded. Plant Disease Survey Sheet was used to collect information on symptomology of diseases and to record disease incidence and severity data. The surveys were conducted under natural epiphytic condition. Data was collected with three replications. Moreover, data were collected by interview of the respondents (rose farmers). Questionnaire, the instruments for data collection, were formulated and pre-tested in two districts namely Dhaka and Manikganj prior to the survey. In first experiment, field diseases of rose were investigated. During investigation, in total, 11 diseases were identified from rose plants. The diseases were leaf spot, black spot, leaf blight, flower blight, powdery mildew, mosaic, dieback, stem dry rot, dry brown spot, foot rot, and rust.

Four types of leaf spot diseases were observed in the field. One leaf spot disease was light brown to orangish in color, irregular in shape, surrounded by dark brown to black thin margin. The spots are generally occur on the margin of the leaves and visible in both upper and lower surfaces. Another kind of leaf spot showed light brown to ash color spots, nearly circular to irregular in shape, surrounded by dark brown to black margin. The spots are initially small, blackish in color and numerous in number. They appears on the whole leaf and only be seen on the upper surface of the leaf. In progress, they become coalesces from the leaf margin and gradually make the leaf blighted. Again, another type of leaf spot had numerous, black, circular to irregular spots. They appear scattertedly upon the whole leaf. They only be seen on the upper surface of the leaf. The spot size are small. The spots have no center and no margin surrounding it. In case of cercospora leaf spots, the spots are purple to brown in color, round or nearly round in shape, numerous in number. Spots are seen only on the upper surface of the leaves. They have a tiny centre, light brown to whitish in color surrounded by dark margins. The isolated mycoflora associated with leaf spot diseases of Rose were *Pestalotia guepinii., Alternaria alternata, Alternaria sp., Botrytis cinerea*, *Penicillium* sp., *Cercospora* sp. *Cladosporium* sp., *Epicoccum purpurescens, Nigrospora oryzae, Aspergillus niger* (black), *Aspergillus flavus* (green), *Aspergillus ochraceous* (brown), *Aspergillus sydewii* (yellow) and *Aspergillus terreus***.** The leaf spots were one of the common diseases of Rose. It was found in all the 21 locations of Jhikorgacha Upazila, Jashore, Savar and Manikganj except Nimtola at Jashore. All the fields were affected almost more or less in same extent. Panisara union of Jashore had the highest disease incidence which is 43.33% whether the highest disease severity was found at Singair Upazila of Manikganj district which is 11%. Both the disease incidence and severity varied significantly with the locations.

Black spot disease was found as black, nearly circular or unevenly circular in size, occur on the upper leaf surfaces. They have characteristic feathery or fringed margins. Few spots had small, irregular light brown center, some had not any center. The identified mycoflora from black spot disease were *Pestalotia guepinii., Alternaria* sp., *Penicillium* sp., *Rhizoctonia solani*, *Aspergillus niger* (black), *Aspergillus flavus* (green), and *Chaetomium* sp. This disease was recorded at 15 locations. The highest disease incidence and disease severity were recorded in Singair Upazila of Manikganj (86.33% and 25%, respectively) and No disease was found in Patuapara of Godkhali union, Panisara of Panisara union, Hariya, Sarifpur and Mathuapara villages of Navaron union of Jhikargacha, Jashore.

The leaf blight disease was divided into leaf blight$_1$, leaf blight$_2$ and leaf blight$_3$ according to the leaf blight symptoms characteristics. In leaf blight$_1$, the blighted area of infected leaves were greenish brown, irregular in shape, occur on the both upper and lower leaf surfaces. Leaf blight was started from the margin of the leaves and gradually moved towards the center irregularly and blighted area had very thin dark brown margin. In leaf blight$_2$, blighted area of infected leaves were dark brown, irregular in shape, occur on the both upper and lower leaf surfaces. The blighting of the leaf was started from the margin of the leaves irregularly. In leaf blight$_3$, leaves were started to blighting from the lower part and gradually move to the upper part of the leaf. Blighted area of infected leaves were dark brown to black, irregular in shape and occur on the both upper and lower leaf surfaces. The blighted area was irregular in shape and had a blackish center. The peripheral region of the blight was dark to light brown in color, relatively lighter than the center and blighted area had no prominent margin. The identified causal organisms from leaf blight disease were *Pestalotia guepinii., Alternaria* sp., *Botrytis cinerea., Aspergillus flavus* (green), *Aspergillus sydewii* (yellow), and unknown fungi of ascomycotina. The leaf blights were more or less common diseases of Rose. They were found on all the 22 locations of Jhikorgacha Upazila, Jashore, Savar and Manikganj. All the fields were affected almost more or less in same extent. Kulia of Panisara union, Jashore had the highest disease incidence which is 61.67% whether the highest disease severity was found at Singair Upazila of Manikganj district which is 9%. Sayedpara under Panisara union had the lowest (12.33%) disease incidence and disease severity (1.07%). Both the disease incidence and severity varied significantly with the locations.

Similar results also reported by Ghosh and Shamsi in 2014. They worked on four diseases viz. black spot, leaf spot, leaf blight and anthracnose disease of rose in Bangladesh. They reported about the presence of 20 species of fungi belonging to 17 genera, in which they found seven fungal species were associated with black spot viz. *Cladosporium cladosporioides, Cladosporium oxysporum., Marsonina rosea*, *Penicillium* sp., *Alternaria alternata*, *Aspergillus flavus,* and *Pestalotia guepinii*, seventeen fungal species were associated with leaf spot viz. *Aspergillus niger*, *Cladosporium cladosporioides, Cladosporium oxysporum, Curvularia pallescens, Gibberella* sp., *Penicillium* sp., *Pestalotia guepinii*, *Pestalotia guepinii*$_1$ (culture type 1), *Pestalotia guepinii*$_2$ (culture type 2), *Cercospora* sp. *Anthrinium saccharicola*, *Fusarium* sp., *Epicoccum purpurascens, Nigrospora sphaerica* and *Trichoderma viride* and six

fungal species were associated with blight symptom viz. *Alternaria alternata, Aspergillus flavus, Cladosporium cladosporioides, Penicillium* sp., *Pestalotia guepinii* and *Trichoderma viride.* Rao (1964) reported severe leaf spot disease of rose in India associated with an undetermined species of *Alternaria*. However, Hagan (2005) stated that *Cercospora* leaf spot of Rose was caused by *Cercospora rosicola*.

