INTEGRATED APPROACH FOR THE MANAGEMENT OF PURPLE BLOTCH OF ONION CAUSED BY *Alternaria porri*

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INTEGRATED APPROACH FOR THE MANAGEMENT OF PURPLE BLOTCH OF ONION CAUSED BY *Alternaria porri*

BY

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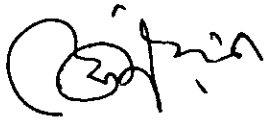

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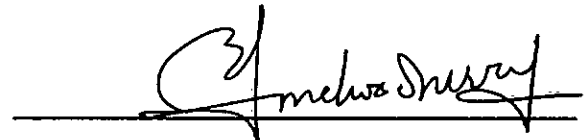

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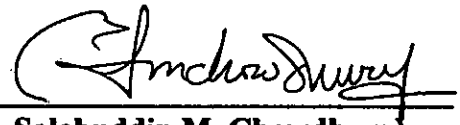

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This is to certify that thesis entitled, "INTEGRATED APPROACH FOR THE MANAGEMENT OF PURPLE BLOTCH OF ONION CAUSED BY Alternaria porri" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in PLANT PATHOLOGY, embodies the result of a piece of bonafide research work carried out by Tangima Benta Hafiz, Registration No. 04-01347 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or sources of information as has been availed of during the course of this inquire have been duly acknowledged and the contents & style of the thesis have been approved and recommended for submission.

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Place: Dhaka, Bangladesh

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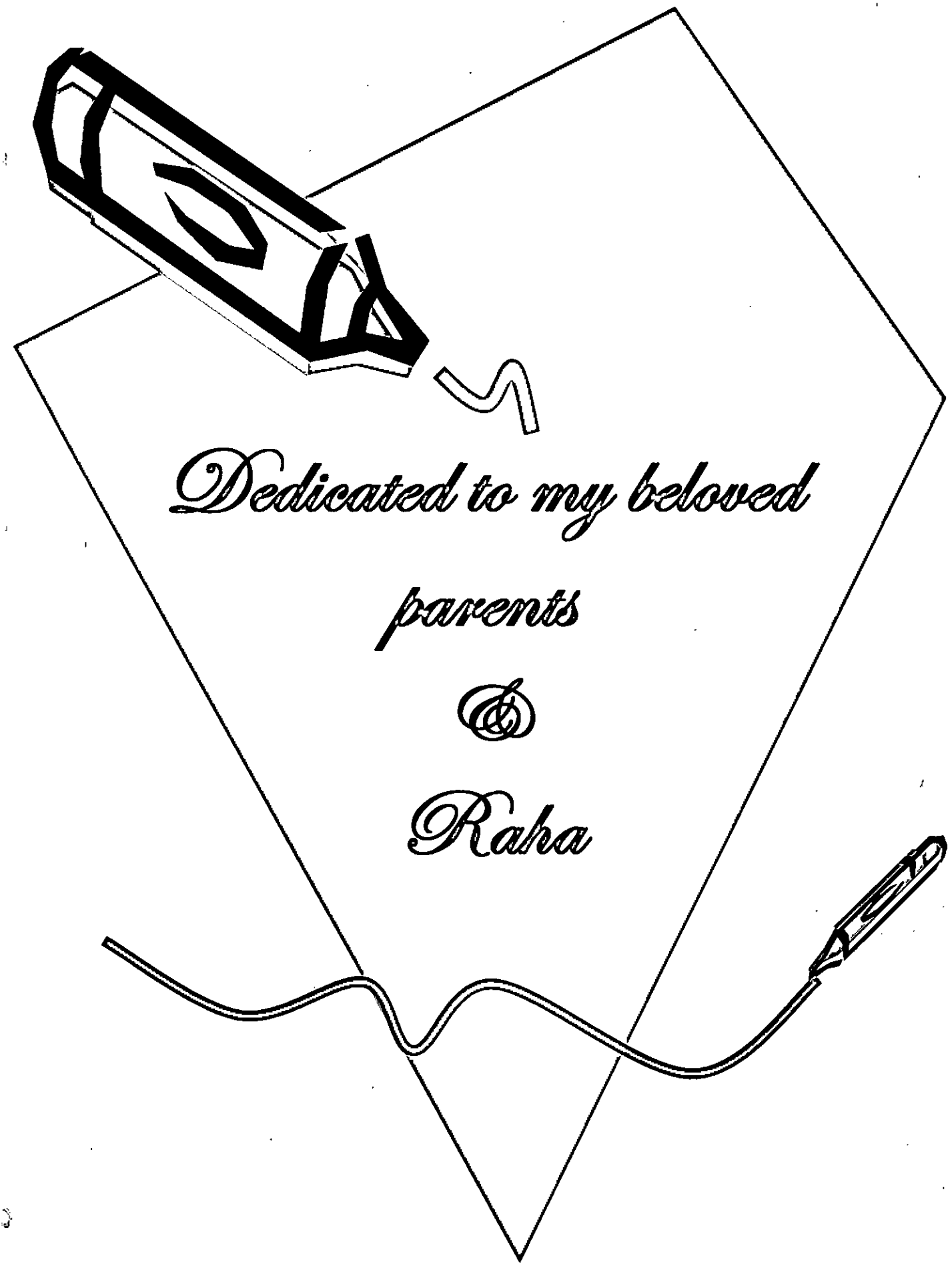
Dedicated to my beloved
parents
&
Raka

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June, 2009 — The Author

SAU, Dhaka

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ABSTRACT

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, during the winter season 2009-2010 to evaluate the efficacy of fungicides, poultry manure and neem seed extract against purple blotch of onion. The field experiment was laid out using onion variety Taherpuri to evaluate the eighteen different treatments combination of fungicides, poultry manure and neem seed extract with different spray schedules. A positive and significant effect of fungicides, poultry manure and neem seed extract was found in respect of % plant infection, % leaf infection, % Leaf Area Diseased (%LAD) and yield of onion. The highest performance in reducing disease incidence and disease severity of purple blotch of onion was found by the application of treatment PDF_1S_7 where soil was amended with poultry manure and onion seedlings were dipped in Rovral 50WP solution followed by foliar spraying with same fungicide at seven days interval. The highest onion bulb yield (5.063t/ha) was recorded in case of application of treatment PDF_1S_7. Neem seed extract also showed better performance in combination with poultry manure in reduction of disease incidence and severity as well as increasing yield.

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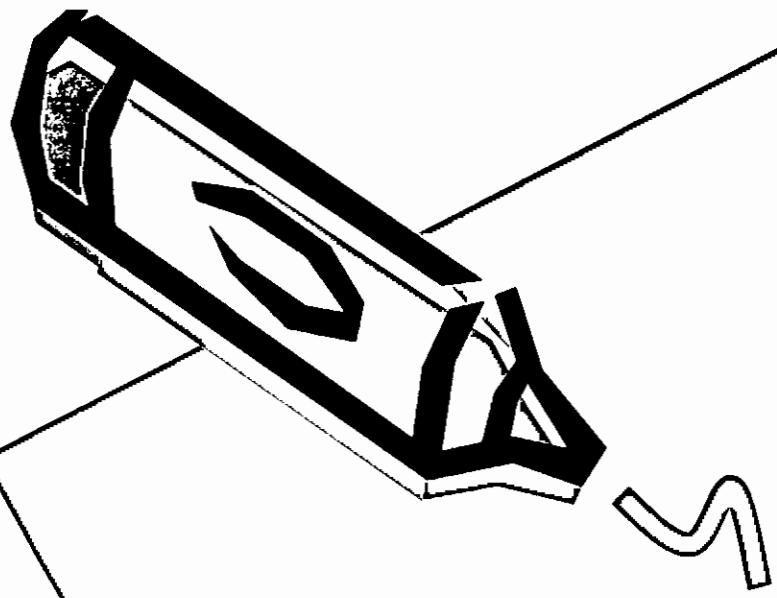
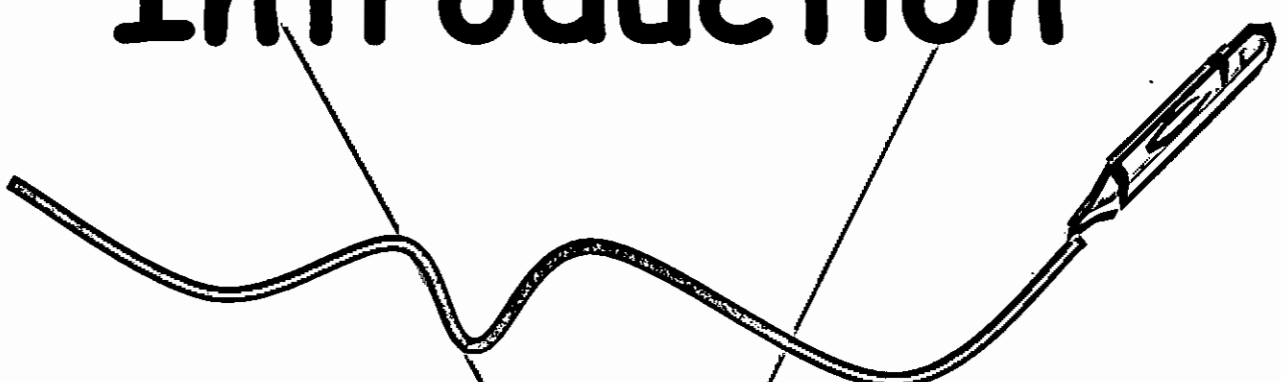
LIST OF ABBREVIATED TERMS

ABBREVIATIONS	FULL WORD
AEZ	Agro-Ecological Zone
et al.	And others
@	At the rate
ANOVA	Analysis of variance
Anon.	Anonymous
B	Boron
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
cm	Centimeter
CMI	Commonwealth Mycological Institute
Cu	Copper
CV	Co-efficient of Variation
cv.	Cultivar Variety
DAP	Days After Planting
DMRT	Duncan's Multiple Range Test
etc.	Etcetera
eg.	Example
FAO	Food and Agricultural Organization
Fe	Iron
Fig.	Figure
g	Gram
ha	Hectare
$HgCl_2$	Mercuric chloride
hr	Hour
ISTA	International Seed Testing Agency
IDM	Integrated Disease Management
j.	Journal
K	Potassium
Kg	Kilogram
Kg/ha	Kilogram per hectare



Chapter I
Introduction



CHAPTER – I
INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important and familiar spices crop throughout the world. It is member of the family Alliaceae. It is also used as popular vegetable in country of Asia and very common and favorite spices in Bangladesh. Onion has manifold uses such as spices, vegetables, salad dressing etc. It also used as condiments for flavoring a number of foods and medicines (Vohora *et al.* 1974).

In terms of global weight of vegetable production, nearly 28 million tons onion bulbs per annum next to tomatoes and cabbages bear importance (FAO, 1991). In Bangladesh onion is mainly grown in winter season as a spice crop. Out of 15 important vegetables and spice crops listed by the FAO, onion stands second in terms of annual world production (Anon. 1997). The world average yield of onion is 17.5t/ha. In Bangladesh, it is grown in 51, 820 hectares of land with an annual production of 2, 72, 000 metric tons. The average yield of onion in Bangladesh is 5.2 t/ha, which is too low compared to the world average (Anon. 2004). According to BBS, 2008 the production of onion is nearly 8, 89, 000 M tons in 3, 09, 000 acres of land in Bangladesh where the national annual yield is only 5.71 t/ha. Our annual requirement of onion is around 14, 00,000 tons (BBS, 2006). The 23

districts of onion growing areas of the country are Faridpur, Comilla, Manikganj, Dinajpur, Jessore, Pabna, Rajshshi, Mymensingh, Jamalpur, Patuakhali, Kishorganj, Tangail, Borishal, Bandarban, Khagrachari, Sylhet, Bogra, Rangamati, Kustia, Dhaka, Chittagong and Rangpur. The highest yield 2, 08,935 metric ton was in Faridpur in 78,695 acre of land. (BBS, 2007).

Pre-eminant produce in volume grown and traded is the onion bulb. Recently, Bunching onion (*Allium fistulatum*) is coming up as a popular vegetable too. It does not form bulbs but grows in clusters with long white stems (Benoit and Ceusterman's, 1987). The local varieties namely Faridpuri and Taherpuri are commonly grown in Bangladesh. In Bangladesh, the demand of bulb onion as well as the onion seeds is increasing every year and the price of the true seed remains fairly high in each season.

Onions are attacked by ten diseases caused by various pathogens (Ahmed and Hossain, 1985; Bose and Som, 1986). Most of the disease caused by the fungi and among the fungal diseases, the most important and damaging ones are seed borne. Seven diseases were reported as seed borne viz. purple blotch, seed rot, germination reduction, black mould, germination failure and white rot. Proper disease control measures can improve the quality of onion bulbs and significantly increase the yield.

Purple blotch of onion is noted as a major disease throughout the world including Bangladesh (Ahmed and Hossain, 1985; Meah and Khan, 1987; Bose and Som, 1986 and Castellanos-Linares *et al.*, 1988). In India purple blotch of onion is a major devastating and widespread disease and causes serious yield reduction (Ahmed and Goyal, 1988). The disease is also a threat for seed production of onion (Gupta *et al.*, 1986; Rahman *et al.* 1988 and Yazawa, 1993).

The disease is characterized with small water-soaked lesions initially produce on leaves and seed stalk that quickly develop white centers. As lesions enlarge, they become zonate, brown to purple, surrounded by a yellow zone and extend upward and downward for some distance. Under humid condition, the surface of the lesion may be covered with brown to dark gray structure of fungus. A few large lesions have been formed in a leaf or seed stalk which may coalesce and girdle the leaf or seed stalks and tissues, distal to the lesions die. Usually the affected leaves or seed stalks fall down and die within 4 weeks if the environment favours the disease (Gupta *et al.*, 1991).

Damage of foliage and breaking of floral stalks due to purple blotch resulting failure of seed production of onion are common (Ashrafuzzaman and Ahmed, 1976). Hossain *et al*, (1997) reported that the disease causes 41-

44% yield loss in Bangladesh. Sharma (1986) reported that under favourable environmental conditions, complete failure of the crop takes place and there will be no seed setting. In India, the disease causes 20 to 25 % loss in seed yield (Thind and Jhooty, 1982).

Temperature and humidity are the most predominant factors for the development of purple blotch disease. The disease is favoured by moderate temperature (24-30^{0}C) and high relative humidity (Gupta and Pathak, 1986; Evert and Lacy, 1990 and Rodriguez *et al.*, 1994).

Literature from home and abroad indicate that many researchers explored to find out suitable control measures of the disease, viz. resistant variety, date of planting, use of fertilizers and chemical control with fungicides (Shandhu *et al., 1983*; Vishwakarma, 1986; Gupta and Pathak ,1987 ; Martinez – Reyes , 1987 ; Mishra *et al.*, 1989; Sugha *et al.*, 1993 and Srivastava *et al.*, 1995). The recent realization is that presence of naturally occurring substances in plant species plays a significant role in plant disease resistance. Available literature indicating quite a large number of plant species have been reported to have the antipathogenic activity (Ahmed and Sultana, 1984; Singh *et al.*, 1991; Bhowmick and Vardhan, 1991 and Sharvamangala and Datta, 1993).

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In Bangladesh, limitted attempts have been made to find out the suitable control measures of this disease for bulb and seed production (Ashrafuzzaman and Ahmed, 1976, Rahman *et al.*, 1988 and Rahman, 1990). A good number of fungicides, cultural practices are yet remained untested against this disease. Considering the present situation of the disease in the country, further selection of fungicides against leaf blotch of onion is urgently necessary. Soil amendment with poultry manure could be the options for the management of purple blotch of onion. In this contex, many poultry farms have been established recently surrounding Dhaka to meet increasing demand, and waste management is a concern. Thus appropriate incorporation of this organic waste into soil may benefit both onion farmers and poultry producers.

People globally are conscious about environmental hazards due to use of costly and toxic chemicals. The increasing public awareness about these problems has stimulated research on the use of biocontrol agents and development of commercial byproducts. The goal of biocontrol research in combination with chemical control is to provide an additional tool for integrated approach of disease management. To save the nature and environment, a judicial use of fungicides, organic amendments and plant

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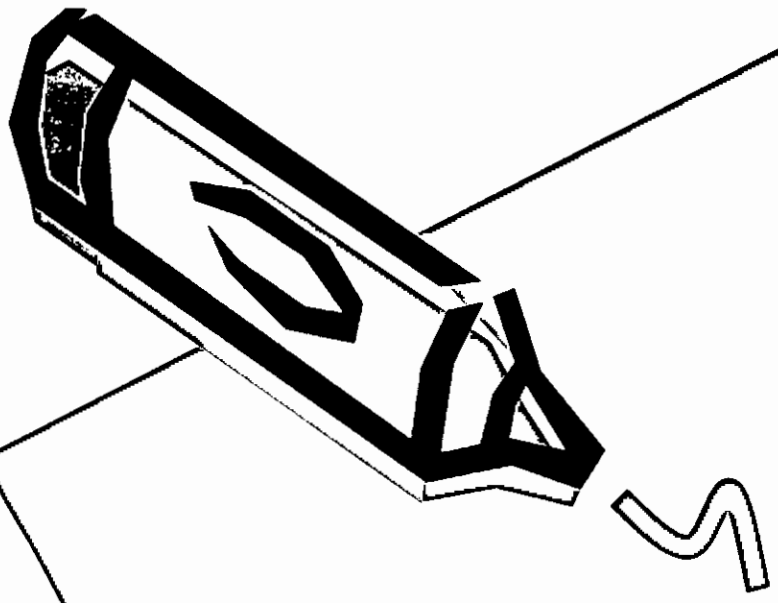
extracts are need to be explored. In this contex, the present study was undertaken to achieve the following objectives

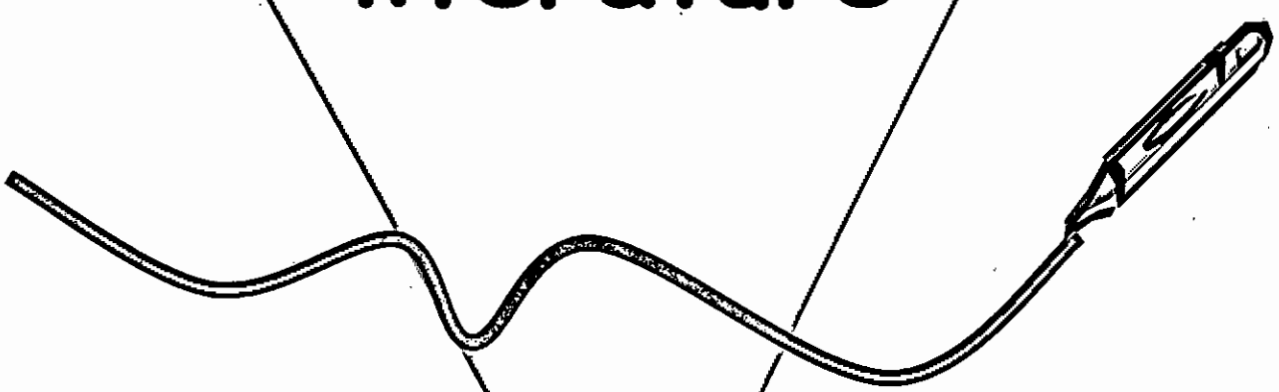
a) To focus the effective fungicides, organic amendments and botanicals for control purple blotch of onion caused by *Alternaria porri.*

b) To integrate the IPM components for the management of purple blotch disease of onion caused by *Alternaria porri.*



Chapter II

Review of literature



CHAPTER II

REVIEW OF LITERATURE

Purple blotch of onion caused by *Alternaria porri*, is a common and most important disease throughout the country. It causes serious yield reduction of the crop. Integrated approach for the management of the disease by using chemical fungicides, host resistance, cultural practices, botanical control and biological control measures are being explored in many countries of the world. Literature in relation to integrated approach for management of purple blotch of onion is reviewed and presented in this chapter.

