# MANAGEMENT OF PURPLE BLOTCH AND WHITE BLOTCH OF ONION USING CHEMICALS, MICRONUTRIENTS AND BOTANICALS

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**DECEMBER, 2020**

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**Reg No : 18-09110**

**A Thesis**
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**

**SEMESTER: JULY-DECEMBER, 2020**

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# *CERTIFICATE*

*This is to certify that thesis entitled, "**MANAGEMENT OF PURPLE BLOTCH AND WHITE BLOTCH OF ONION USING CHEMICALS, MICRONUTRIENTS AND BOTANICALS**" submitted to the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M. S.) IN PLANT PATHOLOGY**, embodies the result of a piece of bona fide research work carried out by **Reg. No. 18-09110** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

**Dated:**

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**DEDICATED**

**TO**

**BELOVED PARENTS**

## *ACKNOWLEDGEMENTS*

*All praises and thanks are due to the supreme ruler of the universe, the almighty Allah for her grace bestowed upon the author for accomplishment of this research study.*

*The author expresses the deepest sense of respect and heartiest gratitude to her respectable supervisor* ***Hosna Ara Chowdhury Nisha****, Department of Plant Pathology, Sher-e-Bangla Agricultural University for her efficient and scholastic guidance, constructive criticism, valuable suggestions and immense help to carry out the research work toward successful completion and preparation of the thesis by necessary corrections and modification through reviewing the text.*

*she wishes to express her sincere appreciation and heartfelt gratitude to her co-supervisor* ***Prof. Dr. Md. Belal Hossain,*** *Department of Plant Pathology, Sher-e-Bangla Agricultural University, for his valuable suggestions, constant cooperation, inspiration and sincere advice to improve the quality of the thesis.*

*Cordial thanks to* ***Prof. Dr. Fatema Begum,*** *Chairman, Department of Plant Pathology and all respected teachers of the Department of Plant Pathology, Sher-e-Bangla Agricultural University for their help and co-operation during the study and research.*

*The author is also grateful to* ***Md. Yunus Ali*** *former student of SAU for his kind support to improve the thesis. The author would like to thank all of her friends and well-wishers who always inspired her during her research are* ***Zamin Tamima, Arif Uz zaman Shuvo, Shawon Shammy, Sabjana Akter Nishi*** *and who helped her with their valuable suggestions and directions during the preparation of this thesis paper.*

*The author would like to thank specially to her mother* ***Mst. Afroza Aman*** *and father* ***Md. Amanullah.*** *she can never repay the debt of her teachers, parents, uncle, aunty, sisters, brothers and all other well-wishers for their inspiration, constant encouragement and sacrifice for her higher education whose inspiration guided her toward the achievement of her goal.*

*The author expresses her immense gratefulness to all of them who assisted and inspired her to achieve higher education and regret for her inability for not to mention every one by name.*

*The author*

# MANAGEMENT OF PURPLE BLOTCH AND WHITE BLOTCH OF ONION USING CHEMICALS, MICRONUTRIENTS AND BOTANICALS

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## ABSTRACT

A field experiment was carried out in the central farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during October 2019 to March 2020.The experiment was conducted to evaluate the effect of selected chemicals, micronutrients and botanicals in controlling purple blotch complex of onion. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and local variety faridpuri was used as a planting material. In this experiment, three fungicides viz. Indofil, Mancer and Ridomil Gold, three micronutrients viz. Zinc, Boron and Magnesium and two botanical extracts namely neem and eucalyptus were used to evaluate their effect on disease incidence, percent disease index, number of leaves per plant,leaf length, bulb diameter, bulb weight (fresh and dry) and yield. Among the treatments, chemical fungicide Ridomil Gold gave better performance in comparison to other treatments. Data was recorded at 70, 80 and 90 days after transplanting and it was found that the lowest disease incidence (52.67%) and percent disease index (49.00%) was recorded in Ridomil Gold treated plots with the highest number (9.77) and length (43.43cm) of leaf. It was also found that the highest bulb diameter (18.23 cm), single bulb weight (47.98 g), fresh weight (3.16 Kg/plot), dry weight (2.88Kg/plot) were also obtained from Ridomil Gold treated plots. This treatment also gave the highest yield (9.60 t $ha^{-1}$) followed by Indofil (8.20 t $ha^{-1}$) and Mancer (7.90 t $ha^{-1}$). Among the nine treatments, Ridomil Gold also increased yield by 54.34% over control treatment. Boron and eucalyptus leaf extract was given satisfactory results in all considering parameters tested in the experiment. However, chemical fungicide performed better than micronutrients and botanical leaf extracts.

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# ACRONYMS AND ABBREVIATIONS

| ACRONYMS | ABBREVIATIONS |
|---|---|
| AEZ | Agro-Ecological Zone |
| BARI | Bangladesh Agricultural Research Institute |
| cm | Centimeters |
| CV | Coefficient of Variation |
| DAS | Days After Sowing |
| *et al.*, | And others |
| e.g. | exempli gratia (L), for example |
| etc. | Etcetera |
| FAO | Food and Agricultural Organization |
| BBS | Bangladesh Bureau of Statistics |
| i.e. | id est (L), that is |
| Kg | Kilogram (s) |
| LSD | Least Significant Difference |
| M | Meter squares |
| LAD | Leaf Area Disease |
| M. S. | Master of Science |
| No. | Number |
| SAU | Sher-e-Bangla Agricultural University |
| Var. | Variety |
| $^{o}$C | Degree Celsius |
| % | Percentage |
| RCBD | Randomized Complete Block Design |
| DAP | Diammonium Phosphate |
| BAU | Bangladesh Agriculture University |

| | |
|---|---|
| Cl | Chlorine |
| PDA | Potato Dextrose Agar |
| N. P. K | Nitrogen, Phosphorus, Potassium |
| WP | Wettable Powder |
| TSP | Triple Super Phosphate |
| MP | Muriate of potash |
| CMI | Cell Mediated Immunity |
| PDI | Percent Disease Index |
| NL/P | Number of leaves per plant |
| BD | Bulb Diameter |
| BW | Bulb Weight |
| DAT | Days After Transplanting |
| Z | Zinc |
| B | Boron |
| Mg | Magnesium |
| Entomol. | Entomology |
| Econom. | Economics |
| Int. | International |
| Phytopathol. | Phytopathology |
| LL | Leaf Length |
| PEM | Post Emergence Mortality |
| DI | Disease Incidence |
| DS | Disease Severity |
| Mn | Manganese |
| EC | Emulsifier concentrates |
| Cu | Copper |