The flower blight disease caused by *Alternaria sp. and Botrytis cinerea.* was found as brown discoloration with stunted and blighted petals. This disease was found at 18 locations. Disease incidence was ranged from 6 to 95%. The highest disease incidence was recorded in Godkhali (95%) that is statistically identical with Panisara (93.33%) and the lowest disease incidence was 6% in Sayedpara. Similarly severity of flower blight was observed in Godkhali of Jashore which is 33.33% followed by Singair (19%) and Baliadangi (8.33%) of Manikganj and in Golap Gram of Savar was 0.67%. No disease was observed in Sadirali, Dhalipara and Baisha villages of Jhikargacha. Pscheidt and Rodriguez (2018) also reported that the flower blight disease was caused by *Botrytis cinerea*.

Powdery mildew was one of the most devastating diseases which was observed in only 10 villages of Jhikorgacha union. Other locations were freed from this disease. Among the villages, Patuapara and Godkhali were highly infected. The disease starts from the leaves and with the time the whole plant are infected. A white, powdery fungal growth on the leaves and shoots was noticed. It affected mainly lower part of the leaves and also affected flower stalks, stems, calyces and petals. It is caused by *Podosphaera pannosa*. The both highest disease incidence and disease severity were recorded in Godkhali (98.33% and 30%, respectively) followed by Dhalipara (96.67% and 26.67%, respectively) and the lowest disease incidence and disease severity were 7.67% and 1.33%, respectively in Sadirali. No disease was recorded in Sayedpara, Kulia, Nimtola, Baisha, Chandpur, Mathuapara, Nirbaskhola, Shiorda, Singair, Baliadangi, Golap Gram and Sadullapur. Pscheidt and Rodriguez (2018) and Sivaplana (1993&1994) also found powdery mildew disease of rose caused by *Podosphaera pannosa*.

Rather, the Mosaic, a viral disease caused by different viruses is also a very common disease of Rose which was found at 18 locations of Jashore, Savar and Manikganj. The symptoms were highly variable. The leaf symptom was a pattern of light and dark green areas including yellow patches that gave a mosaic effect in infected leaves. The highest disease incidence was recorded in Chandpur (40.33%) followed by Sarifpur (37%) and the lowest disease incidence was 5.67% in Sayedpara. In case of disease severity, similar results were observed. Severity of mosaic also varied significantly. The highest disease severity was observed in Singair which is 8.33% followed by Nilkonthonagar (3.67%). Moreover, No disease was observed in Belemath, Dhalipara, Nimtola and Baisha. Paret *et al.* (2014) also found similar result. They reported that *Prunus necrotic ringspot virus* (PNRSV) and *Apple mosaic virus* (ApMV) was associated with mosaic disease of rose.

Another disease of rose was dieback. The disease was recorded in 13 locations. The infected stems were black to brown in color and dry. Incidence of dieback of Rose

ranged from 3 to 68.33%. The both highest disease incidence and disease severity were recorded in Nimtola (68.33% and 4.67%, respectively) and the lowest disease incidence and disease severity were 3% and 0.33%, respectively in Nilkonthonagar and no disease was found in Godkhali, Sadirali, Kulia, Gaburapur, Chandpur, Mathuapara, Shiorda, Golap Gram and Sadullapur. Randy 2013 reported that several fungi are capable of causing stem canker and dieback of roses and responsible fungus was *Coniothyrium* spp.

Stem dry rot diaease of rose was not a very commondisease. It was found in few fields of Patuapara, Belemath and Nilkonthonagar at Jashore. Yellowish to brown spots were found on the stem. The disease formed canker, became sunken, forming wrinkled or cracked lesions that were tan to dark brown. The highest disease incidence and disease severity were recorded in Patuapara (10.67% and 1.67%, respectively) followed by Belemath (3% and 0.33%) and Nilkonthonagar (2.67% and 0.33%) respectively. The lowest disease incidence and severity was 2.67% and 0.33% in Nilkonthonagar and Belemath, respectively. Stem dry rot disease was not recorded in Godkhali, Sadirali, Belemath, Dhalipara, Panisara, Sayedpara, Kulia, Gaburapur, Hariya, Nimtola, Sarifpur, Chandpur, Mathuapara, Nirbaskhola, Shiorda, Singair, Baliadangi, Golap Gram and Sadullapur.

Again a symptom appeared as numerous brown spots on the stems, irregular in shape, brown to light brown in color, surrounded by dark brown, thin margin which was named as dry brown spot. It was found in only 3 locations of Jashore named Patuapara, Panisara and Shiorda. The highest disease incidence was recorded in Shiorda (41%) followed by Panisara (38.33%) and the lowest disease incidence was 14.67% in Patuapara and the highest disease severity was observed in Panisara which is 4%. Moreover, in Shiorda and Patuapara the lowest disease severity was observed which is 1.17%. Most locations were fully freed from this disease. Again, a prominent uneven gall was formed at the soil level of the plants causing rot at the base, which was identified as foot rot diaease of Rose. identified causal organisms are *Fusarium oxysporum*. This disease was recorded in only one location named Gaburapur village of Jhikargacha, Jashore. The disease incidence and disease severity were 8.33% and 0.33%, respectively. Rust disease of rose was observed having numerous reddish to orangish spots on leaves gaving the leaves rusty appearance. It was found only in Sarifpur, Jashore. The disease incidence and disease severity were recorded in Sarifpur was 35% and 3.33% respectively.