2.1. Varietal resistance and symptomology

Thirumalachar *et al.* (1953) reported about the existence of some varietal resistance and they stated that the fungus *Alternaria porri* (purple blotch) caused severe scorching of some onion varieties at the College of Agriculture Sabour; but the indigenous red variety had remained uninfected.

Sandhu *et al.* (1982) reported that none of 102 genotypes they screened was resistant to *Alternaria porri.* However, they could locate 12 genotypes which showed moderate resistance reaction. The genotypes that had flat erect

leaves showed moderately resistance reaction. Whereas all those with curved, drooping leaves were susceptible.

Nuchnart Jonglaekha *et al.* (1982) observed that symptoms of purple blotch disease appearing on onion, shallat, multiplur onion, leek and garlic were similar except that the levels of susceptibility were different. They also observed that most of the conidia produce germ tubes and penetrate through wounds on leaves within 8 hrs. of inoculation. The conidia observed were club-shaped with transverse and longitudinal septa. This fungus produces spores when the temperature lies between18-26^0 C.

2.2. Growth of *Alternaria porri in-vitro* and *in-vivo*

A study on the sporulation of *Alternaria porri* was conducted by Khare and Nema (1981). They observed maximum sporulation at 8-00 a.m. under field condition. A seasonal periodicity was also noted, indicating maximum sporulation immediately after rains. Under laboratory conditions maximum sporulation was at 22^{0}C at 90% RH followed by 30^{0}C.

Khare and Nema (1982) also reported that temperature, humidity and nutrients seemed to play an important role for ensuring infection of *A. porri*

on onion. Cent percent spore germination occurred *in vitro* within 4 hrs at 22^0C, while maximum germination was recorded within 6 hrs at 25^0C on the host surface. According to them, temperatures between 22 to 25^0C are the best for the leaf blotch disease development.

Raju and Mehta (1982) demonstrated an experiment on certain nutritional aspects of *Alternaria porri* (Ellis) Ciferri on onion *in vitro* and summarized that potato dextrose agar having p^H 6 was best to culture the fungus. Temperature ranging 22-25^0C was optimum for mycelial growth and sporulation of *Alternaria porri.*

Sixty-days-old onion plants (cv. Nasik Red) were most susceptible to the purple blotch pathogen (*Alternaria porri*) (Gupta and Pathak, 1986). Plants inoculated at high RH (100%) for 120 hours resulted in maximum disease severity and shortest incubation period.

Ariosa-Terry and Herrera-Isla (1986) measured the damage of onion due to purple blotch caused by *A. porri.* The first symptoms appeared 50 days after sowing and disease intensity was the highest at 110 days. White onions were more affected than red onions.

Evert and Lacy (1990) examined formation of conidia by *Alternaria porri* under variable dew duration and controlled relative humidity (RH). Viable conidia produced on lesions after 9 hrs of dew to 38 hrs and conidia formed during 16 hrs of dew duration caused typical lesions. Conidia were formed at all RHs tested (75-100%); numbers were very low at 75-85% RH but increased with increasing RH. Conidia formed on lesions on senescent leaves when incubated in dew chamber at 25^0C and conidia formed repeatedly (up to eight cycles) on lesions to alternating low RH (35-50%) and high (100%) RH.

The intensity and dynamics of *Alternaria porri* conidial germination were studied by Rodriguez *et al.* (1994) in different temperatures (5-40^0C) and RH (76-100%). Conidia developed at 5-37.5^0C, with an optimum temperature of 30^0C. Germination started within 1 hr of incubation at 20-35^0C and 50% of the conidia had germinated at 4 hrs of incubation.

Srivastava *et al.* (1994) reported the high incidence (2.5 - 87.8%) of purple blotch (*Alternaria porri*) in both the kharif and robi onions, when high humidity prevailed, during the 5 years of the survey (1988-93).

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Srivastava *et al* (1994) reported the high incidence (2.5 - 37.8%) of purple blotch (*Alternaria porri*) in both the kharif and rabi onions, when high humidity prevailed, during the 5 years of the survey (1988-93).

Everts and lacy (1996) studied the factors influencing infection of onion leaves by *Alternaria porri* and subsequent lesion expansion. Conidia deposited on onion leaves formed single to several germ tubes and appressoria and often penetrated at more than one locus under conditions favorable. After 3 hrs in the dew chamber at 24^0 C following inoculation of onion leaves, 73% of conidia had germinated and 5% had formed appressoria. Infection hyphae were not observed until 6 h following inoculation, at which time 2% of conidia had formed infection hyphae and 0.5% of conidia had caused visible lesions. Length of dew period was significantly and positively correlated with lesion numbers but not with lesion size.

2.3. Chemical control

Bekhit *et al.* (1963) in a field experiment observed that Zineb and Captan were superior to Bordeaux mixture in controlling purple blotch of onion *(Alternaria porri,* where infection was reduced by 50%).

Ashrafuzzaman and Ahmed (1976), reported that among 5 fungicides Benlate (Benomyl) at 500 ppm or Dithane M-45 (Mancozeb) at 500 ppm

gave the best control of *Alternaria porri* on onions and significantly increased the yield. Lower concentrations (125 or 250 ppm) were less effective.

Patil *et al.* (1976) evaluated different fungicides against leaf blotch of onion. In culture media the fungus was inhibited by Kitazin, Cuman, Difolatan, Vitavax, Captan, Hinosan, Dutex, Miltox and Aureofungin. As a prophylactic spray, Kitazin was proved to be superior to all the other fungicides applied.

Padule and Utikar (1977) found the best control and the highest yield of onion by using Dithane M-45 followed by Zineb, Miltox, (Zineb+Ca) and Fytolan (Cu-oxychloride) in a field trial against *Alternaria porri.*

Joi and Sonone (1978) evaluated nine fungicides for the control of leaf blight of onion (*Alternaria porri*) in three experiments over three years and found that Dithane M-45 reduced the disease by 23.6% and increased the yield by 35%, whereas Miltox reduced the disease by 22.6% and increased the yield by 26%.

Bedi and Gill (1978) studied on purple blotch of onion and its control in the Punjab. *Alternaria porri* causing purple blotch of onion was significantly reduced by Bordeaux mixture or Dithane M-45 (Mancozeb) + Thiodan (Endosulfan).

Nuchnart Joglackha *et al.* (1982) worked on the effectiveness of ten selected fungicides against the fungus cultured on PDA, artificially inoculated plants and infected plants in the field. It was revealed that Mangate-D was the most effective one while Dithane M-45 and Antracol become the second to control purple blotch of onion. Azinmag and Delsene MX also showed satisfactory results *in-vitro* tests.

Quadri *et al.* (1982) reported that out of eight fungicides, Difolatan (Captafol), Thiram, Dithane M-45 (Mancozeb) and Bavistin (Carbendazim) gave the best control against *Alternaria porri* under culture condition. Millar (1983) observed that the severity of leaf blotch is directly correlated with the age of leaves of onion.

Georgy *et al.* (1983) found disease severity of purple blotch reached 100% on plants in non sprayed plots while they screened several fungicides to

combat the disease. Fungicides differed in their effectiveness and differences between treatments in most cases, were significant. The Ridomil group especially Ridomil MZ (Metalaxyl + Mancozeb) proved most effective in reducing disease severity and increasing bulb and seed yield.

Comparative effectiveness of 10 fungicides to control Alternaria infection (*Alternaria* spp.) of mustard was evaluated in India by Sharma (1984). He reported that among the tested fungicides, Dithane M-45 gave the best control against the disease followed by Daconil, Dithane Z-78. The fungicides reduced the infection rate by 16.6 - 30.1%.

Miura (1985) found that *Alternaria porri*, *A. alternata* and *Fusarium spp.* are predominated among the fungi isolated from onion seeds. In vitro products based on Iprodione gave the best results resulting 97.4% control of the fungi with 81.4% germination against 54.8% germination of untreated seeds.

Ramos *et al.,* (1985) reported that in field trials under natural infection, Metalaxyl gave the best results against *Alternaria porri.*

Gupta *et al.* (1986) tested 10 fungicides for 3 growing seasons and found Dithane M-45 (Mancozeb) effective against *Alternaria porri* with a maximum return / net profit. Spraying of 5 times at 15-days interval with Dithane M-45 + the sticker triton is recommended for control of purple blotch of onion seed crops.

Sharma (1986) reported that the best control of *A. porri* under field condition was given by Dithane M-45 (Mancozeb) applied at 6 times from the on set of infection. However, he added that, 3 sprays were optimum for maximizing bulb yields of onion.

Gupta *et al.* (1987) observed in the field tests over 3 years that Dithane M-45 (Mancozeb) sprays at 0.25% reduced incidence and severity of infection by *Alternaria porri* and thereby increased bulb yield of onion.

Ahmed and Goyal (1988) carried out an experiment by taking onion seedling with 85% natural infection by *Alternaria porri* and dipped in suspension of Aureofungin (Parnino Ocetophenonne). Bavistin (Carbendazin), Brassicol (Quintozene), Cman (Ziram), Difolatan (Captafol), Dithane M-45 (Mancozeb), Dithane Z-78 (Zineb) and Topsin-M (Thio-phanate methyl) and

Gupta *et al.* (1985) tested 10 fungicides for 3 growing seasons and found Dithane M-45 (Mancozeb) effective against *Alternaria porri* with a maximum return / net profit. Spraying of 5 times at 15-days interval with Dithane M-45 + the sticker triton is recommended for control of purple blotch of onion seed crops.

Sharma (1986) reported that the best control of *A. porri* under field condition was given by Dithane M-45 (Mancozeb) applied at 6 times from the on set of infection. However, he added that 5 sprays were optimum for maximizing bulb yields of onion.

Gupta *et al.* (1987) observed in the field tests over 3 years that Dithane M-45 (Mancozeb) sprays at 0.25% reduced incidence and severity of infection by *Alternaria porri* and thereby increased bulb yield of onion.

Ahmed and Goyal (1988) carried out an experiment by taking onion seedling with 85% natural infection by *Alternaria porri* and dipped in suspension of Aureofungin (Parnino Oectophenonne), Bavistin (Carbendazim), Brassicol (Quintozene), Ciman (Ziram), Difolatan (Captafol), Dithane M-45 (Mancozeb), Dithane Z-78 (Zineb) and Topsin-M (Thio-phanate methyl) and

then transplanted. Half the plots were later sprayed 3 times with the same fungicide at 20 days intervals. All treatments significantly reduced disease incidence and resulted increased bulb yield.

Gupta *et al.* (1996) stand that Stemphylium blight (*Stemphylium vesicarium*) and purple blotch (*Alternaria porri*) is important diseases causing considerable damage to onion crops in India. The diseases are severe during the rainy seasons especially when thrips are also associated with the crops. Studies were undertaken in Karnal, Haryana, India, during kharif, 1994 and 1995 to control the diseases. Tretment comprised of either 5,4 0r 3 sprays of Mancozeb, Chlorrathalonil and Fosetyl as (aliette) starting at 40 DAP at intervals of 10 days intervals starting at 50 DAP reduced infection caused by *Stemphylium vesicarium* and *Alternaria porri.* Three spray of 0.25% kavatch at 10 days intervals starting 60 DAP was also effective.

The efficacy of six fungicides was evaluated by Rahman *et al.* (1988) for controlling leaf blotch of onion (*Alternaria porri*). Rovral and Dithane M-45 were found to be the best both in laboratory and field conditions. Under field conditions, all the test fungicides gave significant reduction of disease severity but significant increase of onion yield was achieved with Rovral,

Dithane M-45 and Bordeaux mixture that gave 61, 35 and 29% yield increases, respectively.

Barnoczki-stoilova *et al.* (1989) conducted trials with onion cv. Makoi Brons to determine the efficacy of several treatments (2 insecticides and 4 fungicides) for pest and disease control during flowering. At the initiation of flowering (10-15% open flowers), spraying had a beneficial effect on seed yield and plant health. Spraying at full bloom (50-60% open flowers) should be avoided for harmful effect. At the end of flowering (5-10% open flower), spraying improved seed health. Ridomil plus 50 WP (Methyl + Copper oxychloride) and Rovral 25 FW were the most effective fungicides.

Mishra *et al.* (1989) evaluated 7 fungicides against purple blotch of onion (*Alternaria porri*) and found Dithane M-45 as effective at 0.2% followed by Jkstein that reduced disease intensity and increased bulb yield by 25.73 and 17%, respectively over untreated control.

Rahman *et al.* (1989) evaluated six fungicides viz. Antracol (Propineb) 65 WP, Bordeaux mixture (Copper sulphate and lime), Cupravit (copper oxychloride), Dithane M-45 (Mancozeb), Rovral (Iprodione) and Trimiltox

forte (Cu-salts and Mancozeb) for their efficacy against leaf blotch (*Alternaria porri*) of onion in laboratory and field condition. All the fungicides gave significant reduction of mycelial growth and disease severity. Increase of onion yield was achieved with Rovral, Dithane M-45 and Bordeaux mixture. Maximum yield increase was achieved with Rovral (61%) followed by Dithane M-45 (36%) and Bordeaux mixture (29%).

Tahir *et al.* (1991) tested 7 fungicides against *Alternaria porri* in a field trial and found Daconil (Chlorothalonil) as the most effective one followed by Cupravit, Ridomil MZ-72 and Pencozeb (Mancozeb). Fungicidal treatments increased bulb yield by 8.4-19.9% over control.

Srivastava *et al.* (1991) evaluated 4 fungicides viz. Copper oxychloride, Mancozeb, Carbendazin and Thiram against *Alternaria porri* and all the fungicides significantly reduced the disease incidence.

Gupta *et al.* (1991) evaluated on the economical spray schedule of Mancozeb for the control of purple blotch disease of kharif onion. In field trials conducted at the Regional Research Station, Karnal, Haryana, India, during 1987-89. Three sprays of Mancozeb at 0.25% applied at 7- days

intervals after the appearance of disease symptoms provided good control of *Alternaria porri* which resulted maximum yield (280 q/ha).

Perez- Moreno *et al.* (1992) observed that Iprodione gave the best control of purple spot and downy mildew followed by Fosetil. Fosetil gave the best control of the disease in the fresh market cultivars whereas; Iprodione gave the most effective disease control in the hybrids (USA origin). Iprodione gave the highest yield followed by Fosetil.

Gupta *et al.* (1992) observed that *Alternaria porri* and *Stemphylium vesicarium* cause the most important disease of onion crop, which is grown throughout India. Both were successfully controlled by 4 sprays of Dithane M-45 (Mancozeb) at 0.25% applied at weekly intervals.

Filajdic and Suttan (1992) evaluated four fungicides alone or in combination to control *Alternaria* blotch of apples (*Alternaria mali)* but no satisfactory control was achieved except Iprodione (Rovral). About 75.1% disease reduction was obtained using higher (0.30g/litre) rate. After artificial inoculation, disease reduction ranged from 53.7 to 68.9% at the higher and lower rates of Iprodione.

From India, Sugha *et al.* (1993) reported that 5 spray of Metalaxyl+ Mancozeb (0.3%), at 15 days interval from the appearance of disease gave the most effective control of purple blotch of onion. Sprays of Metalaxyl+ Mancozeb (0.3%) were superior to those of Copper oxychloride (0.25%), Captafol (.0.2%) and Mancozeb (0.25%).

Perez Moreno and Chavez (1993) conducted an experiment with three fungicides (Iprodione, Fosetyl-aluminium and Maneb) to control *Alternaria porri* on three commercial cultivar of onion in Mexico. They opined that Iprodione performed excellent in reducing disease intensity and gave highest yield.

Srivastava and Gupta (1993) reported that three fungicides (0.25% Mancozeb, 0.3% Copper oxychloride and 0.25% Captan) in combination with 2 insecticides (0.05% Monocrotophos and 0.05% Demetonmethyl) were assessed against *Alternaria porri, thrips tabaci* on onions in Maharastra, India, in 1988-91, Mancozeb at 0.25% + Monocrotophos at 0.5% reduced infection and infestation and increased seed yield and improved the cost benefit ratio.

Sugha *et al.* (1993) conducted experiments during the winter seasons of 1989-90 and 1990-91 to study the effect of heat treatment of bulbs alone and in combination with a spray of Metalaxyl + Mancozeb (as Ridomil MZ) for the control of *Alternaria porri* in the onion cv. Patna red. Heat treatment to onion bulbs at 35^0C for 8 hr before sowing followed by a single prophylactic spray of Metalaxyl + Mancozeb (0.25%) at the bolting stage or no heat treatment and 3 sprays of Metalaxyl + Mancozeb (0.3%) at 15 days intervals from the appearance of disease gave the most effective control. Heat treatment of bulbs at 40 and 45^0C reduced crop growth. Sprays of Metalaxyl + Mancozeb (0.3%) were superior to those of Copper oxychloride 0.25%, Captafol 0.27 and Mancozeb 0.25%.