In the second experiment, nursery diseases of Rose were investigation and identification in different nurseries of Dhaka district. The data were collected under normal epiphytic condition. In total, five diseases were identified in nursery condition. The diseases were leaf spot, black spot, leaf blight, flower blight and mosaic.

In case of leaf spot disease, numerous, small to medium sized, black colored, roundish shaped spots were present on the upper side of the leaves. The identified microfungi from leaf spot disease of Rose were *Alternaria sp., Penicillium sp., Rhizoctonia solani., Aspergillus niger* (black), *Aspergillus flavus* (green), *Aspergillus ochraceous* (brown), and *Curvularia* sp. Disease Incidence of leaf spot of Rose at Savar and Agargaon were

21% and 11.33% and the disease severity were 1.40% and 1.23%, respectively. The black spot disease was found as black, nearly circular, or unevenly circular in size, occur on the upper leaf surfaces. The identified mycoflora from black spot disease of Rose were *Alternaria* sp., *Penicillium* sp., *Aspergillus niger* (black), *Aspergillus flavus* (green), and *Aspergillus ochraceous (brown)*. Disease incidence of black spot of Rose at Savar and Agargaon were17.33% and 17% and the disease severity were 1.90% and 1.33%, respectively.

Another disease was recorded named leaf blight was had dark brown and irregular in shaped with blight symptoms. The fungi isolated from of leaf blight disease of Rose were *Alternaria* sp., and *Penicillium* sp. Disease incidence of leaf blight of Rose at Savar and Agargaon were 16.60% and 11% and the disease severity were 1.33% and 1.17% respectively. Again in flower blight disease, the outer petals of the flowers started to blight first. The identified causal organisms of flower blight disease of Rose were *Alternaria sp., and Botrytis cinerea*. Disease incidence of flower rot of Rose at Savar and Agargaon were 4.67% and 10.67% and the disease severity were 0.50% and 0.67% respectively. In case of mosaic disease, the leaf symptom was a pattern of light and dark green areas including yellow patches that gave a mosaic effect in infected leaves. Disease incidence of mosaic of Rose at Savar and Agargaon were 9% and 19% and the disease severity were 0.67% and 1.83%, respectively.

Depending on the disease incidence and severity, the major diseases of infected rose plants are; black spot, leaf spot, leaf blight, flower rot and powdery mildew. From Bangladesh this is the second report of association of *Pestalotia guepinii., Alternaria alternata, Alternaria* sp., *Penicillium* sp., *Rhizopus* sp., *Cladosporium* sp., *Epicoccum purpurescens, Nigrospora oryzae, Rhizoctonia solani, Chaetomium* sp., *Curvularis* sp., *Cercospora* sp., *Aspergillus niger* (black), *Aspergillus flavus* (green), *Aspergillus ochraceous* (brown), *Aspergillus sydewii* (yellow) *and Aspergillus terreus* with rose plant and first report on investigation and identification on nursery diseases of rose.

The third experiment was survey on socio-economic status of rose farmers, cultivation practices, diseases and problems related to Rose cultivation at Jashore, Savar and Manikganj district which was carried by using a pre tested questionnaires and interviews. Total 63 rose farmers were selected from 22 villages for this interview. Physical field visit was also done to get a real picture. Among the selected farmers, 93.89% were male and rests 6.35% of the farmers were female. Most of the farmers (42.86%) participated in the field survey at Jashore were 30 to 40 years old and least (15.87%) of them were above 50 years old. Another, 19.05% farmers were 40-50 years and 20.63% farmers were below 30 years old, respectively. The farmers participated in the field survey at Savar and Manikganj were 30 to 50 years old.

However, the education level of farmers was considered in the survey. Only 3 farmers completed post graduation. But education level of most (33.33%) of them was Class IV to SSC. Again, a considerable portion (11.11%) of them were illiterate. Most of the rose farmers utilized their land under rose cultivation was 2 to 10 bigha (73.02%). Around

47% farmers cultivated rose within 6 to 10 bigha lands. Above 10 bigha land area was utilized by least (9.52%) number of farmers. However, on an average total land area owned of 63 farmers at Jashore, Savar and Manikganj was 1.62 ha, of which cultivable land under total land owned was 1.48 ha. The average land under Rose flower cultivation was 0.54 ha. From these findings, it was revealed that a large portion (64.07%) of the cultivable lands of the selected farmers was engaged under Rose flower cultivation. However, 15.87% of the total farmers are cultivating Rose from more than 15 years. Out of 63 farmers, most of them were cultivating Rose from 6 to 10 years (38.10%). About 23.81% of the farmers has been recently engaged in Rose cultivation who are cultivating from below 5 years. During the survey, in most of the fields (65.08%) plant age was between 3 to 10 years. Moreover, 22.22% fields were observed cultivating Rose from 11-15 years. The farmers were collecting planting materials of Rose from very limited sources for cultivation. Out of 63 farmers, most of them (80.96%) were collecting planting materials of Rose from nursery, importers and dealers. The importers and dealers import planting materials mostly from India of different hybrid varieties such as Mirinda, Irani rose etc. Quality hybrid varieties were found less in numbers comperatively in lower price than imported seedlings and some farmers collected there seedlings from importers (30.16%) where they found rich quality hybrid Roses. A less number (4.76%) of farmers have started to preserve plantlets personally as it is more reasonable in production cost. Few (6.35%) collects materials from local market too.

During the survey, the fertilizer application pattern was also recorded as per the opinion of the farmers. Total amount of Cow dung is applied once during land preparation @ 10,000kg/ha with Urea, TSP, MOP, Zinc and Zypsum @ 40kg/ha, 45kg/ha, 35kg/ha, 12kg/ha and 20kg/ha respectively as basal dose. P and K are applied again with N, Boron, Zypsum and zinc as top dressing after prunning @ 20 days interval. When flowering starts rest of NPK, Boron, Zypsum and Zinc are applied @ 185, 110, 100, 8, 14 and 85 kg/ha @ 2 weeks interval respectively. Again, a significant amount of cost is involved for pest management too. According to the farmers opinion, total cost involved for pest management of Rose is around 30,000 taka per year per bigha. 12000 taka is for disease management and the rest is for insects and weeds. Insect and weed management needs 8000 taka and 5000 taka per year per bigha. 5000 taka is needed for other pest management. Moreover, Among the 63 farmers 46.03% reported that they sell the flowers through middle man. Least (3.17%) number of farmers can sell directly to the export company. Some (36.51%) of the farmers can sell directly in the marker too. Different companies also buy from (7.94%) farmers.

Again, the production cost of Rose cultivation was more or less same of all farmers. Farmers who cultivated as open cultivation in field comperatively had less cost than who practiced protective cultivation under shade. Though the open cultivation had less cost for production, there produced less quality flower sticks, more diseases infested and farmers got less market price than these which produced flower under shade. In shade cultivation, there produced comperatively high quality flowers, less infested by diseases, comperatively easy for managements and farmers got more market price. On average 7,14,800 Tk/bigha was involved in shade cultivation during first year of planting. The

cost was varied year to year. Generally they kept the Rose plants in the field up to 15 to 16 years. After that they replanted the seedlings. On average, 11,77,100 Tk was involved in 10 years. The production of flower sticks was varied and depended upon different factors. The flower sticks productions was lower initially and gradually increased with time. Generally rose plants gave higher and quality sticks upto 10 years. After that the production was decreased. On an average 1,27,968 sticks/year/bigha was produced in first year, 2,55,936 sticks/year/bigha was produced in 5^{th} year and 1,91,952 sticks/year/bigha was produced in 10^{th} year. On average 7,35,816 sticks in 10 years were produced. In the peak season farmers got about 10 Tk/stick, in off peak they got about 4 Tk/stick and on average they sell flower as per 7 Tk/stick. On some special days and occassions such as International Mother Language Day, Independence Day, Victory Day, Valentines Day the demand of flowers was high and farmers get more price of their flowers. They got upto 15 Tk/stick on these occasions. On average the total income was 51,50,712 Tk and the net profit cames from rose cultivation was about 39,73,512 Tk/Bigha/10 years.

Considering the opinion expressed by the farmers, the diseases incidence of Rose in field were leaf spot, leaf blight, flower rot, mosaic, die back and canker, black spot, anthracnose, powdery mildew, foot rot, leaf curl, dry brown spot, stem dry rot, rust, wilt and gall. Among these diseases, flower rot, leaf spot, leaf blight, mosaic, powdery mildew, die back and black spot ranked 96.83%, 90.48%, 76.19%, 60.32%, 52.38%, 49.21%, and 36.51% in the opinion of farmers. In all growth stages rose were attacked by the diseases, where the dominating disease such as leaf spot, leaf blight and Mosaic caused infections at seedling, vegetative and flowering stages, whereas flower rot, powdery mildew and black spot was common in vegetative and reproductive stages of the rose plants in the field. The infestation intensity of the maximum diseases was low to medium expressed by the most of the farmers. On the other hand, flower rot caused damage with high intensity as per opinion of the 96.83% farmers.

At Jashore, Savar and Manikganj most of the farmers (88.89 %) expressed their opinion that there were a positive relationship among insect pest, disease and weed infestation in the field. Whereas only 11.11% farmers expressed their negative opinion. There was a positive and high degree of relationship among insect pest and disease incidence with weed infestation as well as disease infection with the incidence of insect vector in the Rose field. This result indicates insect infestation and disease infection become high when weed infestation become high expressed by the 52.83% farmers, i.e., insect infestation and disease infection increased with the increase of the weed infestation. Similarly, disease infection become high when insect vector populations become high expressed by the 25.40% farmers, i.e., disease infection was increased with the increase of the vector population. From this finding it was revealed that weed infestation enhanced the insect pest population and disease incidence; similarly, insect vector also enhanced the incidence of disease infection in the Rose field. Thrips and red spider mites are the major pest of Rose and act as vectors. Some other pests such as mealy bug, aphid, leaf miner, white fly, caterpillars, sawfly etc. are also damaged Rose. The probable sources of diseases were from seedlings (cuttings), imported seedlings, soil borne, local

planting materials, due to use of imbalanced fertilizer and irrigation water. Among the probable ways of spread out of Rose diseases were affected seedlings and insect vectors as per opinion of growers (76.19% and 57.14%, respectively). Other important ways of dissemination of Rose pests and disease were weeds, wind, grasses, and rain splas expressed by the 30.16%, 52.38% and 46.03% farmers. Irrigation water, crop debrises and manure, interculture with other crops were also played role as probable ways in spreading rose pests and disease. Some of the farmers were interculture rose with Thuja, Chilli, Brinjal, Marigold etc. Among 63 farmers of Jashore, Savar and Manikganj, majority (60.32%) of them said that they took measures to control diseases and pest of rose in the field. Among 63 farmers, majority (52.38%) of them was taken both preventive and curative measures to control diseases of rose in the field. Whereas 42.86% farmers said that they took preventive measures and 22.22% farmers took curative measures to control diseases in the field.

The survey indicte that, all of the farmers applied pesticides to control insect pests, diseases and weeds i.e., application of pesticides was the most widely used method to control rose pests and diseases in the field. They consider it the better management practices for disease and pest control. Considering the farmers' opinion, the better management practices for disease control in rose were the spraying of fungicides such as Dithane M-45, Tilt, Mancozeb, Acrobat MZ, Amamectin benzoid, Abamectin etc. The concentration was used about 2ml/L of water in case of liquid fungicide and insecticide (Amamectin benzoid, Abamectin) and for Mancozeb they used 3gm/L water as spray. Again, Most of the farmers responded positive about receiving assistance and other services from different sources. Out of 63 respondent, 33.33 % of the farmers said that the field level officers visit the fields regularly and observe the disease development. Moreover, 7.93% farmers reported to get suggestions from the experts an 36.51% farmers mentioned that the field level officers often sit in meetings about their problems. However, 4.74% farmers had no opinion on it.