During surveys in the Cape Province of South Africa, Aaveling *et al.* (1993) found *Alternaria porri* and *Stemphylium vesicarium* to be very destructive seed-borne pathogens of onion. Six fungicides (Anilazine, Benomyl, Carbendazim/flusilazole mixture, Procymidone, Tebuconazole and Thiram) were tested for their efficacy to control *Alternaria porri* on the seed and in culture. None of the treatments eradicated *Alternaria porri* and *Stemphylium vesicarium* from onion seeds.

During 1992-93 and 1993-94 in Haryana, India, total failure of onion seed crop occurred due to Stemphylium blight (*Stemphylium vesicarium*) and purple blotch (*Alternaria porri*). To overcome this alarming situation Srivastava *et al.* (1995) conducted trials with Iprobenfos (Kitazin), Iprodione (Rovral), Fosetyl (Aliette), Kavatch, Thiophanate-methyl (Topsin M), Benomyl, Metalaxyl (Ridomil) and Mancozeb. Observation on disease intensity/PDI were recorded at fortnightly intervals, just before each spray,and a total of 5 sprays were applied. They recommended that seed growers in North India should apply fortnightly sprays of 0.25% Mancozeb or 0.25% Iprodione to control onion seed diseases caused by *Stemphylium vesicarium* and *Alternaria porri.*

Kolte *et al.* (1993) reported association of *Alternaria porri* in 142 diseased samples of onion out of 200. They observed that foliar spray with Dithane M-45 at 40 DAT, 61 DAT and 82 DAT (days after transplanting) were the most economic and effective compared with Thiram, Copper oxychloride, Bavistin (Carbendazim), Calixin (tridemorph), Aliette (fosetyl), Topsin (thiophanate methyl) and Rovral (Iprodione).

Yazawa (1993) reported that application of Captan, Dithane and Benlate at 10 days interval gave excellent control of *Alternaria porri* for healthy onion seed production.

Rochecouste (1984) recommended use of Ridomil (Metalaxyl + Mancozeb) against *Puccinia alli*, *Alternaria porri* and *Peronospora destructor* of garlic and onion.

Rovral had also been reported to be effective against bulb rot of onion (Presly and Maude, 1980; Rod and Janyska, 1984) and leaf spot (Hall and Kavanagh, 1981).

A field trial was conducted by Upadhaya and Tripathi (1995) to determine the effect of Bavistin (Carbendazin), Blitox (copper oxychloride), Calixin (Tridemorph), Captafol, Dithane M-45 (Mancozeb), Dithane Z-78 (Zineb), Jkstein (Methyl), Karathane EC (Dinocap) and Topsin M-70 (thiophanate-methyl) on control of *Alternaria porri* on onions (*Allium cepa*). All treatments significantly reduced disease intensity and gave increased yields over the control. The best results, however, were obtained with Captafol.

Sugha (1995) conducted a field trial on the management of purple blotch of garlic caused by *Alternaria porri* during winter season of 1989-90, 1990-91 and 1991-92 and reported that three foliar sprays of Iprodione @ 0.1% alone or in combination with Copper oxychloride 0.1% and Mancozeb 0.1% at 15-days intervals resulted in 53.5 to 62% protection to the crop. Clove dip in Iprodione 0.25% for 1 hr before sowing followed by 2 sprays of Metalaxyl + Mancozeb (Ridomil MZ @ 0.25%) or Iprodione @ 0.2% proved highly effective, giving 79.6-84.9% control of the disease. Iprodione and Metalaxyl + Mancozeb were superior to Chlorothalonil, Copper oxychloride, Mancozeb and Zineb improving protection to garlic crop from purple blotch.

The efficacy of 10 fungicides in controlling downy mildew caused by *Perenospora destructor* and purple blotch caused by *Alternaria porri* on onion was tested by El-Shehaby *et al.* (1995) in experimental plots. Fungicide sprays at the rate of 250g/100 liters were started 45 days after planting and repeated 5 times, every 15 days until harvesting. Metalaxyl 8% + Mancozeb 64% (Ridomil- MZ 72%) and Metalaxyl 10% + Mancozeb 48% (Ridomil MZ 58) were the most effective, reducing disease on seed and bulb onions by 86% and increasing seed and bulb yield by 194 and 199%, respectively, compared to control.

Borkar and Patil (1995) tested different fungicides for control of *Alternaria porri* on onions during a severe disease outbreak. Mancozeb reduced disease intensity by 6%, increased yield by 10.99% and also had a higher cost: benefit ratio than other fungicides.

Islam (1995) evaluated seven fungicides against *Alternaria porri* causing purple blotch of onion. Score (Difenconazole) was found as the most effective fungicide followed by Rovral (Iprodione), Tilt 250 EC (Propiconazole) and Folicur (Tebuconazole). Percentage of reduction in disease index varied from 48.34 to 65.44 in score, 45.48 to 64.02 in Rovral, 34.90 to 47.24 in Tilt 250 EC and 32.93 to 46.34 in Folicur. Fungicidal treatments increased bulb yield by 10.53% to 95.53% over unsprayed control.

Datar (1996) tested eight fungicides, viz. Carbendazim, Copper oxychloride, Zineb, Mancozeb, Iprodione, Thiophanate methyl, Dithianon and Ziram at 100, 250 and 500 ppm which significantly reduced the conidial germination of *Alternaria porri* on onion cv. N-53-1 over control.

Srivastava *et al.* (1999) conducted an experiment at Nashik, India, during the robi seasons from 1994 to 1998, using onions cv. Agrifound Light Red. The treatments were Pendimenthalin (0 or 3.5 liters/ha), nitrogen (0, 50 or 100 kg/ha) and Mancozeb (0.25%), Copper oxychloride 0.3%, or no fungicides application against purple blotch disease. *Alternaria porri* incidence was significantly the lowest and crop yield was the highest in the 3.5 litres Pendimenthalin/ha treatment. The lowest purple blotch incidence was recorded with Mancozeb.

Islam *et al.* (1999) evaluated seven fungicides against *Alternaria porri* causing purple blotch of onion. Score (Difenconazole) was found as the most effective fungicide followed by Rovral (Iprodione). Tilt 250 EC (Propiconazole) and Folicur (Tebuconazole). Percentage of reduction in disease index varied from 48.34 to 65.44 in score. 45.48 to 64.02 in Rovral, 34.90 to 47.24 in Tilt 250 EC and 32.93 to 46.34 in Folicur. Fungicidal treatments increased bulb yield by 10.53% to 65.53% over unsprayed control.

Islam *et al.* (2003) reported the relative efficiencies of ten fungicides against *Alternaria porri* causing purple blotch of onion. Rovral and Ridomil reduced all disease parameters and incurring higher seed yield.

Rahman (2004) observed the effect of three fungicides viz., Ridomil, Rovral and Tilt 250 EC (0.2%) comprising 13 treatments in field experiment. Eight sprays of Rovral or Ridomil at 7 days interval minimized disease incidence and increased yield. Rovral 0.2% spray at 7 days interval treatment was the best, which gave the highest reduction in disease incidence and severity of leaf blotch and eventually increased the yield of onion.

Prodhan (2005) evaluated thirteen fungicides to control purple blotch of onion. All the tested fungicides reduced the severity of the disease. The performance of Rovral, Controll, Contaf and Pharzeb was the best in reducing mean severity of the disease and increased bulb yield compared to control.

Uddin (2005) conducted an experiment at the research farm of Sher-e-Bangla Agricultural University, Dhaka during the rabi season of January-April, 2004 to study the management of purple blotch complex of onion

(*Alternaria porri* and *Stemphylium botryosum*) with selected fungicides. Six treatments Dithane M-45 @0.45%, Rovral 50WP @0.2%, Bavistin 50WP @0.1%, Tilt 250EC @0.2%, Ridomill MZ-72 @0.2% and untreated Control (bulb treatment and foliar spraying with normal water) were evaluated in the experiment. Bulb treatment followed by six foliar spraying at 10 days interval starting from 20 days after bulb sowing with Dithane M-45 (0.45%) or Rovral (0.2%) minimized diseased incidence and severity and increased seed yield. The least seed infection by *Alternaria porri* and the highest seed germination was recorded in the seed sample picked up from Dithane M-45 and Rovral 50WP treated plot in a post harvest seed health test.

Ali (2008) conducted an experiment both in Seed Health Laboratory, Department of Plant Pathology and in the research farm of Sher-e-Bangla Agricultural University, Dhaka during the winter cropping season of 2007-2008 to study the control of Purple Blotch complex of onion through fertilizer and fungicide application. The *in vitro* test with ten treatments comprising Dithane M-45, Rovral 50WP, Cupravit 50WP, Ridomill Gold MZ-72 in combination with micronutrients and Control were explored in the experiment. Among the fungicides, Rovral 50WP @ 0.2% reduced the highest mycelia growth of *Alternaria porri* and *Stemphylium vesicarium*

followed by Ridomill Gold MZ-72 @ 0.2% and Dithane M-45 @ 0.45% compared to control. In the field experiment, the treatments showed significant effect in respect of disease incidence, disease severity, seed yield and seed yield contributing characters. The lowest disease incidence and disease severity were observed in Rovral 50WP @ 0.2% + micronutrients followed by Rovral 50WP @ 0.2% alone, Dithane M-45 @ 0.45% +micronutrients and Dithane M-45 @ 0.45% alone. The highest disease incidence and disease severity were recorded in control treatment.

2.4. Botanical Control

Reports are available about the successful use of plant extracts in reducing the sporulation, growth and infection of fungal pathogen; some of them are incited below;

Lakshmanan *et al.* (1990) reported that Aqueous extracts of Neem (*Azadiracta indica*) and Baganbilash (*Bougainvilla spectabilis*) inhibited mycelial growth and sclerotial germination of *Thanatephorus cucummeris*.

Mia *et al.* (1990) tested extracts of 16 plants species against five fungal pathogens of rice; where 4 showed more than 50 % inhibition of mycelial

Bhowmick and Vardhan (1991) reported the relative efficacy of leaf extracts of some plants on growth, sporulation and spore germination of *Curvularia*

lunata manifesting different types of leaf spot disease. Among the extracts, *Cinnamonum camphora* and *Catharanthus rosen* completely cheeked the radial growth and spore germination of the test fungus followed by *Azadirachta indica, Clerodendrum viscosum* and *Vitex megundo*. Leaf extracts of *Nyctanthes arbor-tristis, Acalypha indica* and *Kalanchoe pinnate* were ineffective. *Myctanthes arbor- trists, Acalypha indica* and *Kalanchoe pinnata* were ineffective. Mycelial dry weight of the test pathogen was reduced in varying proportions after treatment with all the above mentioned leaf extracts. Scantly sporulation was induced by the application of leaf extracts of *V. megundo, A. indica, C. viscosum* and *Phyllanthes arbortristis* and excellent sporulation by *Acalypha indica, Kalanchoe pinnata* and in control (no leaf extract, only plain water) treatments.

Dubey and Dwivedi (1991) investigated the fungitoxic properties of *Acacia arabica* (*Fruit and berk*), *Allium cepa* and *A. Sativum* (*leaf and bulb*) against vegetative growth and sclerotial viability of *Macrophomina phoseolina* and found that bulb extract of *A. sativum* was more effective than its leaf extract. Even 0.1% concentration extracts cheeked the growth of *M. phaseolina* by 54.2%. Similarly, berk extract of *A. arabica* exhibited two -fold greater inhibitory effect on fungal growth than the fruit extracts. Bulb extract of *A.*

Sativum revealed greater fungal effect than *A. cepa* where selerotia germination was reduced significantly by 27% as compared to control.

Antifungal activity of leaf extracts of *Azadirachta indica, Calotropis gigantea, Catharanthus roseus, Eucalyptus sp., Parthenium hystrophorus* and *Pongamia pinnata* were tested by Sarvamangala and Datta (1993) against *Cerotelium fici* and *Cercospora morciola* in vitro causing leaf rust and leaf spot diseases of mulberry, respectively, *Azadirachta indica* was more effective, inhibiting spore germination by 91.2% whereas extracts of *Eucalyptus sp.* and *C. gigantean* proved highly toxic to *C. moricota* inhibiting condial germination by 91.5 and 91.3% respectively.

Islam (2003) reported the relative efficiencies of seven plant extracts (Dhatura, Dholkalmi, Garlic, Ginger, Marigold, Neem, Nymbicidine) which was tested in the field condition, Nymbicidine showed significanlty the best performance in reducing the disease incidence and giving higher yield.

Prasad and Barnwal (2004) reported the effects of leaf extracts of leaf extracts of *Azadirachta indica, Pongamia pinnata, Datura metel, Ocimum sanctum (Ocimum tenuflorum), Eucalyptus citriodora and Mentha arvensis*

on Stemphylium blight and Purple blotch of onion (cv, N-53). In *in vivo* evaluation, disease intensity was the lowest with 20% leaf extracts of *A. indica* (recording 38.1 and 38.2% intensity during 1998-99 and 1999-2000 crop seasons, respectively), followed by 20% leaf extract of *Datura metel*(with disease intensities of 41.4 and 43.2%, respectively). Bulb yields of were the highest in plots sprayed with 20% leaf extracts of *Datura metel* (177.8 and 173.3 q/ha), followed by sprays of 20% A. indica leaf extract (172.2 and 168.9 q/ha), during 1998-99 and 1999-2000 crop seasons, respectively.

Akter (2007) conducted a field experiment at the research farm of Sher-e-Bangla Agricultural University, Dhaka during the rabi season of 2006-2007 to study the management of purple blotch of onion through chemicals and plant extracts. Eleven treatments comprising Dithane M-45, Rovral 50WP, Bavistin 50WP, Cupravit 50WP, Proud 250EC, Champion, Tilt 250EC, Ridomill Gold, Neem leaf extract, Allamanda leaf extract and Control were explored in the experiment. The highest bulb yield (8.767 t/ha) and bulb diameter (3.787 cm) were obtained with Rovral 50WP treated plot. The percent plant infection, percent leaf infection, percent Leaf Area Diseased (% LAD) and Percent Disease Index (PDI) were found the lowest in foliar

spray with Rovral 50WP and the highest in control treatment. Between the two plant extracts Neem extract performed better than Allamanda extract.

Hossain (2008) conducted an experiment both in Seed Health Laboratory, Department of Plant Pathology and in the research farm of Sher-e-Bangla Agricultural University, Dhaka during the winter cropping season of 2007-2008 to study the management of purple blotch of onion for seed production. The *in vitro* test with nine treatments comprising Dithane M-45, Rovral 50WP, Bavistin 50WP, Cupravit 50WP, Ridomill Gold MZ-72, Neem leaf extract, Allamanda leaf extract in combination with micronutrients and Control were explored in the experiment.Among the fungicides, Rovral 50WP @ 0.2% reduced the highst mycelial growth of *Alternaria porri* followed by Ridomill Gold MZ-72 @ 0.2% and Dithane M-45 @ 0.45% compared to control. Between two botanical treatments, Neem leaf extract (1:6 w/v) gave the better result than with Allamanda leaf extract (1:6 w/v). In the field experiment, the treatments showed significant effect in respect of disease incidence, disease severity, seed yield and seed yield contributing characters. The lowest disease incidence and disease severity were observed in Rovral 50WP @ 0.2% + micronutrients followed by Ridomill Gold MZ-72 @ 0.2% + micronutrients and Dithane M-45 @ 0.45% +micronutrients.

The highest infection observed in control treatment. Between the two botanical treatments Neem leaf extract (1:6 w/v) + micronutrients performed better than Allamanda leaf extract (1:6 w/v) + micronutrients.

2.5. Effect of organic amendments

Nahar *et al.* (2006) conducted an on-farm experiment to evaluate the effect of soil organic amendments, nematicides and fungicides in managing purple blotch disease of onion. The experiment was carried out during summer 1998 and 1999 in naturally infested fields. Plots incorporated with poultry manure (3t/ha) plus standard fertilization (composted cow manure 10t, Nitrogen 69kg, Phosphate 90kg, Potassium 96.6kg, Sulfur 19.8kg, Zinc 4.29kg and Boron 0.45kg per hectare) alone, and in combination with a foliar application of Iprodione at a rate of 1000ppm produced taller, heavier and healthier onion plants with minimum diseases compared with those of the traditional farmer practice (composted cow manure 20t, Nitrogen 92kg, Phosphate 299.7kg and Potassium 199.8kg per hectare) and control treatment (only standard fertilizers). Both treatments also resulted in about twice the yield of the plots managed using the traditional farmer practice.

Diogzon and Gapasin (2000) showed that poultry manure (5-10t/ha) improved the growth of onion and decreased diseases.

2.6. Relevant information regarding the pathogen, epidemiology and its management

Fanceli and Kimati (1991) conducted an experiment in Brazil to determine the influence of culture media and light on the sporulation of *Alternaria dauci*. They noted that Czapek's and host leaf extract medium yielded better sporulation of the fungus compared to other tested media.

Bhode *et al.* (2001) observed the effect of varying irrigation frequencies and N fertilizer levels on onion cv. Agrifound Dark Red seed production during rabi 1998/99 and 1999/2000 at Nasik, Maharashtra, India. The irrigation frequencies tested were: (I_1) irrigation at 15- day's intervals up to day 60, 12-days intervals from day 60 to 100 and 8-days intervals from day 100 until maturity; (I_2) irrigation at 12-days intervals up to 60 and 8-days intervals thereafter; and (I_3) irrigation at 10-days intervals throughout the cropping period. The N fertilizer treatments include: (N_1) 80 kg/ha applied in 2 splits, 50% at planting and 50% at 45 days after planting (DAP); (N_2) 100 kg/ha applied in 2 splits, 50% at planting and 50% at 45 DAP; and (N_3) 120 kg/ha

applied in 3 splits, 33% at planting, 33% at 45 DAP and 33% at 60 DAP. Based on these traits and on the resistance to purple blotch (*Alternaria porri*) and thrips, No significant differences in any of these traits were observed as a result of varying Nitrogen level, while the interaction effects were only significant for seed germination

A study on the sporulation of *Alternaria porri* was conducted by Khare and Nema (1981). They observed maximum sporulation at 8.00 am under field condition. A seasonal periodicity was also noted, indicating maximum sporulation at 22^0 C at 90% RH.

Khare and Nema (1982) also reported that the temperature ranged between 22^0C to25^0C was not only suitable for growth and sporulation of *Alternaria porri* but also optimum for spore germination as well as for infection in onion. They also argued that spore germination on leaves decreased with the increase of nitrogen doses to the host. They also reported that temperature, humidity and nutrients seemed to play important roles for ensuing infection of *Alternaria porri* in onion. Cent percent (100%) spore germination occurred in vitro within 4 hrs at 22^0 C, while maximum germination was recorded within 6 hrs at 25^0 C on the host surface.

applied in 3 splits, 33% at planting, 33% at 45 DAP and 33% at 60 DAP. Based on these traits and on the resistance to purple blotch (*Alternaria porri*) and thrips. No significant differences in any of these traits were observed as a result of varying Nitrogen level, while the interaction effects were only significant for seed germination.

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Nuchart Jonglaekha *et al.* (1982) observed that most of the conidia produced germ tubes and penetrated wounds on leaves within 8 hrs. After inoculation, the conidia were club shaped with cross and longitudinal septa. This fungus produces spores when the temperature lays between18-26^{0}C.

Raju and Metha (1982) demonstrated an experiment on certain nutritional aspects of *Alternaria porri* (Ellis) Ciferri on onion in vitro and summarized that potato dextrose agar, having P^H 6, was the best to culture the fungus. Temperature ranging 22-25^{0}C was optimum for mycelial growth and sporulation of *Alternaria porri.*

Miller (1983) reported that measurements of infected leaves were taken weekly from bulb initiation to bulb maturity. They observed that the leaf damage levels were significantly lowered on younger than older leaves. Leaves emerging 9, 8, 7, 6 and 5 week before bulbing maturity required $5^1/_2$, 5, $4^1/_2$, $3^1/_2$ and $2^1/_2$ weeks respectively to reach 50% damage.

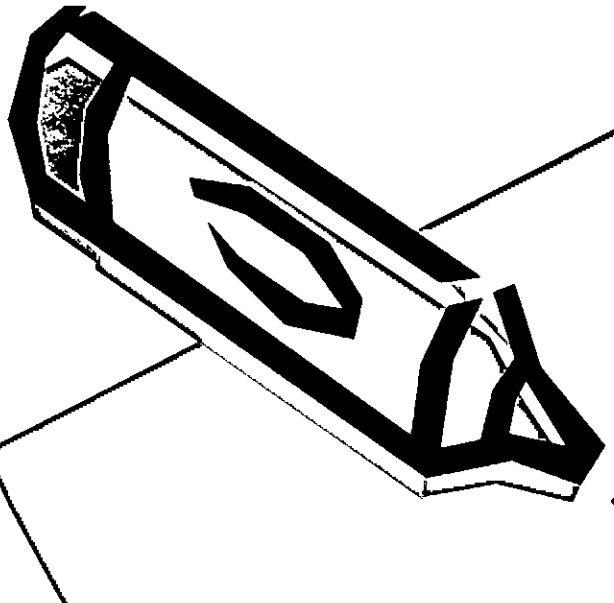
Khare and Nema (1984) conducted an experiment to determine the effect of temperature and humidity of the development of symptoms of purple blotch of onion incited by *Alternaria porri* and noted that temperature between 22^0

to 25^0 C and relative humidity 90% are the best for the development of leaf blotch symptom.

Gupta and Pathak (1988) reported that bulb and seed yields and 1000 seed weight of Nashik Red onion were significantly reduced by *Alternaria porri* infection. Disease severity was computed in terms of the co-efficient of disease index (Codex). A linear relationship was found between yield and Codex.

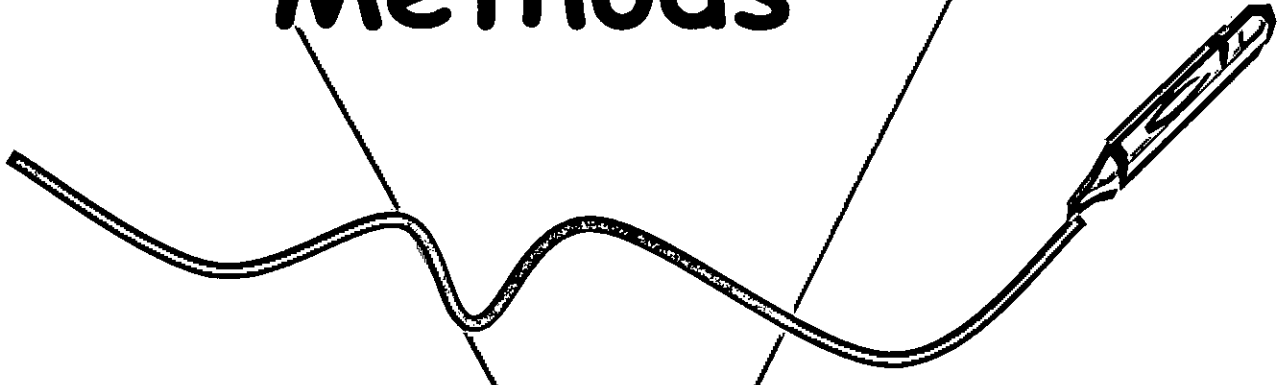
Srivastava *et al.* (1999) conducted *in vitro* studies to determine the role of infected plant debris and soil in the perpetuation of disease and air borne spore of purple blotch (*Alternaria porri*) and Stemphylium blight (*S. vesicarium*) on onions in Haryana, India, in order to establish a forecasting system for effective control measures. The pathogens remained viable for 4 months on diseased plant debris, 3 months at soil in depths of 2.5, 5.0 and 7.5 cm and for 2 months at soil in depths of 10.0 and 15.0 cm. It was suggested that the inoculum load of *Alternaria porri* and *Stemphylium vesicarium* during ploughing of infected soil was higher during the winter.

Lakra (1999) conducted an experiment at the Choudhury Charan Singh Haryana Agricultural University, Hisar, India, found that numerous purple spots / blotchs were observed on older leaves and scapes when fortnightly dew fall was >1.0 mm, mean maximum relative humidity > 75% and mean maximum temperature 20-30^0 C with > 18 hr favourable temperature (10-30) duration. Exposure of leaf and/or scape to wetness for 8 hr was a pre-requisite for conidial germination with increasing disease intensity, every tield component was adversely affected; the most severe infection reduced the number of scapes/plant, the height of scape, the number of umblets/umbel, the number of seeds/umblet, 1000-grain weight, number of seeds/plant and the seed yield/plant by 28.7, 74.5, 89.9, 41.7, 35.7, 95.7 and 97.3% respectively compared with healthy plants.



Chapter III

Materials & Methods



CHAPTER III

MATERIALS AND METHODS

3.1. Field experiment

A field experiment with different fungicides in combination with poultry manure and neem seed extract was assayed in the Rabi season (December, 2009 to March, 2010) to control the purple blotch of onion for bulb production.

3.1.1. Experimental site

The research was conducted at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, during the period from 22nd December, 2009 to 29th March, 2010. The experimental field is located at 90^{0}33′ E longitude and 23^{0}77′ N latitude at a height of 9 meter above the sea level (Fig.1). The land was medium high and well drained.

CHAPTER III

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3.1.1. Experimental site

The research was conducted at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, during the period from 20th December, 2009 to 29th March, 2010. The experimental field is located at 90°33' E longitude and 23°77' N latitude at a height of 9 meter above the sea level (Fig.1). The land was medium high and well drained.

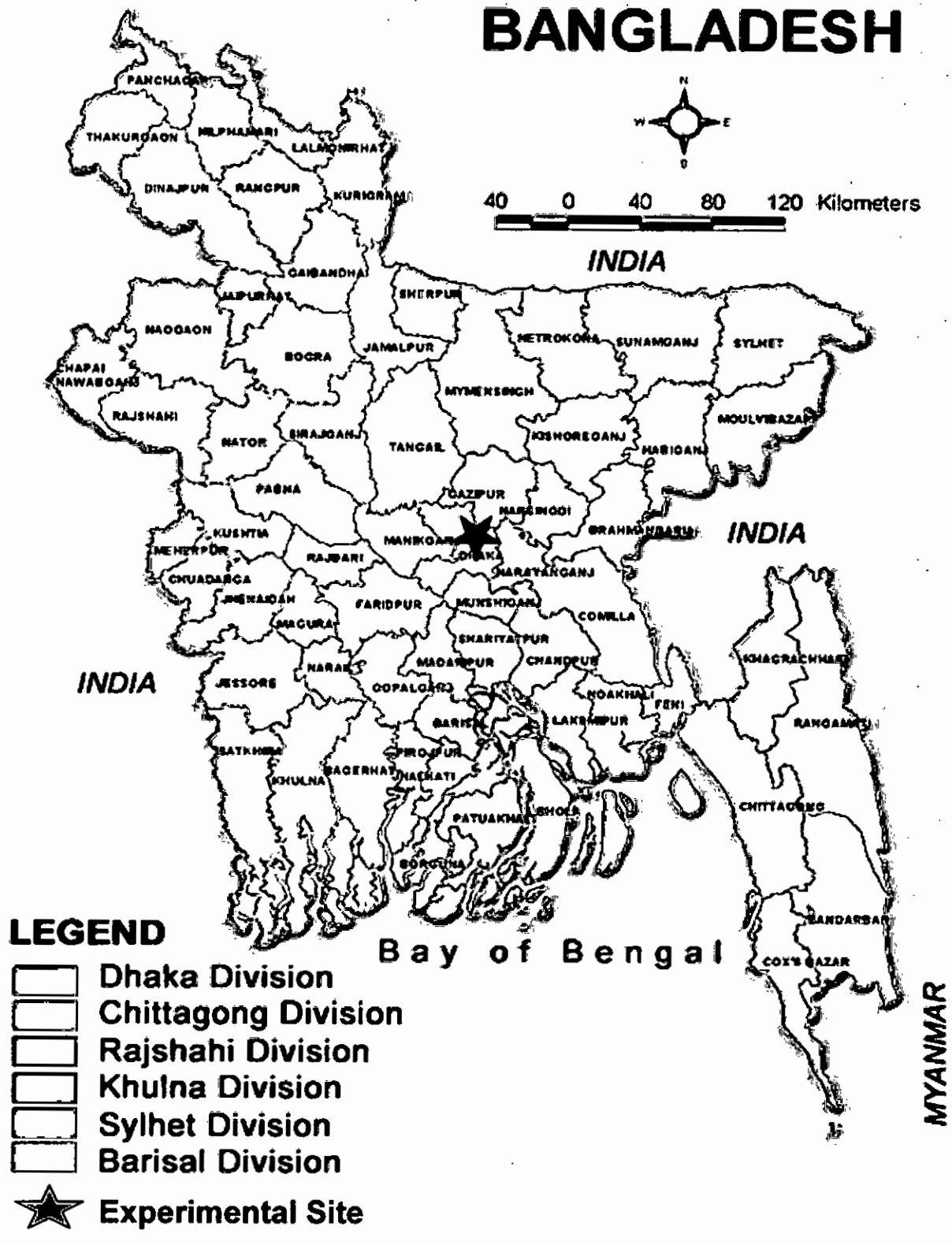


Fig.1. Map showing the experimental site under study

3.1.2. Climate

The experimental area was under the sub-tropical climate which characterized by the comparatively low rainfall, low humidity, low temperature, relatively short day during October to March, and high rainfall, high humidity, high temperature and long day period during April to September.

The annual precipitation and potential evapotranspiration of the site were 2152 mm and 1297 mm, respectively. The average maximum and minimum temperature was 30.34^{0}C and 21.21^{0}C, respectively with mean temperature of 25.17^{0}C. (Appendix- II)

Temperature during the cropping period ranged between 12.2^{0}C to 31.2^{0}C. The humidity varied from 73.52% to 81.2%. The day length ranged between 10.5-11.0 hours only.

3.1.3. Soil type

The soil of the experimental site belongs to the Agro-Ecological Zone of "Madhupur Tract" (AEZ No. 28). It was Deep Red Brown Terrace soil and belongs to "Nodda" cultivated series. The top soil is slightly clay loam in texture. Organic matter content was very low (0.82%) and soil pH varied from 5.07-5.63. The information about AEZ 28 is given below:

Characteristics of AEZ-28

Land type	Medium high land
General soil type	Non-Calcareous Dark gray floodplain soil
Soil series	Tejgaon
Topography	Upland
Elevation	8.45
Location	SAU Farm, Dhaka
Field Level	Above flood level
Drainage	Fairly good
Firmness (consistency)	Compact to friable when dry

3.1.4. Land preparation

The experimental field was ploughed with power tiller drawn rotovator. After ploughing the field it was left to nature for 10 days for sun and nature to work upon. Subsequent cross ploughing was done followed by laddering to make the land level. Then the soil clods were broken by a wooden hammer and all weeds, stubbles and residues were removed from the field. Later, Cowdung @ 10 ton/ha and chemical fertilizer like Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) was mixed with soil during final land preparation.

3.1.5. Fertilizer application

The experimental field was fertilized with Nitrogen (in the form of Urea), Phosphorus (in the form of Triple Super Phosphate -TSP), Potassium (in the form of Muriate of Potash -MP), Gypsum, ZnO. As per the treatment whole quantity of TSP, MP, Gypsum, ZnO, and one fourth of Urea were applied at final plot preparation. The rest third fourth Urea was applied later in three installments (40, 60 and 80 days after planting). Fertilizer was applied as recommended doses (BARC, 1997). Applied doses were as follows:

Doses of chemical fertilizers

Name of the Fertilizer	Fertilizer dose (kg/ha)	Fertilizer applied during final land preparation (kg/183.75 m^2 land)	Rest installments (Urea) (kg/183.75 m^2 land)		
			1st	2nd	3rd
Urea	320	1.47	1.47	1.47	1.47
TSP	415	7.62	-	-	-
MP	168	3.08	-	-	-
Gypsum	100	1.83	-	-	-

3.1.6. Experimental design

The experimental plots were arranged in Randomized Complete Block Design (RCBD) with three (3) replications (Appendix-I). The experiment details were given bellow:

- Total area : 255.75 m^2
- No. of plot : 54
- Plot size : (2 × 1.5) m^2
- Block to block distance : 1.0 m
- Plot to boundary distance : 1 m
- Plot to plot distance (Length wise) : 0.5 m
- Plot to plot distance (Breath wise) : .0.5 m
- Plant to plant spacing : 15 cm
- Row to row spacing : 20 cm

3.1.7. Treatments of experiment

Altogether there were 18 different treatments as stated bellow. The treatments were applied into the assigned plots as per design of the experiment.

Treatments

T_1 (PoDoFo) = No poultry manure + Seedlings not dipped in respective solution + No fungicide (Control)

T_2 (PDoFo) = Poultry manure + Seedlings not dipped in respective solution + No fungicide

T_3 ($PoDF_1S_7$) = No poultry manure + Seedlings dipped in Rovral 50WP solution + Foliar spray with Rovral 50WP at seven days interval

T_4 ($PoDF_2S_7$) = No poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_5 ($PoDF_3S_7$) = No poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_6 (PDF_1S_7) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at seven days interval

T_7 (PDF_2S_7) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_8 (PDF_3S_7) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_9 ($PoDF_1S_{15}$) = No Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{10} ($PoDF_2S_{15}$) = No Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{11} ($PoDF_3S_{15}$) = No Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{12} (PDF_1S_{15}) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{13} (PDF_2S_{15}) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{14} (PDF_3S_{15}) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{15} ($PoDNS_7$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{16} ($PDNS_7$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{17} ($PoDNS_{15}$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

T_{18} ($PDNS_{15}$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

3.1.8. Fertility status of the field soil:

The soil of experimental site was analyzed in Soil Resource Development Institute (SRDI), Dhaka and found as loamy soil which contains total Nitrogen 0.057(%), Phosphorus 41205.88 microgram per gram of soil, Sulphur- 50.50 microgram per gram of soil, Potassium 0.23 miliequivalent per 100gram soil and Calcium-2.67 miliequivalent per 100 gram soil.

Physical and chemical properties of the experimental soil

Soil properties	Value
Soil texture	clay loam
Soil pH	5.1
Organic matter (%)	1.14
Total N (%)	0.057
C : N ratio	10 : 1
Available P (ppm)	41.18
Available B (ppm)	0.57
Available Zn (ppm)	5.54
Exchangeable K (me/100g soil)	0.23
Available S (ppm)	50.50

3.1.9. Variety used:

The experiment was conducted with a local onion variety Taherpuri collected from Manikgonj, Dhaka. This onion variety is most popular in Bangladesh and its quality is more standard than other local or high yielding variety.

3.1.10. Seedling treatment

According to the spacing of sowing seedling in the experiment, 91 seedlings were required for each of the treatment. So, 91 seedlings were treated for each treatment with the respective plant extracts and fungicidal solution by dipping the seedlings in the solution for 5 minutes. The seedlings were then drained off, shade dried and sown in the field without delay.

3.1.11. Growing of onion

3.1.11.1. Age of the seedling:

Forty five days old healthy seedlings of onion having more or less uniform vigour were collected from Manikgonj, Dhaka and transplanted in the experimental plot.

3.1.11.2. Transplanting of seedling:

The healthy seedlings were selected for transplanting in experimental plots. The seedlings were transplanted maintaining row to row distance 20 cm and plant to plant distance 15 cm. The seedlings were transplanted on 22nd December, 2009.

3.1.11.3. Transplantation procedure:

Before transplantation, the top of seedling's leaves, at length of 10 to 12 cm from the base was cut with a sharp knife, the roots were also cut at a 2 cm from the base (a usual practice followed by farmers which may help decreased transpiration and faster root development). The prepared seedling was transplanted, as per design and spacing in the evening and watered on the next following days up to establishment of seedlings. A good number of seedlings were transplanted at the border for later use as gap fillers.

3.1.12. Intercultural operation:

3.1.12.1. Irrigation

Irrigation was normally done after each weeding. The young plants were irrigated by a watering can at the day after transplantation. Subsequent irrigation was done as per requirements.

3.1.12.2. Gap filling

The dead or sick seedlings were replaced by healthy seedlings within a week after transplantation. The damaged plants were also replaced by border plants through gap filling.

3.1.12.3. Weeding and mulching

Weeding and mulching were done when required to keep the crop free from weeds, for better soil aeration and conserve soil moisture. The common weeds were *Cynodon dactylon* L. (Durba grass), *Cyperus rotundus* L. (Mutha) etc. Weeding was done carefully keeping the delicate young plants undisturbed. The first weeding was done after one month of seedling transplantation and second weeding was done one month after the first weeding.