According to the farmer's opinion, the major diseases of rose were leaf spot, leaf blight, flower rot, mosaic, die back and canker, black spot, anthracnose, powdery mildew, foot rot, leaf curl, dry brown spot, stem dry rot, rust, wilt and gall. Among these diseases, flower rot, leaf spot, leaf blight, mosaic, powdery mildew, die back and black spot ranked first to seventh position as per opinion given by the 96.83%, 90.48%, 76.19%, 60.32%, 52.38%, 49.21%, and 36.51% of 63 farmers. However, according to the farmers' suggestion, few operations should be involved for better management of disease of Rose like use of healthy planting materials, effective use of insecticides & pesticides, proper inter-culture operation, regular field visit, more research and use of disease resistant variety for disease management. Most (84.13%) of the farmers responded were positive about effective use of insecticides & pesticides for better management of disease of Rose. About 61.90% farmers suggested about use of healthy planting materials and least (11.11%) number of farmers emphasized on more research on disease management and 12.70% of farmers gave their opinion on use of disease resistant variety.

Similar work on socio-economic status of rose flower cultivation was also done by Khandokar *et al*. (2016). They performed a survey at Dhaka and Narayanganj districts of Bangladesh during 2010-2011 to assess the socioeconomic status and profitability of flower production on 60 farmers. They reported that the highest percent of farmers came from the age group of 31 to 40 years and had primary level of education, the average annual income of farm was estimated at tk. 1,95,000 of which 56% came from agriculture, per hectare gross cost of producing rose was tk. 5,30,238, per hectare gross return from rose was tk. 8,49,609, net returns from rose was 3,19,372 tk and benefit-cost ratio of rose was 1.60 which implied that flower production was profitable in that study area (Khandokar *et al*., 2016).

CHAPTER VI

SUMMARY AND CONCLUSION

Three experiments were conducted from February 2018 to May 2019 to investigate diseases of rose in Bangladesh. The field investigation was done in Jashore, Manikganj and Dhaka districts. A survey was conduction to know socio-economic status of rose growers, cultivation practices, disease and their management practices related to Rose cultivation in Bangladesh. All laboratory works were done in Plant Disease Clinic of Sher-e-Bangla Agricultural University, Dhaka. The main objectives of these experiments were to detection, identifications and measurement of diseases of Rose in Bangladesh.

Rose (*Rosa sp*.) is a woody perennial flowering plant of the genus *Rosa*, in the family Rosaceae. Rose is a well-known cut flower grown all over the world in a variety of weather circumstances. It is an economically important horticulture crop cultivated throughout the world and is generally referred as king of flowers. Rose is a rising cash crop in Bangladesh. It's also a remarkable cut flower in the floriculture of this country. The floral industry is one of the major industries in many developing and underdeveloped countries like Bangladesh. Rose was first introduced in Godhkhali of Jhikorgachaa, Jashore. It is commercially and aplenty grown at Godkhali in Jashore, Kaligonj, Maheshpur and Nepa in Jhenaidah, Jibonnagar in Chuadanga, Savar in Dhaka and in Manikgonj, Gajipur, Bogra, Rangpur and Chittagong districts. Now the plants are also cultivated throughout the country as garden plant. But the demand of this flower in floral industry is met up by the Jashore region. Jhikorgacha Upazila is the most flower cultivated region in Jashore. Thus, this study was targeted into this area specially. Report showed that, 10,000 ha of land covers flower cultivation taking the lead by Jashore district. More than 5,000 farmers are growing flower and foliage in the country and about 150,000 people are directly or indirectly involved in floriculture business as their sole livelihood. Approximately 8,000 farmers are involved in flower cultivation and 2000 to 3000 farmers in ornamental plants on commercial basis. The employment generation for both men and women are increasing with the increase in area at about 15.79% per year under floriculture industry.

In field condition, 18 villages from 4 Unions of Jhikorgacha Upazila of Jashore district, 2 villages from 1 union of Savar Upazila of Dhaka and 2 villages from 1 union of Singair Upazila of Manikganj were considered for field investigation and disease survey. The disease incidence and severity were measured in three consecutive days in winter season considering the weather conditions at Jashore and 2 times in Savar and Manikganj. The collected disease samples were incubated in PDA media following tissue planting method to isolate the causal organisms. The pathogens were observed in stereo and compound microscope and transferred into pure culture. The diseases were identified based on the symptomological study and identified causal organisms. The causal organisms of the disease were detected and identified as CMI (Commonwealth Mycological Institute) description and other related reference articles. However, repeated isolation and observation was carried out to confirm the pathogen. But Kotch's

postulates were not done because of limitation of time and materials. The data of disease incidence and severity was analyzed by using STATISTIX-10 and the mean difference was judged by Least Significant Difference (LSD). Analysis of variance (ANOVA) was used to find out the variation of result from experimental treatments.