3.1.13. Collection of materials:

3.1.13.1. Collection of fungicides

The fungicides Rovral 50 WP, Bavistin DF and Ridomil Gold MZ-72 were collected from Krishibid Nursery, Farmgate and Kustia seed store, Mirpur-11, Dhaka, Bangladesh.

Particulars of the chemicals (fungicides) used in this study

Fungicides	Active ingredient
Rovral 50 WP	Iprodione 50%
Bavistin DF	Carbendazim 50%
Ridomil Gold MZ-72	Metalaxyl 67% + Mancozeb 6%

3.1.13.2 Collection of botanical

Seeds of Neem were collected from Siddique bazaar, Gulistan, Dhaka (Plate1).

The botanical used in this study

Common name	English name	Scientific name	Plant parts used
Neem	Margosa	*Azadirachta indica*	Seed

3.1.13.3 Collection of poultry manure

Poultry manure was collected from the ATI (Agricultural Training Institute) poultry farm, College gate, Dhaka (Plate 2).

3.1.14. Application of poultry manure

The soil amendment was done by using composted poultry litter by mixing into the top 15 cm of soil during the final land preparation. Poultry manure was applied at 1.5 kg/plot.

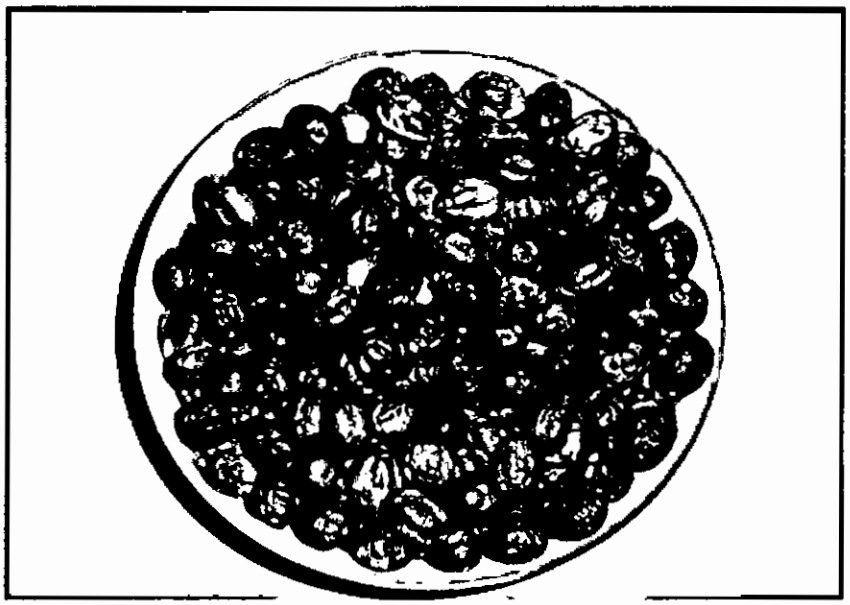


Plate 1. Neem seed

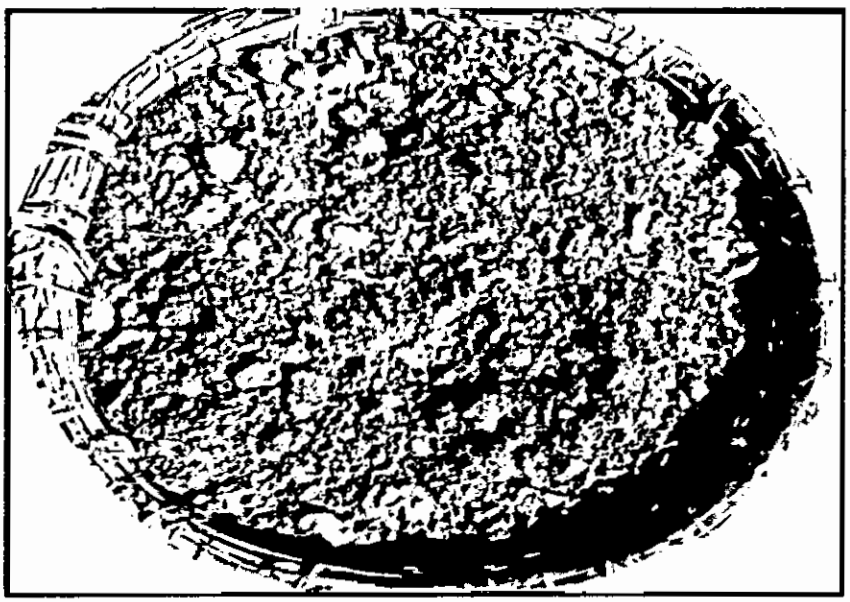


Plate 2. Poultry manure

3.1.14.1. Nutrient analysis for poultry manure

Nutrients	Methods used*	%Nutrients**
Nitrogen	Kjeldahl method (modified salisylic method)	1.28
Organic Carbon	Wet oxidation method	32.11
Sulphur	Double bean spectrophotometer following ASI analytical method	0.57
Phosphorus	Double bean spectrophotometer following ASI analytical method	0.23
Boron	Double bean spectrophotometer following ASI analytical method	0.012
Calcium	Atomic absorption spectrophotometer	3.66
Magnesium	Atomic absorption spectrophotometer	0.38
Potassium	Atomic absorption spectrophotometer	0.88
Sodium	Atomic absorption spectrophotometer	3.9

*According to Chapman and Avaft (1988)

**Dry weight basis

3.1.14.2. Processing of poultry manure

Poultry manure was sun dried before application and ground it evenly with the help of hand for proper mixing with the soil.

3.1.15. Field spray of fungicides

3.1.15.1. Preparation of suspension/solution/chemicals:

At recommended doses suspension/solution of fungicides were prepared by mixing thoroughly with requisite quantity of normal clean water. Spray was given at seven days interval and fifteen days interval in the assigned plots.

The spray suspensions of fungicides used in the experiment were presented below with their doses.

Fungicides	**Doses rate**
1. Rovral 50 WP	0.2%
2. Bavistin DF	0.1%
3. Ridomil gold MZ-72	0.2%

3.1.15.2. Application of fungicide

At recommended doses suspension/solution of fungicides were prepared by mixing thoroughly with requisite quantity of normal clean water. Spraying was started from one month after transplanting. Totally 6 spraying were

done at 7 days intervals and 15 days interval with a hand sprayer. To avoid the drifting of the fungicides during application, spraying was done very carefully, specially observing air motion. A control treatment was maintained in each block where spraying was done with normal water only.

3.1.16. Field spray of Neem seed extract

3.1.16.1. Preparation of Neem seed extracts solution

The extracts were prepared by using the method of Sridhar and Vijayalakshmi, 2002. For preparation of extracts, collected seeds were weighted in an electric balance and then washed in water. After washing shells were removed from the seeds and ground seeds gently by placing in a pot. For getting extract, weighted seeds were ground with the help of mortar and pestle and then required amount of water was added into the pot. The mouth of the pot was covered securely with the cloth and leaves it as such for 3 hours. After that strained it with the help of strainer to get clear extract. For getting seed extracts 10 liters water was added with 3-5 kg seeds.

3.1.16.2. Application of Neem seed extracts solution

Neem seed extracts spraying were started from 34 days after seedlings planting. Totally 6 spraying were done at 7 days intervals with a hand

sprayer. One liter of plant extracts solution was used to spray the plants under each treatment. A control treatment was maintained in each block where spraying was done with plain water only.

3.2. Laboratory work

These comprised isolation of *Alternaria porri* from infected onion plant under laboratory condition. This isolation was done at the Seed Health Laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the month of March-April, in 2010.

3.2.1. Isolation and identification of pathogen from leaf tissue

Isolation and identification of pathogen were made in two ways-

3.2.1.1. By direct inspection.

3.2.1.2. By inoculating diseased tissues on Potato Dextrose Agar (PDA) medium.

3.2.1.1. By direct inspection

The diseased leaves of onion plants were collected and kept in polythene bags and tagged. The samples were then taken to Seed Health Laboratory of

the Department of Plant Pathology, SAU, Dhaka. Then slides were prepared from the diseased samples, observed under microscope and identify the pathogen according to CMI description (Vol. no. 338).

3.2.1.2. By growing on Potato Dextrose Agar (PDA) medium

The diseased leaves were cut into pieces (4 mm diameter) and surface sterilized with $HgCl_2$ (1:1000) for 30 seconds. Then the cut pieces were washed in sterile water thrice and were dried in keeping untreated blotting paper then placed on to acidified PDA in petridish. The plates containing leaf pieces were placed at room temperature for seven days. When the fungus grew well, and sporulated, then the pathogen slide was prepared and was identified under microscope with the help of relevant literature to CMI description (Vol. No. 338)

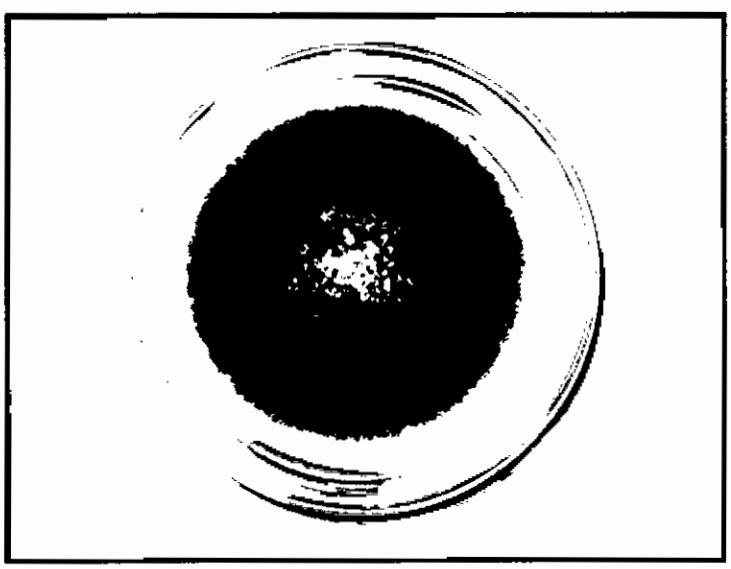


Plate 3. Pure culture of *Alternaria porri*

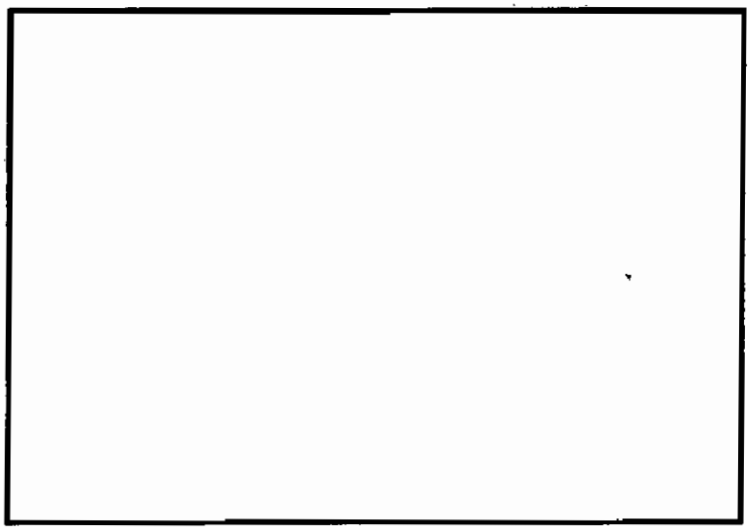


Plate 4. Conidia of *Alternaria porri (x 40)*

3.3. Data collection

Ten plants were selected randomly for each unit plot and tagged for data collection. Data collection was started after the onset of the disease symptoms and continued up to maturity with 7 days intervals.

3.3.1. Total no. of Plants/plot

Number of total plants was counted at different vegetative growth stages.

3.3.2. Healthy plants/plot

Number of healthy plants was counted at different vegetative growth stages.

3.3.3. No. of symptoms bearing plants/plot

Number of infected plants under each treatment was counted at different observation dates as scheduled.

3.3.4. No. of leaf/plant

Number of leaves per plant was counted from randomly selected 10 plants from the each plot at different dated as scheduled.

3.3.5. No. of infected leaf/plant of different treatment

Number of leaves infected per plant were recorded and used for calculation of disease incidence. The leaf with characteristic purple colored spot or blighted tip was denoted as diseased leaf.

Calculation of disease incidence of different treatment

The percent disease incidence was calculated using the following formula (Wheleer, 1969):

$$\%\text{plant infection} = \frac{\text{Number of infected plant}}{\text{Total number of inspected plant}} \times 100$$

$$\%\text{ leaf infection} = \frac{\text{Number of infected leaf}}{\text{Total number of inspected leaf}} \times 100$$

3.3.6. Leaf Area Diseased (LAD)/plant in different treatment

Leaf area diseased of the ten selected plants in each plot against each treatment were measured and recorded by conversion to percentage. Mean percentage of leaf area diseased was calculated by dividing number of total observation.

3.3.7. Harvesting

Onion bulbs were harvested on 29th March 2010, at which the plants have been showing the sign of drying out of most leaves. Onion bulbs were carefully lifted with the help of khupry. To avoid injury, care was taken during harvesting the bulbs by khupry. Then the stalks were cut 2 cm above bulbs and dried in the sun and later weight was taken.

3.3.7.1. Weight of bulb per plot

Weight of onion bulbs per plot were recorded individually for each treatment.

3.3.7.2. Yield of onion per hectare

Yield of onion was calculated as ton per hectare.

3.3.7.3. Storing of the bulbs

After harvesting, curing and sun drying, the onion bulbs were stored at room temperature for the months of April to May, on the floor of a pakka room keeping good ventilation.

3.4. Analysis of Data/Statistical Analysis

Data were analyzed statistically using MSTAT Computer Program. Data were transformed, whenever necessary, following Arcsine transformation. Means of treatment were separated using Duncan's Multiple Range Test (DMRT), (Gomez and Gomez, 1983).

3.5. Weather report

The monthly average data on temperature, rainfall and humidity during experimental period were collected from the authority of Bangladesh Metrological Department, Agargoan, Dhaka which are presented in Appendix (II).

Plate 5. Photograph showing the field view of the experiment

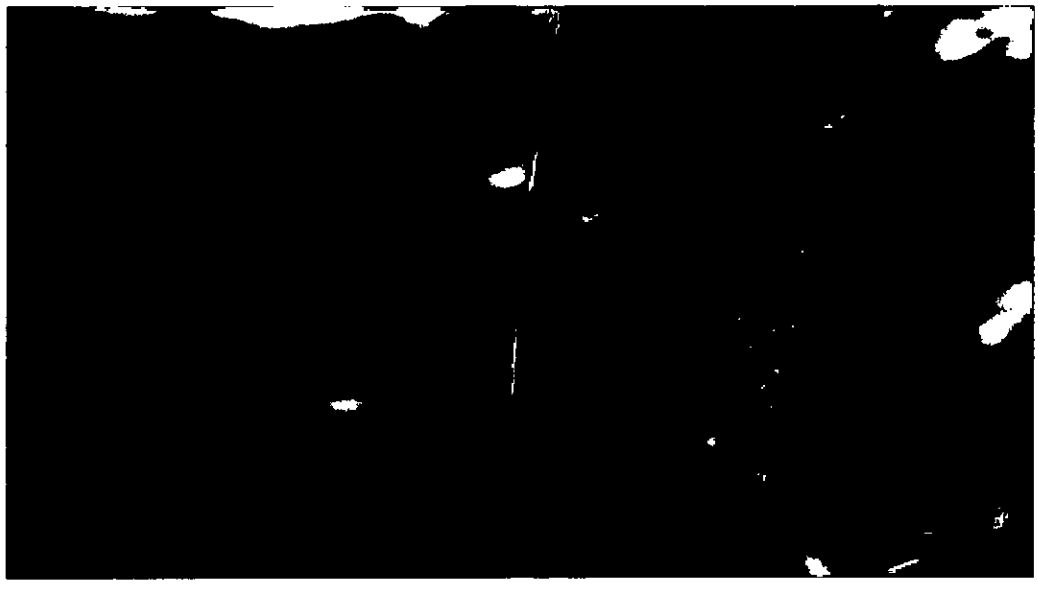
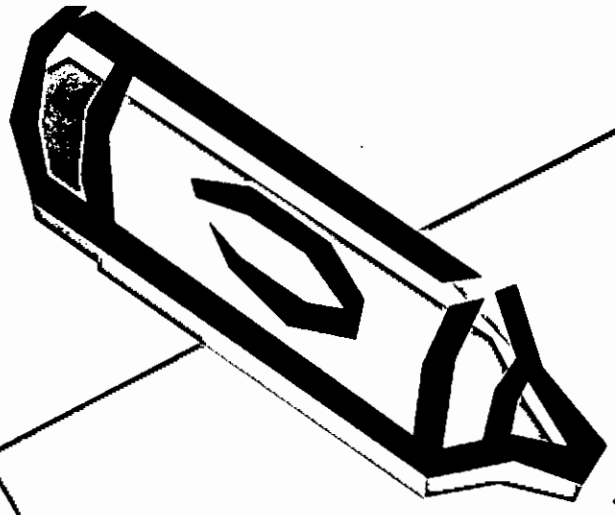


Plate 6. Photograph showing preliminary symptom of Purple blotch of onion on leaf

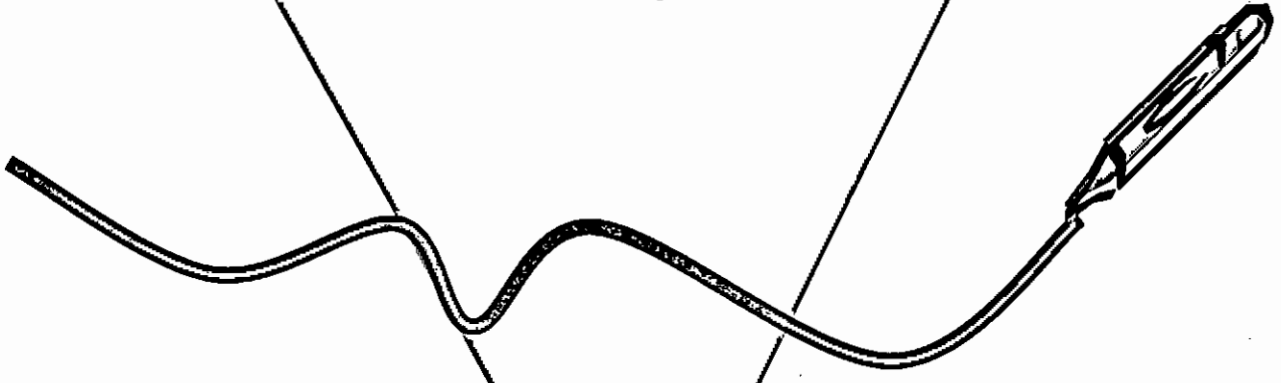
Plate 7. Photograph showing typical symptom of Purple blotch of onion on leaf

Plate 8. Photograph showing advanced stage of Purple blotch disease of onion



Chapter IV

Results



CHAPTER IV

RESULTS

4.1. Effect of different fungicides in combination with poultry manure and neem seed extract on purple blotch disease of onion

Efficacy of selected fungicides viz. Rovral 50 WP, Bavistin DF and Ridomil Gold MZ-72 in combination with poultry manure and neem seed extract were assessed against A. *porri* in controlling purple blotch of onion. The efficacy of the treatments was measured in respect of percent plant infection, percent leaf infection, percent leaf area diseased (%LAD) and yield.

4.1.1. Percent plant infection

Results obtained on the effect of spraying Rovral 50 WP, Bavistin DF, Ridomil Gold MZ-72 and neem seed extract in combination with poultry manure in controlling purple blotch of onion in terms of percent plant infection were observed and recorded at 34, 41, 48, 55, 62 and 69 DAP are presented in Table 1. The effects of the treatments on plant infection differed significantly at different DAP with some extent. At 69 DAP the lowest plant infection (74.33%) was observed in case of the treatment PDF_1S_7 (Soil amendment with poultry manure + Seedling dipped in Rovral 50WP solution + Foliar spray with Rovral 50WP at 7 days interval) followed by the treatment $PoDF_1S_7$ and $PDNS_7$ which were statistically identical. The highest plant infection (100%) was observed in control treatment which is

statistically similar with PDoFo. In case of poultry manure treatments T_7 (PDF_2S_7) showed better performance for controlling purple blotch of onion. It was noted that the percent infected plant was gradually increased with the age of the crop and increasing rate was comparatively slower in treatment T_6 (PDF_1S_7), T_3 ($PoDF_1S_7$) and T_{16} ($PDNS_7$)

4.1.2. Percent Leaf infection

The effect of spraying Rovral 50 WP, Bavistin DF, Ridomil Gold MZ-72 and neem seed extract in combination with poultry manure in controlling purple blotch of onion in respect of % leaf infection were observed and recorded at 34, 41, 48, 55, 62 and 69 DAP are presented in Table 2. Different treatments showed statistically significant variation in respect of percent leaf infection. The lowest infection (69.33 %) was observed in case of the treatment T_6 (PDF_1S_7). The highest leaf infection (94.04%) was observed in untreated control plot. Fungicide Bavistin DF in combination with poultry manure at seven days interval showed significantly better performance in treatment T_7 =PDF_2S_7 (71.86%). The result showed that at 69 DAP treatment T_4 ($PoDF_2S_7$), T_5 ($PoDF_3S_7$) and T_{11} ($PoDF_3S_{15}$) yielded statistically similar effect in reducing the disease incidence (% leaf infection) of purple blotch of onion.

Table 1. Effect of different treatments on disease incidence (% plant infection) of purple blotch of onion at different days after planting (DAP)

Treatmens	% plant infection (Data taken on 7 days interval)					
	34 DAP	41 DAP	48 DAP	55 DAP	62 DAP	69 DAP
T_1=PoDoFo	63.72 a	71.67 a	74.98 a	80.65 a	90.95 a	100.00 a
T_2=PDoFo	62.75 ab	71.28 a	74.72 a	79.99 ab	90.08 a	100.00 a
T_3=PoDF$_1$S$_7$	59.33 a-c	52.75 bc	62.50 b-d	71.21 c-e	77.51 e-g	78.67 fg
T_4=PoDF$_2$S$_7$	58.74 a-d	54.06 bc	63.46 bc	73.08 b-d	81.49 b-e	90.00 bc
T_5=PoDF$_3$S$_7$	57.79 a-d	55.02 bc	65.43 b	74.66 a-c	84.57 b	93.00 b
T_6=PDF$_1$S$_7$	53.74 a-e	44.67 d	51.59 ef	64.88 ef	70.71 h	74.33 g
T_7=PDF$_2$S$_7$	45.66 e	54.12 bc	55.98 d-f	67.61 c-f	75.79 fg	83.00 ef
T_8=PDF$_3$S$_7$	49.07 c-e	52.75 bc	57.52 c-e	68.76 c-e	79.42 d-f	85.67 c-e
T_9=PoDF$_1$S$_{15}$	48.67 c-e	55.00 bc	61.83 b-d	68.78 c-e	80.08 c-e	84.00 d-f
T_{10}=PoDF$_2$S$_{15}$	51.33 b-e	52.79 bc	60.36 b-d	68.88 c-e	82.42 b-d	87.33 b-e
T_{11}=PoDF$_3$S$_{15}$	53.67 a-e	53.24 bc	61.47 b-d	69.13 c-e	85.29 b	89.33 b-d
T_{12}=PDF$_1$S$_{15}$	47.45 de	52.33 bc	60.60 b-d	67.81 c-f	83.41 b-d	87.00 c-e
T_{13}=PDF$_2$S$_{15}$	54.88 a-e	54.32 bc	63.75 bc	69.39 c-e	83.55 b-d	88.67 b-e
T_{14}=PDF$_3$S$_{15}$	54.28 a-e	54.67 bc	64.46 bc	70.91 c-e	83.94 bc	88.67 b-e
T_{15}=PoDNS$_7$	56.55 a-e	58.74 b	64.96 bc	69.15 c-e	81.50 b-e	83.67 d-f
T_{16}=PDNS$_7$	49.89 c-e	50.02 c	62.30 b-d	66.90 d-f	75.17 g	79.00 fg
T_{17}=PoDNS$_{15}$	51.33 b-e	51.68 c	62.98 b-d	66.28 d-f	75.09 g	83.97 d-f
T_{18}=PDNS$_{15}$	53.36 a-e	53.79 bc	64.71 bc	67.20 c-f	78.12 e-g	84.33 d-f
LSD (0.05)	9.86	5.58	6.32	6.62	3.70	5.12
CV (%)	11.00	6.13	6.11	5.71	2.76	3.58

Treatments:

T_1 (PoDoFo) = No poultry manure + Seedlings not dipped in respective solution + No fungicide (Control)

T_2 (PDoFo) = Poultry manure + Seedlings not dipped in respective solution + No fungicide

T_3 (PoDF$_1$S$_7$) = No poultry manure + Seedlings dipped in Rovral 50WP solution + Foliar spray with Rovral 50WP at seven days interval

T_4 (PoDF$_2$S$_7$) = No poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_5 (PoDF$_3$S$_7$) = No poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_6 (PDF$_1$S$_7$) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar

spray with Rovral 50 WP at seven days interval

T_7 (PDF_2S_7) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_8 (PDF_3S_7) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_9 ($PoDF_1S_{15}$) = No Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{10} ($PoDF_2S_{15}$) = No Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{11} ($PoDF_3S_{15}$) = No Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{12} (PDF_1S_{15}) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{13} (PDF_2S_{15}) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{14} (PDF_3S_{15}) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 fifteen at days interval

T_{15} ($PoDNS_7$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{16} ($PDNS_7$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{17} ($PoDNS_{15}$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

T_{18} ($PDNS_{15}$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

Table 2. Effect of different treatments on disease incidence (%leaf infection) of purple blotch of onion at different days after planting (DAP)

Treatmens	%leaf infection (Data taken on 7 days interval)					
	34 DAP	41 DAP	48 DAP	55 DAP	62 DAP	69 DAP
T_1=PoDoFo	28.53 a	35.15 a	45.35 a	55.89 a	70.48 a	94.04 a
T_2=PDoFo	26.76 ab	33.91 ab	42.44 ab	54.93 ab	69.49 a	79.52 ab
T_3=PoDF$_1$S$_7$	22.37 de	30.59 de	38.52 bc	50.90 b-e	61.99 gh	73.76 d-f
T_4=PoDF$_2$S$_7$	24.26 b-d	32.53 b-d	40.45 bc	53.31 a-d	63.98 d-g	75.86 cd
T_5=PoDF$_3$S$_7$	25.10 bc	33.40 a-c	39.06 bc	54.59 a-c	64.39 d-f	76.06 cd
T_6=PDF$_1$S$_7$	17.94 f	25.27 h	34.32 d	44.83 g	58.56 j	69.33 g
T_7=PDF$_2$S$_7$	19.76 ef	26.64 gh	37.99 c	48.22 fg	61.12 hi	71.86 fg
T_8=PDF$_3$S$_7$	20.75 e	28.02 fg	38.40 bc	50.02 d-f	62.65 f-h	74.00 d-f
T_9=Po DF$_1$S$_{15}$	21.43 e	27.86 fg	39.86 bc	51.51 b-f	63.59 e-g	75.33 c-e
T_{10}=PoDF$_2$S$_{15}$	22.12 de	27.12 gh	39.80 bc	52.19 a-f	64.76 c-f	75.43 c-e
T_{11}=PoDF$_3$S$_{15}$	22.63 c-e	29.63 ef	40.86 bc	52.71 a-e	65.85 b-d	76.12 cd
T_{12}=P DF$_1$S$_{15}$	24.52 b-d	30.15 e	40.74 bc	51.93 a-f	67.04 b	77.33 bc
T_{13}=PDF$_2$S$_{15}$	22.11 de	30.71 de	40.35 bc	50.61 b-f	66.76 bc	74.42 c-f
T_{14}=PDF$_3$S$_{15}$	21.11 e	31.43 c-e	40.41 bc	48.52 e-g	65.38 b-e	73.20 d-f
T_{15}=PoDNS$_7$	20.67 e	31.63 c-e	42.42 ab	50.50 c-f	65.70 b-e	73.46 d-f
T_{16}=PDNS$_7$	20.63 e	27.55 g	39.18 bc	50.16 b-f	59.29 ij	72.65 e-g
T_{17}=PoDNS$_{15}$	19.85 ef	27.53 g	38.94 bc	49.46 d-f	62.02 gh	72.33 e-g
T_{18}=PDNS$_{15}$	20.65 e	27.98 fg	41.08 bc	50.35 c-f	63.99 d-g	73.32 d-f
LSD (0.05)	2.44	1.81	3.62	3.72	1.87	2.83
CV (%)	6.65	5.68	5.49	4.41	1.76	2.29

Treatments:

T_1 (PoDoFo) = No poultry manure + Seedlings not dipped in respective solution + No fungicide (Control)

T_2 (PDoFo) = Poultry manure + Seedlings not dipped in respective solution + No fungicide

T_3 (PoDF$_1$S$_7$) = No poultry manure + Seedlings dipped in Rovral 50WP solution + Foliar spray with Rovral 50WP at seven days interval

T_4 (PoDF$_2$S$_7$) = No poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_5 (PoDF$_3$S$_7$) = No poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_6 (PDF$_1$S$_7$) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar

spray with Rovral 50 WP at seven days interval

T_7 (PDF_2S_7) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_8 (PDF_3S_7) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_9 ($PoDF_1S_{15}$) = No Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{10} ($PoDF_2S_{15}$) = No Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{11} ($PoDF_3S_{15}$) = No Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{12} (PDF_1S_{15}) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{13} (PDF_2S_{15}) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{14} (PDF_3S_{15}) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 fifteen at days interval

T_{15} ($PoDNS_7$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{16} ($PDNS_7$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{17} ($PoDNS_{15}$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

T_{18} ($PDNS_{15}$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

4.1.3. Percent Leaf Area Diseased (%LAD)

Results obtained on the effect of spraying Rovral 50 WP, Bavistin DF, Ridomil Gold MZ-72 and neem seed extract in combination with poultry manure in controlling purple blotch of onion in terms of diseased severity (%LAD) were observed and recorded at 34, 41, 48, 55, 62 and 69 DAP are presented in Table 3. The effects differed significantly among the treatments with some extent. The variation of the treatments effect become sharpen with the increase of time in reducing % LAD of purple blotch of onion. The results showed that treatment PDF_1S_7 (Soil amendment with poultry manure + Seedling dipped in Rovral 50WP solution + Foliar spray with Rovral 50WP at 7 days interval) performed the best performance (59.94%) in *minimizing* percent leaf area diseased of purple blotch of onion at 69 DAP. The highest % LAD was observed in control treatment (92.09 %) where only water was applied as foliar spray. The second highest performance in controlling purple blotch severity (% LAD) of onion was shown by T_{16} ($PDNS_7$) which is statistically similar with PDF_2S_7.

Table 3. Effect of different treatments on Disease severity(% Leaf Area Diseased) of purple blotch of onion at different days after planting (DAP)

Treatmens	% leaf area diseased (Data taken on 7 days interval)					
	34 DAP	41 DAP	48 DAP	55 DAP	62 DAP	69 DAP
T_1=PoDoFo	15.58 c	25.31 a	35.79 a	45.45 a	57.41 a	92.09 a
T_2=PDoFo	16.11 bc	24.07 b	34.99 ab	44.56 ab	57.18 ab	70.99 b
T_3=PoDF$_1$S$_7$	16.54 b	19.57 f	32.95 cd	39.78 c-g	51.36 f-h	65.29 cd
T_4=PoDF$_2$S$_7$	11.51 e	21.43 cd	33.89 a-d	41.60 cd	52.46 e-g	66.86 bc
T_5=PoDF$_3$S$_7$	18.50 a	23.20 b	34.11 a-c	42.62 bc	53.95 c-e	68.62 b
T_6=PDF$_1$S$_7$	13.56 d	16.95 g	29.97 e	32.02 i	46.22 j	59.94 e
T_7=PDF$_2$S$_7$	15.51 c	19.55 f	32.27 cd	36.01 h	47.99 ij	63.53 d
T_8=PDF$_3$S$_7$	15.34 c	19.97 ef	31.88 d	37.31 f-h	49.54 hi	65.39 cd
T_9=Po DF$_1$S$_{15}$	13.94 d	20.50 d-f	33.19 b-d	38.30 e-h	50.61 gh	65.55 cd
T_{10}=PoDF$_2$S$_{15}$	15.43 c	20.89 c-f	32.41 cd	39.69 c-g	51.76 fg	67.63 bc
T_{11}=PoDF$_3$S$_{15}$	15.24 c	21.20 c-e	33.59 b-d	40.55 c-e	53.20 d-f	67.20 bc
T_{12}=P DF$_1$S$_{15}$	15.88 bc	21.15 c-e	33.91 a-d	41.49 cd	54.18 c-e	67.99 bc
T_{13}=PDF$_2$S$_{15}$	17.79 a	20.81 c-f	32.11 cd	41.13 c-e	55.19 b-d	67.32 bc
T_{14}=PDF$_3$S$_{15}$	17.91 a	22.00 c	32.15 cd	40.51 c-e	55.29 b-d	66.66 bc
T_{15}=PoDNS$_7$	15.52 c	20.79 c-f	33.03 b-d	40.19 c-f	55.45 a-c	67.41 bc
T_{16}=PDNS$_7$	11.91 b	16.55 g	31.11 d	37.38 f-h	47.13 ij	63.13 d
T_{17}=PoDNS$_{15}$	14.10 d	19.55 f	33.05 b-d	37.04 gh	49.42 hi	67.09 bc
T_{18}=PDNS$_{15}$	14.40 d	20.37 d-f	33.26 b-d	38.65 d-h	51.27 f-h	65.43 cd
LSD (0.05)	0.80	1.19	1.74	2.61	1.88	2.34
CV (%)	3.04	3.48	3.20	4.00	2.18	2.14

Treatments:

T_1 (PoDoFo) = No poultry manure + Seedlings not dipped in respective solution + No fungicide (Control)

T_2 (PDoFo) = Poultry manure + Seedlings not dipped in respective solution + No fungicide

T_3 (PoDF$_1$S$_7$) = No poultry manure + Seedlings dipped in Rovral 50WP solution + Foliar spray with Rovral 50WP at seven days interval

T_4 (PoDF$_2$S$_7$) = No poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_5 (PoDF$_3$S$_7$) = No poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_6 (PDF$_1$S$_7$) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar

spray with Rovral 50 WP at seven days interval

T_7 (PDF_2S_7) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_8 (PDF_3S_7) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_9 ($PoDF_1S_{15}$) = No Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{10} ($PoDF_2S_{15}$) = No Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{11} ($PoDF_3S_{15}$) = No Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{12} (PDF_1S_{15}) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{13} (PDF_2S_{15}) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{14} (PDF_3S_{15}) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 fifteen at days interval

T_{15} ($PoDNS_7$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{16} ($PDNS_7$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{17} ($PoDNS_{15}$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

T_{18} ($PDNS_{15}$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

4.2. Effect of different treatments on bulb yield of onion.

A sharp variation of bulb yield was observed which was ranged from 1.093t/ha to 5.063t/ha due to application of different treatment combination. The highest yield (5.063t/ha, 363.22% increased over control) was recorded in case of treatment $T_6(PDF_1S_7)$ where poultry manure was used in soil in combination with seedling dipped in Rovral 50WP solution followed by foliar spraying of Rovral 50WP at 7 days interval (Table 4). The yield performance of T_{12} (PDF_1S_{15}) and T_{16} ($PDNS_7$) were statistically similar with $T_6(PDF_1S_7)$ that were 4.953 t/ha and 3.880 t/ha, respectively. The lowest yield (1.093 t/ha) was obtained in T_1 (Control) preceded by T_2 (PDoFo) where only poultry manure was used in soil.