During the field investigation, eleven diseases were recorded and these were leaf spot, black spot, leaf blight, flower blight, powdery mildew, mosaic, dieback, stem dry rot, dry brown spot, foot rot, and rust. The causal organisms associated with these diseases were identified as *Pestalotia guepinii., Alternaria alternata, Alternaria* sp., *Botrytis cinerea, Penicillium* sp., *Rhizopus* sp., *Cladosporium* sp., *Epicoccum purpurescens, Nigrospora oryzae, Rhizoctonia solani*, *Chaetomium* sp., *Curvularis* sp., *Cercospora* sp., *Podosphaera pannosa*, *Fusarium* sp., *Aspergillus niger (black), Aspergillus flavus (green), Aspergillus ochraceous (brown), Aspergillus sydewii (yellow) and Aspergillus terreus*, and the rest were some unidentified viruses and fungi, respectively. Analyzed result showed that most of the cases, disease incidence and severity were varied significantly among the locations. Farmers reported that some plant diseases occurred highly in rainy season, some diseases occurred more in winter and some were in summer season. Such as the powdery mildew commonly occurs in the late winter dry season and the leaf spots and blights were more acute in rainy season soon. Again, the disease incidence variation may be occurred due to susceptibility of the host, seasonal factors, over wintering and over summering, presence of secondary host, life cycle of host and pathogen, proximity and availability of the host and pathogen etc.

The second part of this study was to survey on socio-economic status of Rose farmers, production technologies and diseases of Rose in Jashore, Dhaka and Manikganj districts. For this purpose, 54 farmers from 18 locations of Jhikorgacha Upazila, 6 farmers of 2 location of Savar and 3 farmers of 2 locations of Manikganj were interviewed with a pre-tested questionnaire. The survey was done on the basis of three angles which were the socio-economic status of the farmers, the production technology used by them and their opinions on diseases of Rose. From the socio-economic point of view, gender, age, education level and the land utilization pattern of the farmers were studied. Again, on the basis of production technology of the farmers, various informations related to it such as planting materials, fertilizer application, pest management, benefit cost ratio etc. were recorded and analyzed. In this way, farmers' opinion on different disease related parameters were also taken in consideration along with their suggestions for better management of the diseases.

During the survey it been seen that farmers mainly faced problem of the powdery mildew and flower blight disease and red spider mites and thrips insects. The fields of Godkhali, Dhalipara and Patuapara of Godkhali union were mostly infected by powdery mildew disease. Morover, rose fields of Godkhali of Jashore and Singair of Manikganj were suffered mostly by flower blight disease. Insect infestation by red spider mites is a big problem for rose cultivation. The mites destroyed the whole field. They made the leaves curled and destroyed the flowers at the bud stage. Ultimately the whole production was hampared. In laboratory study, the result showed that the *Alternaria* sp.

was associated with other mycoflora in leaf spot, black spot, leaf blight and flower blight diseases. The *Pestalotia guepinii* was also associated with leaf spot, black spot and leaf blight diseases. The powdery mildew disease was not so dangerous for growers in past years. But in recent 4 to 5 years, this disease became major and more devastating in Jashore. No infestation of powdery mildew disease was recorded in Savar and Manikganj. The responsible pathogen of powdery mildew disease was *Podosphaera pannosa*. a member of the Ascomycete fungi. Most of the farmers gave their opinion on ineffectiveness of pesticides. Mostly Dithane M-45, Tilt, Mancozeb, Acrobat MZ, Amamectin benzoid and Abamectin were sprayed by rose growers but they did not give satisfactory results.

Rose cultivation is consider high value crop cultivation and may be a great source of employment. Pest risk analysis also essential to issue a quarantine certificate for export and import purposes. Researches are needed to develop pest and disease management practices of Rose plants. Proper management and cultural practices will increase quality production and help to reduce the threat of pests. Continious supply of flower is a great market requirement for this flower throughout the year. Thus this flower can be a blessing for Bangladesh. Among all flowers, rose was ranked first. So it can be said that the floriculture industry has a huge opportunity for improving gross income of our country as well as can reduce unemployment problem. As far our knowledge goes, very little research was conducted about floriculture. Further fundamental and applied research should be conducted for the better improvement of this flower sector in Bangladesh.

Researches on rose diseases in Bangladesh are very limited. The finding of this research work will give a baseline for futher researches on management of rose diseases. However, further research should be carried out to accelerate this type of outstanding research. It is necessary to check the findings of this investigation in different places of our country. Here the causal organism only identified up to genus but it is not sufficient, mare morphological and cultural study is not enough to identify a pathogen accurately. So pathogenicity test, like Kotch's postulates and molecular level examination should be conducted to identify the pathogen species. Again, the sample size for the survey was small to have an over-all view about the whole district or whole country. So, further survey on a large scale basis should be done to get a clear image about the Rose cultivation in our country.

CHAPTER VII

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APPENDICES

Appendix I. Plant Diseases Survey Sheet for Rose

Department of Plant Pathology
Sher-e-Bangla Agricultural University
Plant Diseases Survey Sheet for Rose

Name of the growers/farmers: **Date of Data collection:**

Address: Village: **Union:** **Upazilla:** **District:**

Host common name: **Scientific name:** **Age of Plant/Crop**: Seedling/Vegetative/Flowering

Name of disease/ symptom		Infected plant part(s)	Distribution			Planting		Status		Plant Incidence %	Leaf Incidence %	Stem/Twig incidence %	Bud/ Flower Incidence %	Other incidence %	Disease Severity %
			EF	Edge	R	N	F	New	Old						
Die Back															
Powdery Mildew															
Leaf Spot															
Black Leaf Spot															
Dry Brown Spot															
Botrytis blight/Flower rot															
Wilt															

Name of disease/ symptom		Infected plant part(s)	Distribution			Planting		Status		Plant Incidence %	Leaf Incidence %	Stem/Twig incidence %	Bud/ Flower Incidence %	Other incidence %	Disease Severity %
			EF	Edge	R	N	F	New	Old						
Mosaic															
Leaf curl															
Anthracnose															
Rust															
Canker/Gall															
Leaf blight															

Distribution: Entire field / Edge of field /Random; N= Nursery, F=Field

Symptomological Study

Symptoms	Die Back	Powdery Mildew	Leaf Spot	Black Leaf Spot	Dry Brown Spot	Botrytis blight/ Flower rot	Wilt	Mosaic/ Leaf curl	Rust	Gall/ Canker	Anthracnose / Leaf blight
Size											
Shape											
Margin											
Yellow hello											
Appearance											
Wet/dry											
Sunken/raised											
Sign											
Scattered/ coalesce											
F/B/V/Unknown											
Upper/lower surface of leaf											
Older/middle/ younger leaf											
Others											
Figure											

Name and Signature of Surveyor
Date: / /2019

Name and Signature of Supervisor
Date: / /2019

Appendix II. Questionnaire for Survey on Diseases of Rose

Department of Plant Pathology
Sher-e-Bangla Agricultural University, Dhaka

Questionnaire for Survey on Diseases of Rose in Bangladesh

Field / Nursery / Post Harvest

Serial					Cell Phone											

Name of Respondent:..... Village:.....