Table 4. Effect of different treatments on the yield (t/ha)

Treatments	Yield	% increase of yield over control
T_1=PoDoFo	1.093 e	-
T_2=PDoFo	1.763 e	61.29
T_3=PoDF$_1$S$_7$	2.830 b-e	158.92
T_4=PoDF$_2$S$_7$	3.163 b-e	189.38
T_5=PoDF$_3$S$_7$	3.440 bc	214.73
T_6=PDF$_1$S$_7$	5.063 a	363.22
T_7=PDF$_2$S$_7$	3.050 b-e	179.04
T_8=PDF$_3$S$_7$	3.303 b-d	202.19
T_9=PoDF$_1$S$_{15}$	3.330 b-d	204.66
T_{10}=PoDF$_2$S$_{15}$	3.497 bc	219.94
T_{11}=PoDF$_3$S$_{15}$	2.110 c-e	98.81
T_{12}=PDF$_1$S$_{15}$	4.953 a	353.15
T_{13}=PDF$_2$S$_{15}$	3.330 b-d	204.66
T_{14}=PDF$_3$S$_{15}$	3.027 b-e	176.94
T_{15}=PoDNS$_7$	3.163 b-e	189.38
T_{16}=PDNS$_7$	3.880 ab	254.98
T_{17}=PoDNS$_{15}$	2.663 b-e	143.64
T_{18}=PDNS$_{15}$	3.660 b	234.85
LSD (0.05)	1.209	-
CV (%)	22.52	-

Treatments:

T_1 (PoDoFo) = No poultry manure + Seedlings not dipped in respective solution + No fungicide (Control)

T_2 (PDoFo) = Poultry manure + Seedlings not dipped in respective solution + No fungicide

T_3 (PoDF$_1$S$_7$) = No poultry manure + Seedlings dipped in Rovral 50WP solution + Foliar spray with Rovral 50WP at seven days interval

T_4 (PoDF$_2$S$_7$) = No poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_5 (PoDF$_3$S$_7$) = No poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_6 (PDF$_1$S$_7$) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at seven days interval

T_7 (PDF$_2$S$_7$) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_8 (PDF_3S_7) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_9 ($PoDF_1S_{15}$) = No Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{10} ($PoDF_2S_{15}$) = No Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{11} ($PoDF_3S_{15}$) = No Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{12} (PDF_1S_{15}) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{13} (PDF_2S_{15}) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{14} (PDF_3S_{15}) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{15} ($PoDNS_7$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{16} ($PDNS_7$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{17} ($PoDNS_{15}$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

T_{18} ($PDNS_{15}$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

4.3. Cumulative effect of different treatments on disease incidence and disease severity

Cumulative effect of different treatments on reduction of disease incidence (% plant infection and % leaf infection) and disease severity (% Leaf Area Diseased) was presented in Table 5. Reduction of disease incidence (% plant infection) was found the highest in treatment T_6 = PDF_1S_7 (25.67%) followed by treatment T_3 = DF_1PoS_7 (21.33%) and T_{16} = $PDNS_7$ (21.00%) and the highest reduction of % leaf infection was noted in treatment T_6 = DF_1PS_7 (26.27%) followed by treatment T_7 = DF_2PS_7 (23.58%). In case of disease severity the highest reduction of %LAD was recorded in treatment T_6 = DF_1PS_7 (34.91%) followed by treatment T_{16} = $PDNS_7$ (31.44%).

Table 5. Cumulative effect of different treatments on disease incidence and disease severity of purple blotch of onion in comparison to control

Treatments	Reduction of Disease Incidence		Reduction of Disease severity (% LAD)
	%plant infection	%leaf infection	
T_1=PoDoFo	-	-	-
T_2=PDoFo	-	15.44	22.91
T_3=PoDF$_1$S$_7$	21.33	21.56	29.10
T_4=PoDF$_2$S$_7$	10	19.33	27.39
T_5=PoDF$_3$S$_7$	7	19.11	25.48
T_6=PDF$_1$S$_7$	25.67	26.27	34.91
T_7=PDF$_2$S$_7$	17	23.58	31.01
T_8=PDF$_3$S$_7$	14.33	21.31	28.99
T_9=PoDF$_1$S$_{15}$	16	19.89	28.81
T_{10}=PoDF$_2$S$_{15}$	12.67	19.78	26.56
T_{11}=PoDF$_3$S$_{15}$	10.67	19.05	27.02
T_{12}=PDF$_1$S$_{15}$	13	17.78	26.17
T_{13}=PDF$_2$S$_{15}$	11.33	20.86	26.89
T_{14}=PDF$_3$S$_{15}$	11.33	22.16	27.61
T_{15}=PoDNS$_7$	16.33	21.88	26.79
T_{16}=PDNS$_7$	21	22.74	31.44
T_{17}=PoDNS$_{15}$	15.67	23.08	27.14
T_{18}=PDNS$_{15}$	17	22.03	28.94

Treatments:

T_1 (PoDoFo) = No poultry manure + Seedlings not dipped in respective solution + No fungicide (Control)

T_2 (PDoFo) = Poultry manure + Seedlings not dipped in respective solution + No fungicide

T_3 (PoDF$_1$S$_7$) = No poultry manure + Seedlings dipped in Rovral 50WP solution + Foliar spray with Rovral 50WP at seven days interval

T_4 (PoDF$_2$S$_7$) = No poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at seven days interval

T_5 (PoDF$_3$S$_7$) = No poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_6 (PDF$_1$S$_7$) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at seven days interval

T_7 (PDF$_2$S$_7$) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray

with Bavistin DF at seven days interval

T_8 (PDF_3S_7) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at seven days interval

T_9 ($PoDF_1S_{15}$) = No Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{10} ($PoDF_2S_{15}$) = No Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{11} ($PoDF_3S_{15}$) = No Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{12} (PDF_1S_{15}) = Poultry manure + Seedlings dipped in Rovral 50 WP solution + Foliar spray with Rovral 50 WP at fifteen days interval

T_{13} (PDF_2S_{15}) = Poultry manure + Seedlings dipped in Bavistin DF solution + Foliar spray with Bavistin DF at fifteen days interval

T_{14} (PDF_3S_{15}) = Poultry manure + Seedlings dipped in Ridomil Gold MZ-72 solution + Foliar spray with Ridomil Gold MZ-72 at fifteen days interval

T_{15} ($PoDNS_7$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{16} ($PDNS_7$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at seven days interval

T_{17} ($PoDNS_{15}$) = No Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

T_{18} ($PDNS_{15}$) = Poultry manure + Seedlings dipped in neem seed extract solution + Foliar spray with neem seed extract at fifteen days interval

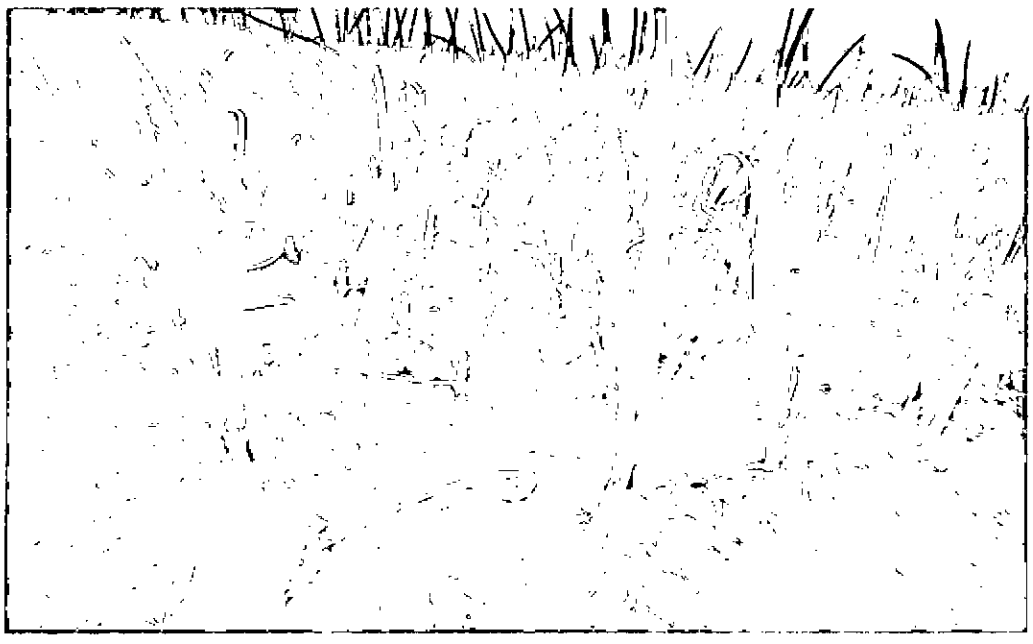


Plate 9. A view of the experimental field showing healthy plant (T_6)

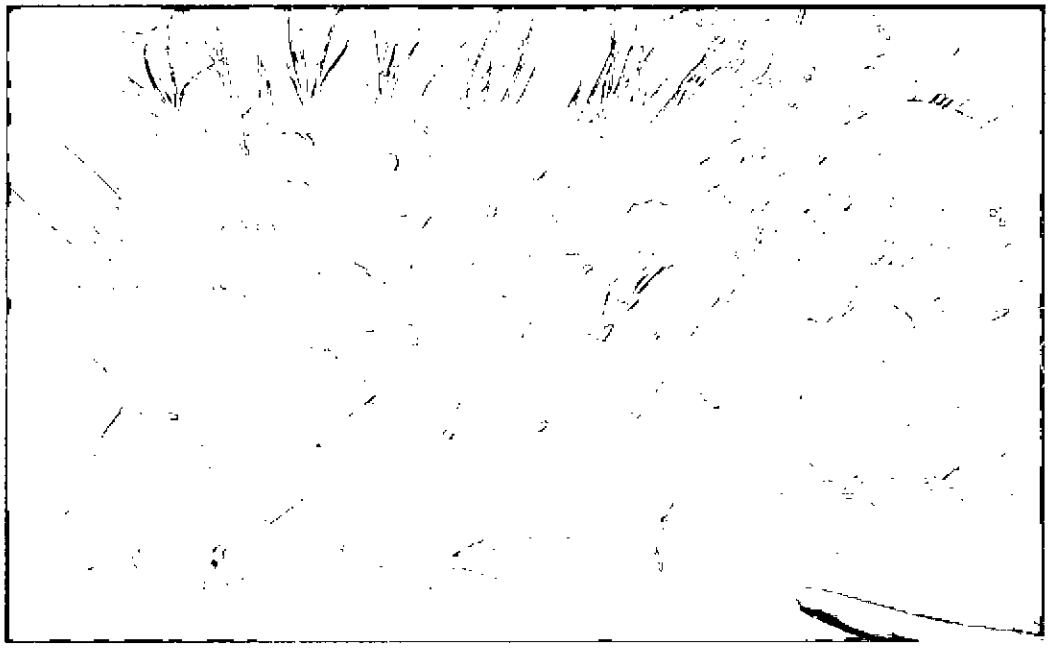
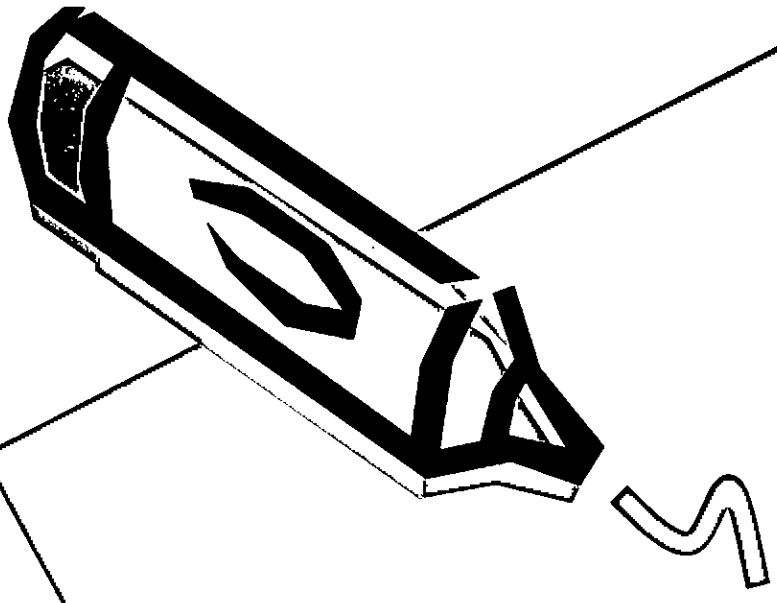
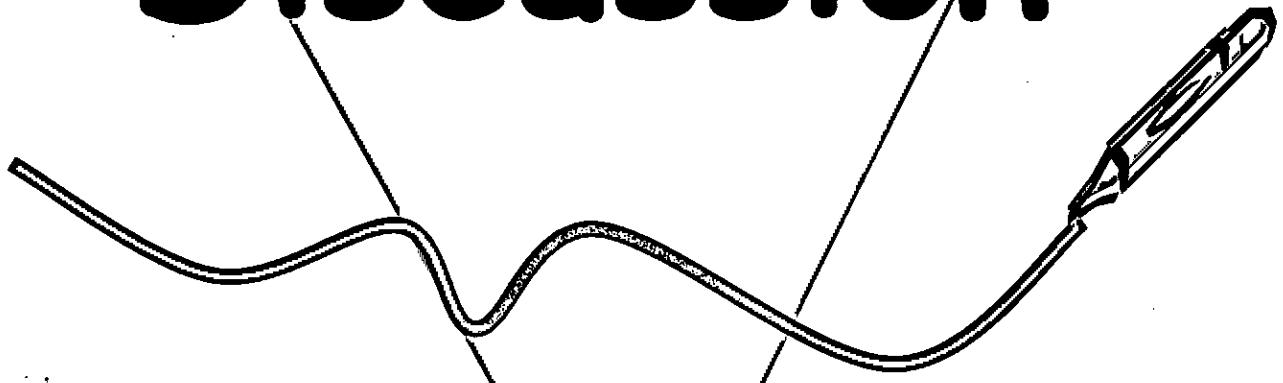


Plate 10. A view of the experimental field showing infected plant (Control).



Chapter V
Discussion



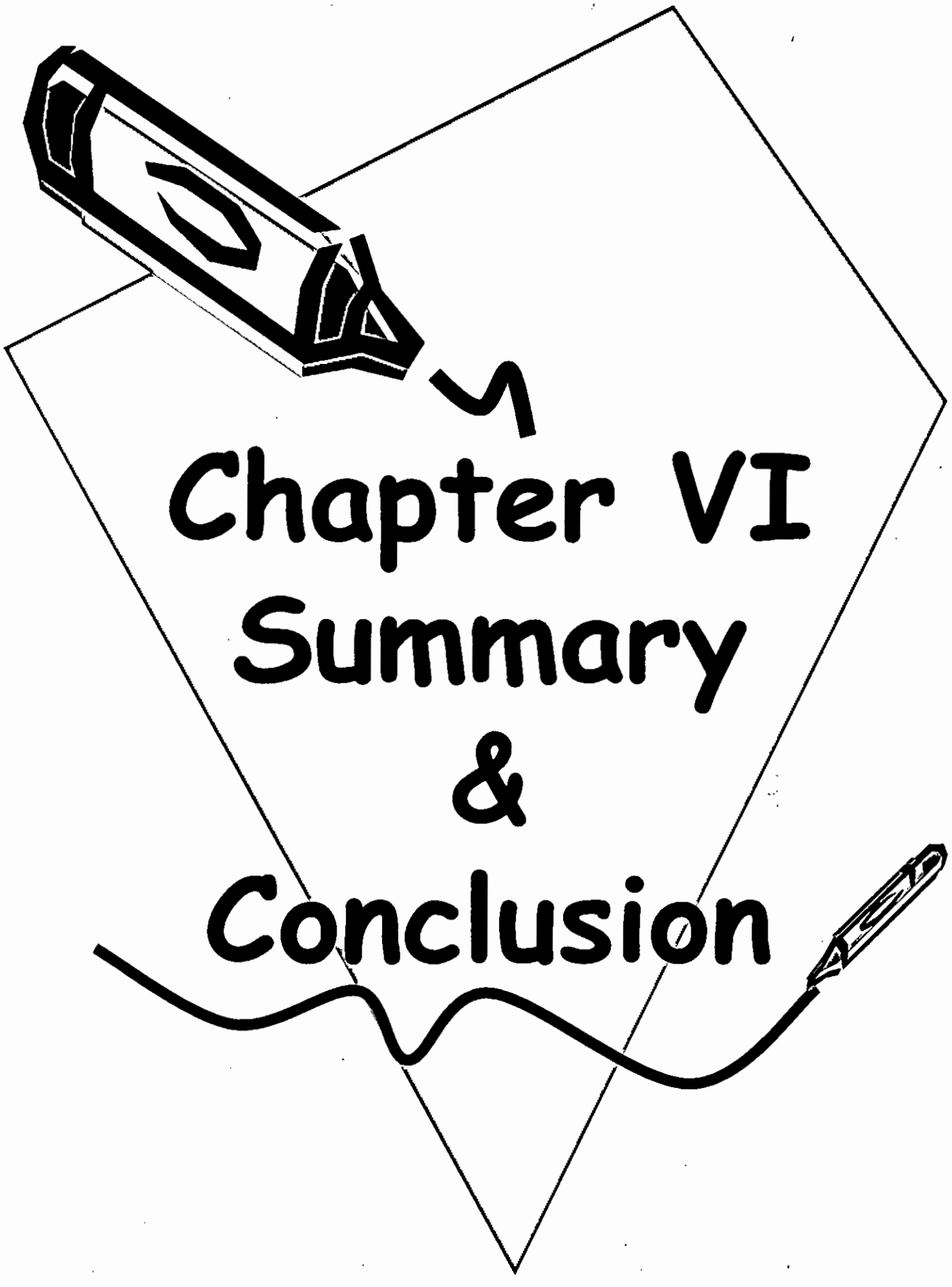
CHAPTER V

DISCUSSION

In the present experiment, the effect of the treatments combination in controlling purple blotch of onion caused by *Alternaria porri* was assessed on the basis of percent leaf infection, percent plant infection, percent leaf area diseased (% LAD) and yield of onion in field condition. The effect of Rovral 50 WP (0.2%) in seedling dressing followed by foliar spraying at 7 days interval along with soil amendment poultry manure against purple blotch of onion found promising in reduction of disease incidence and disease severity. The highest reduction of plant infection (25.67%), leaf infection (26.27%) and leaf area diseased (34.91%) was recorded in case of the treatment T_6(PDF_1S_7) where soil was amended with poultry manure and seedlings were dipped in Rovral 50WP solution followed by foliar spraying with Rovral 50WP at 7 days interval. Statistically similar performances were shown by T_{16}($PDNS_7$) where soil was amended with poultry manure and seedlings were dipped in neem solution followed by foliar spraying with neem extract at 7 days interval and T_7(PDF_2S_7) where soil was amended with poultry manure and seedlings were dipped in Bavistin DF solution followed by foliar spraying with Bavistin DF at 7 days interval.The highest yield was 5.063 t/ha also recorded in case of T_6(PDF_1S_7) which was statistically similar with T_{12}(PDF_1S_{15}) and T_{16}($PDNS_7$). The present

findings was supported by the reports of the previous researches (Ahmed *et al.*, 1999; Sugha, 1995; Diogzon & Gapasin., 2000; Rahman, 2004; Srivastava *et al.*, 1994; Islam *et al.*, 2001; Nahar *et al.*, 2006 and Hoque, 2008). Ahmed *et al.* (1999) reported that the fungicides Rovral 50 WP (0.2%) was effective in reducing incidence and severity of purple blotch of onion. Sugha (1995) reported that Iprodione (0.2%) proved to be highly effective against purple blotch of onion resulting 79.6 - 84.9% control of the disease. Rahman (2004) reported that among 6 fungicides, Rovral 50 WP significantly reduced the disease severity of purple blotch of onion. Srivastava *et al.* (1994) observed that seedling dipped in Carbendazim and thiophanate methyl followed by 4 sprays of Rovral 50 WP was effective against purple blotch of onion. Diogzon and Gapasin (2000) showed that poultry manure (5-10t/ha) improved the growth of onion and decreased diseases. Islam, *et al.* (2001) also reported that Rovral 50 WP gave promising effect in reducing the disease severity of purple blotch of onion. Nahar *et al.* (2006) evaluate the effect of soil organic amendments with poultry manure and spraying fungicides for the management of purple blotch disease of onion and observed that it produced taller, heavier and healthier onion plants with minimum diseases resulted in about twice the yield of onion than the traditional farmer practice. Hoque (2008) also reported that

the bulb treatment with Rovral 50 WP (0.2%) followed by foliar spraying with Rovral 50 WP at 7 days interval starting from onset of the disease minimized disease incidence, severity and increasing yield. There were significant differences among the effect of fungicides spraying at different days interval and seven days interval showed the best performances in controlling purple blotch complex of onion and increasing yield. These findings were well supported by Barnoczki-stoilova *et al.* (1989) and Georgy *et al.* (1983). Barnoczki-stoilova *et al.* (1989) conducted a field experiment spraying with fungicides at different days interval and reported that Rovral 50 WP (Iprodione) and Ridomil plus 50 WP (Methyl + Copper oxychloride) showed effective while spraying at regular interval in controlling disease in onion seed production. Georgy *et al.* (1983) also reported that the Iprodione group and Ridomil MZ (Metalaxyl + Mancozeb) proved most effective in reducing the disease severity and increasing bulb yield. Use of neem seed extract, for dipping of seedlings followed by foliar spraying was found effective in reducing disease incidence and severity of purple blotch of onion but no literature had been found in favor of the findings. However, neem extract has many previous record acting against many plant pathogens (Lakshmanan *et al.* 1990; Bhowmic and Vardan, 1991; Prasad and Barnwal, 2004)