Union: ..... Upazila..... District: .....

Education: ..... Age..... Sex..... Profession.....

1. Land Information

Land Use Pattern (s)	Area (decimal)
1. Total land owned	
2. Cultivable land	
3. Land cultivation under flowers	
4. How long cultivating flowers?	
5. Which flowers are you cultivated?	

2. Cultivation of Rose

Area 1 bigha =33 decimals	Self	Lease	Time of Cultivation		
			Rabi	Kharif	Year Round

3. Sources of purchasing planting materials of Rose

Age of plant/garden	Name of planting materials Seed/seedling/bulb	Sources of planting materials	Do you preserve planting materials? (√)	
			Yes	No
	Seedling			

(*wb‡Ri / cwZ‡ekx/ ‡Kv¤úvbx i / ¯vbxq/ e¨emvqx/ GbwRI/ Avg`vbx/ M‡elbv cwZôvb*)

4. Benefit Cost analysis of Rose (Pick: December – March; Off pick: April –November)

Cultivation Duration (month/year)	Production: stick / year or season/Bigha	Price (Tk) per stick	Total Cost (Tk)/ Bigha/Year or Season	Total Income (Tk)/ Bigha/Year or Season	Net Profit (Tk)
4-5 Years		Pick- Off pick-			

5. Cost involved for pest management of Rose

Total cultivated Land	Cost/ bigha (Taka)			Other pest control cost /bigha (TK
	Diseases	Insects	Weeds	
Total cost				

6. Fertilizer application in Rose field

Total cultivated Land	Fertilizers (Kg)						
	Urea	TSP	MOP	Boron	Zinc	Cowdung	Others
When?							
Which stage?							

7. Insects infestation in Rose in field/ Nursery (please put √)

Name of Insects pest	**Stage of infestation**			**Incidence/severity**		
	Seedling	Vegetative	Flowering	High	Moderate	Low
1. Mites/ মাকড় বা লাল মাকড়						
2. Thrips						
3. Caterpillar/বিছা পোকা						
4. Mealybug/ছাতরা পোকা						
5. Grasshopper/ঘাসফড়িং						
6. Leaf roller/পাতামোড়ানো পোকা						
7. Aphid/ জাব পোকা						
8. কুঁড়ি/ফুল ছিদ্রকারী পোকা						
9. পাতার উইভিল						
10. লেদা পোকা						
11. পাতাখেকো পোকা						
12. Leaf minor						
13. White fly/ সাদা মাছি						
14. মাছি পোকা						
15.						
16.						
17.						
18.						

8. Disease infestation in Rose in field/ Nursery (please put √)

Name of Diseases	Stage of infection			Incidence/ severity			Infected Parts of Plant							Distribution		Status		Seasons		
	S	V	F	H	M	L	L	S	T	B	F	FP	Others	EF	R	New	Old	S	R	W
1. Die Back/আগামরা রোগ																				
2. Powdery Mildew																				
3. Leaf spot / পাতায় দাগ																				
4. Black spot / পাতায়কালো দাগ																				
5. Dry brown spot																				
6. Botrytis blight/Flower rot																				
7. Wilt/ঢলে পড়া/নেতিয়ে পড়া																				
8. Mosaic																				
9. Leaf curl / পাতা কুকড়ে রোগ																				
10. Anthracnose / *c\Z\ cPu*																				
11. Rust																				
12. Canker / Gall / Scab																				
13. Leaf blight/ পাতা ঝলসানো																				
14.																				
15.																				

S= Seedling, V= Vegetative, F= Flowering; H= High, M=Medium, L=Low; L=Leaf, S=Stem, T=Twig, B=Bud, F=Flower, FP= Full Plant; EF= Entire Field, R= Random; S= Summer, R= Rainy Season, W= Winter

9. Weeds Infestation in Rose in field/ Nursery (please put √)

Name of Weeds	Infestation stage			Incidence/severity		
	Seedling	Vegetative	Flowering	High	Moderate	Low
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

(দূর্বা, মুথা, চাপড়া, বথুয়া, ভাদাইল, শ্যামা, ধুতুরা, তিতবেগুন, বনবেগুন, ফোস্কাবেগুন, হেলেঞ্চা, বনকফি, চেচরা, শুশনি, বনশরিষা, নাকফুল, শাকনটে, কাটানটে, বিষকাটালী, আংগুলীগাস, হাতিশুড়, ¯Yj Z¥, c¥‡_¥bq¥g)

10. Is there any relationship among insect, disease and weed pest infestations in the crop field?
[Yes = √, No=X] ☐

11. If yes, what is the relationship among insect, disease and weed incidence in crop field?
[Yes = √, No=X]

9.1 Insect population high when weed incidence is high: ☐

9.2 Disease incidence high when weed incidence is high: ☐

9.3 Disease incidence high when incidence of insect vector is high: ☐

12. When the pest infestations become high in the Rose field / Nursery? (please put √)

Pests	Summer	Rainy	Winter	Season	
				Rabi	Kharif
1. Insect					
2. Disease					
3. Weed					

13. Pests infestation in Rose after harvest/ in stored condition (please put √)

Insect pests/ Diseases	**Extent of Damage**		
	High	**Medium**	**Low**
A. Insect pests			
1.			
2.			
3.			
4.			
B. Diseases			
5.			

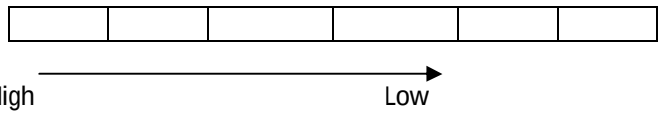
6.			
7.			
8.			
Others			
9.			
10.			

14. Action taken against pest infestation for Rose cultivation (please put √)

Insect pests/ Diseases/Weed	**When taken?**			**Which action taken? If spray, mention the frequency?**
	Prev.	Curative	Both	
A. Insect pests				
1.				
2.				
3.				
4.				
5.				
6.				
B. Diseases				
7.				
8.				
9.				
10.				
11.				
12.				
C. Weed				
13.				
14.				
15.				
16.				
17.				
18.				

15. From where you receive Assistance and Services in controlling diseases of Rose?

Diseases:



[From, DAE= 1, other farmers =2, Dealers =3, NGO=4, Company=5, Others=6]

16. Who purchase Rose from farmer/grower? (please put √)

Sl. No.	Retailer	Middle man	Company	Export company	Others (specify)
1.					

17. Mention major problems on cultivation of Rose according to importance.

Sl. No.	**Problems**
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

18. Put your suggestions for better management of disease of Rose.

Sl. No.	**Suggestions**
1.	
2.	
3.	
4.	
5.	
6.	
7.	

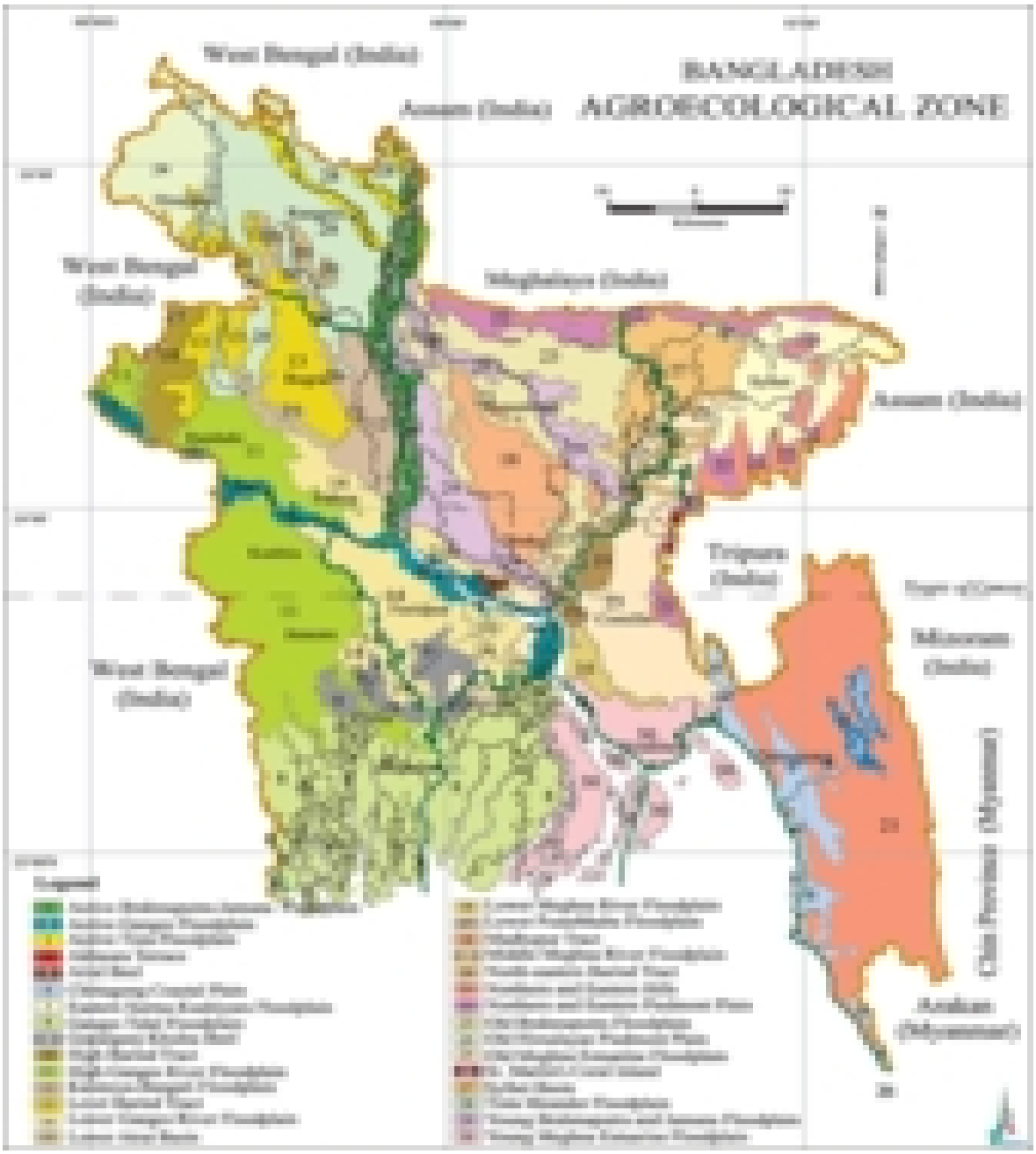
Name and Signature of Surveyor
Date: / /2019

Name and Signature of Supervisor
Date: / /2019

Appendix III. Composition of PDA media

Material	Volume
Distilled water	1000 ml
Potato	200 g
Dextrose	20 g
Agar	20 g

Appendix IV. Map showing the Agro-ecological Zones of Bangladesh



Source: Agroecological Zone, Banglapedia