Chapter VI
Summary & Conclusion

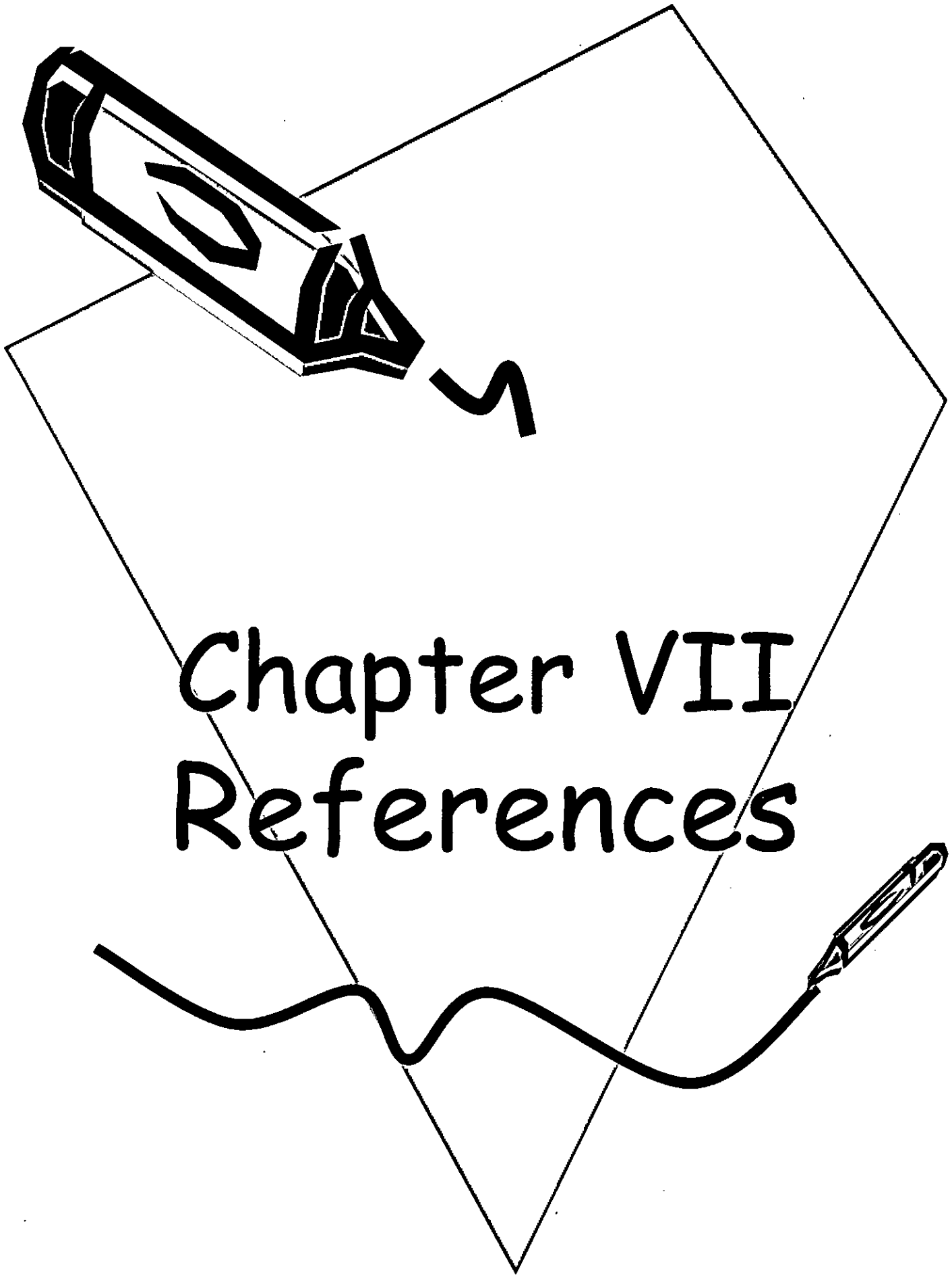
CHAPTER VI

SUMMARY AND CONCLUSION

Onion (*Allium cepa* L.) is considered as one of the most important spices crop and that ranked top of the list as per consumer's preference in Bangladesh as well as in all over the world. Usually onion production is affected by different diseases worldwide. Among those diseases, purple blotch, incurred tremendous yield loss in the country. Purple blotch of onion caused by *Alternaria porri* is a limiting factor of onion production. The fungus reduces the bulb yield, seed yield and quality of onion seeds. The present research program was conducted to determine the effect of some selected chemical fungicides, poultry manure and neem seed extracts on purple blotch of onion for bulb yield.

The experiments were carried out at the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period December, 2009 to March, 2010. Eighteen (18) different treatments were included in the study. In the field experiment, the treatments showed significant effect in reducing disease incidence, disease severity and increasing bulb yield. The lowest disease incidence and disease severity were observed in PDF_1S_7 where soil was amended with poultry manure and seedlings were dipped in Rovral 50WP solution followed by foliar spraying with Rovral 50WP at 7 days

interval in increasing yield also. Statistically similar result on yield was observed in case of $T_{16}(PDNS_7)$ and $T_{12}(PDF_1S_{15})$. The highest disease incidence and disease severity were recorded in control treatment. On the basis of present findings it may be concluded that the onion growers may by suggested to apply Rovral 50 WP (0.2 %) along with Poultry manure in controlling purple blotch of onion for bulb production. However, further studies need to be carried in different Agro-ecological zones taking more options to justify the present findings.



Chapter VII References

CHAPTER VII

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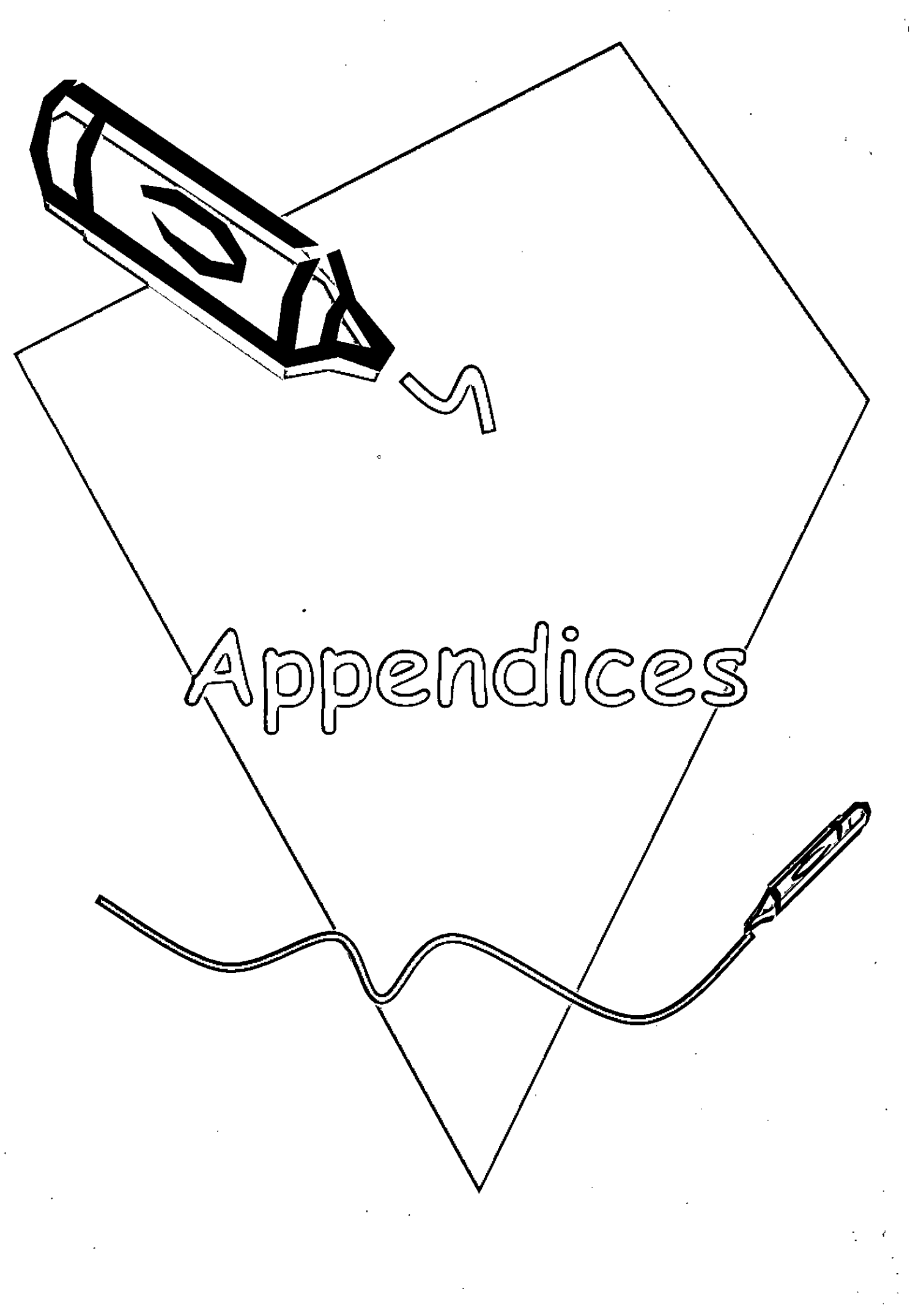
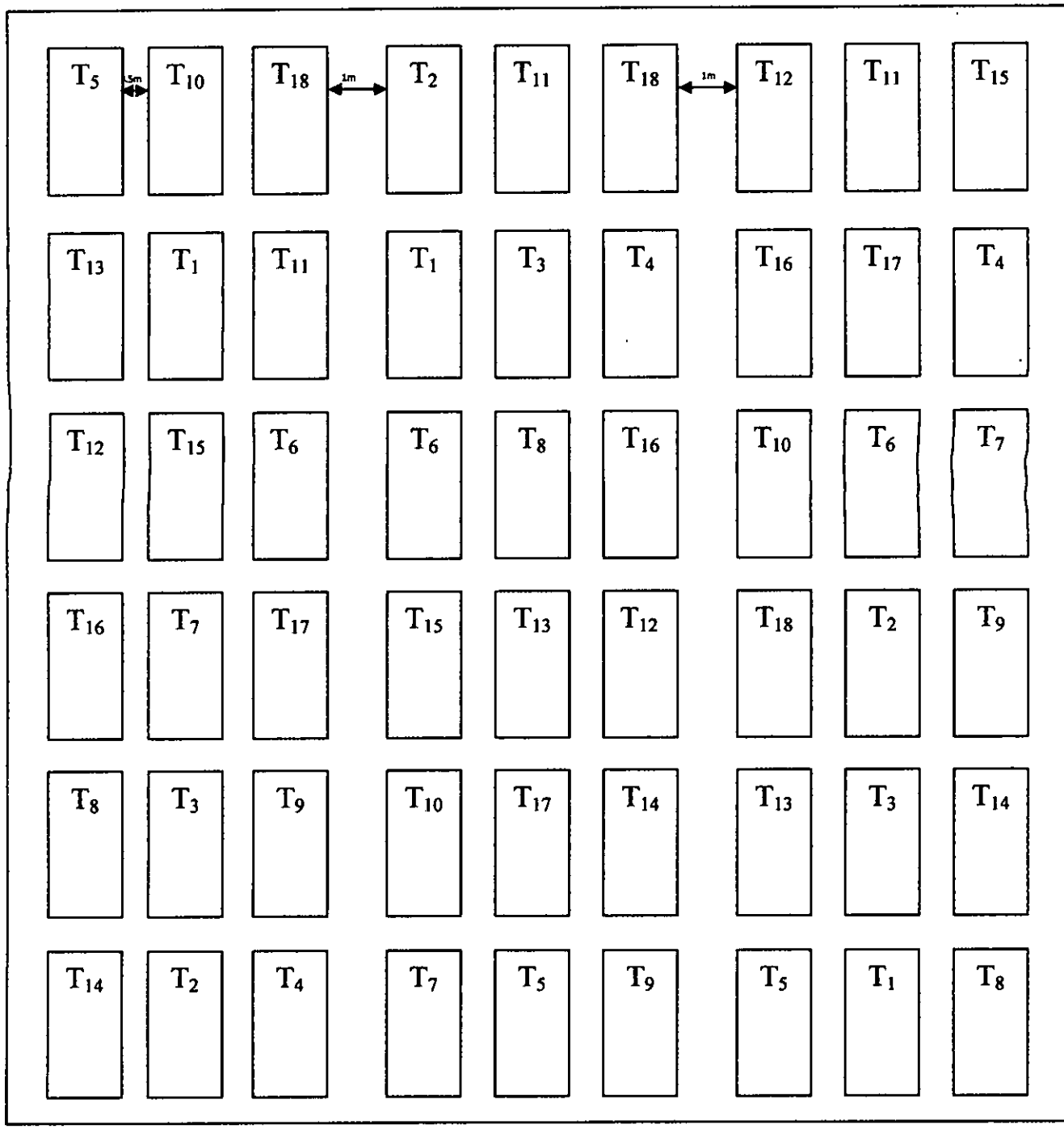

Appendices

Appendix I. Layout of the experiment under the study



- Total area : 255.75 m^2
- No. of plot : 54
- Plot size : (2 × 1.5) m^2
- Block to block distance : 1.0 m
- Row to row spacing : 20 cm
- Plot to plot distance (Length wise) 0.5 m
- Plot to plot distance (Breath wise) 0.5 m
- Plant to plant spacing : 15 cm

Appendix II. Monthly average Temperature, Relative Humidity and Total Rainfall of the experimental site during the period from October, 2009 to March, 2010

Month	Air temperature (°c)		Relative humidity (%)	Rainfall (mm) (total)	Sunshine (hr)
	Maximum	Minimum			
October, 2009	34.8	18.0	77	227	5.8
November, 2009	32.3	16.3	69	0	7.9
December, 2009	29.0	13.0	79	0	3.9
January, 2010	28.1	11.1	72	1	5.7
February, 2010	33.9	12.2	55	1	8.7
March, 2010	34.6	16.5	67	45	7.3
April, 2010	35.8	20.3	65	88	8.3

Source: Bangladesh Metrological Department (Climate division),
Agargaon, Dhaka-1212.

Appendix III. Analysis of variance of the data on percent infected plant of onion as influenced by different treatments used for managing purple blotch of onion (var. Taherpuri)

Source of variation	Degrees of freedom	Mean square					
		% infected leaf of onion					
		34 DAP	41 DAP	48 DAP	55 DAP	62 DAP	69 DAP
Replication	2	9.468	67.10	41.71	61.12	3.16	16.87
Treatment	17	28.497	77.74	141.66	119.18	69.51	93.03
Error	34	10.782	35.31	11.31	14.51	15.94	4.99

Appendix IV. Analysis of variance of the data on percent infected leaf of onion as influenced by different treatments used for managing purple blotch of onion (var. Taherpuri)

Source of variation	Degrees of freedom	Mean square					
		% infected leaf of onion					
		34 DAP	41 DAP	48 DAP	55 DAP	62 DAP	69 DAP
Replication	2	5.11	2.07	11.00	11.86	14.47	10.56
Treatment	17	13.25	24.40	25.50	5.27	21.01	27.00
Error	34	1.84	2.16	1.20	0.93	4.76	5.03

Appendix V. Analysis of variance of the data on percent Leaf Area Diseased (%LAD) of onion as influenced by different treatments used for managing purple blotch of onion (var. Taherpuri)

Source of variation	Degrees of freedom	Mean square					
		% infected leaf of onion					
		34 DAP	41 DAP	48 DAP	55 DAP	62 DAP	69 DAP
Replication	2	4.19	0.004	1.26	0.45	0.33	13.28
Treatment	17	7.13	13.66	14.34	6.37	17.33	37.18
Error	34	0.23	0.52	2.19	1.10	1.05	2.48

Appendix VI. Analysis of variance of the data on yield of onion as influenced by different treatments used for managing purple blotch of onion (var. Taherpuri)

Source of variation	Degrees of freedom	Mean square
		% yield of onion
Replication	2	1.725
Treatment	17	2.220
Error	34	0.531