# INTRODUCTION

Onion (*Allium Cepa* L.) is one of the most important and familiar spices crops (Alliaceae) throughout the world. It is also used as condiments for flavoring a number of foods and medicines (Vohora*etal*., 1974). Raw onion is being used and given protection to human beings from sun stroke, normally is consumed green as well as in mature stages almost by everyone, by different means. It also relieves head sensation and insect bites due to its medicinal properties. Onion contains vitamin B and a trace of vitamin C, and iron, calcium, and volatile oil known as allylpropyl-disulphide (Yawalkar, 1985). Out of 15 important vegetables and spice crops listed by FAO, onion stands second in terms of annual world production (Anonymous,1997).

The major onion growing areas of Bangladesh are Faridpur, Cumilla, Manikgonj, Dinajpur, Jessore, Pabna, Rajshahi, Mymensingh, Jamalpur and Rangpur (BBS, 2020). The local varieties namely Faridpuri and Taherpuri are commonly grown in Bangladesh. The high yielding variety, such as- BARI 1, BARI 2, BARI 3 is now also famous in Bangladesh (Khatun, 2007). In our country, the production of onion is nearly 1802868 ton from 426157 ha of land (BBS, 2020). Globally, China is the largest onion producer in the world with 26% and India produces 21% while Bangladesh produces only 2% of world production yearly (Mahmud 2020). Bangladesh still lags far behind the global average production rate of onions. The average standard production is 18 ton per hectare but the average yield in our country is only11 ton (Mahmud, 2020). The onion production per unit area in Bangladesh is gradually decreasing due to disease problem (BBS, 2006). Besides this, increased population creates another problem by increasing demand. As a result, Bangladesh has to import a large quantity of onion every year to fulfill the national demand at the cost of foreign currency. Our country imports huge quantity of onion from India, Egypt, Turkey, Myanmar and Pakistan. Unfortunately, in the very recent year this crisis exceeds previous year condition and price has been increased manifold. About

5 per cent import duty has been imposed in the budget this year (Mahmud, 2020). Till now we have to buy onion at high price. So, increasing the production through disease management is the utmost needed to overcome the situation. Diseases of the crops are considered as the major limiting factors of onion production in the country. Among the major diseases commonly known as purple blotch, Stemphylium blight, downy mildew, grey mold, seed rot, germination reduction, black mould, germination failure and basal/pink rot etc are the most destructive diseases, damage the crop and reduced bulb yield sometimes up to 100%. (Khatun, 2007). Purple blotch disease caused by *Alternaria porri* is a major production constraint in onion, causing severe crop loss ranging between 30 and 100% (Rao *et al*., 2015).

Among those diseases purple blotch, commonly known as leaf blotch, caused by *Alternaria porri*, is noted as the major disease throughout the world including Bangladesh (Ahmed and Hossain, 1986; Munoz *et al*., 1984; Meah and Khan, 1987; Bose and Som 1986 and Castellanos-Linares *et al*., 1988). Another disease namely, stemphyllium blight or white blotch, caused by *Stemphyliumvesicarium* is also noted as an important disease (Bose and Som 1986; Meah and Khan, 1987 and Castellanos-Linares *et al*., 1988). Now-a-days *Stemphylium vesicarium*, the causal agent of white blotch of onion are being considered as an organism involved indirectly with the causation of purple blotch of onion (Castellanos-Linares *et al*., 1988).It is considered that *Stemphylium vesicarium* initiate the infection, which facilitates subsequent infection of *Alternaria porri* causing purple blotch and hence the disease is designated as Purple blotch complex. The cultivars Faridpuri and Taherpuri are susceptible to the disease (Rahman, 1990).

The disease is characterized with small water-soaked lesions initially on leaves and seed stalk that quickly develop white centre. As lesions enlarged, they become zonate, brown to purple, surrounded by a yellow zone and extents upward some distance. Under humid condition, the surface of the lesion may be covered with brown to dark gray structures of the fungus. A few large lesions have been formed, in a leaf or seed stalk, which may coalesce and girdle of the leaf or seed stalk and tissues. Usually, the affected leaves falldown and die within few days if the environment favors the disease (Gupta *et al*., 1991).

Sharma (1986) reported that under favorable 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 favored by moderate temperature (24- $30^0$C) and high relative humidity (Gupta and Pathak, 1986; Evert and Lacy,1990 and Rodriguez *et al*., 1994).

In Bangladesh, limited attempts have been made to find out the suitable control measures of this disease for bulb and seed production (Ashrafuzzaman and Ahmed, 1976 and 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.

Nutrients are important factor for growth and development of plants and also for microorganisms as they are important factors in disease control. All the essential nutrients can affect disease severity and some showed high sensitivity in onion production *viz.* Zn, B, Mn and Mo (Huber *et al.* 1999 and Havlin*et al.* 2007). Zinc and boron play an essential role in improving plant growth, through the biosynthesis of endogenous hormones which is responsible for promotion of plant growth (Bhatt and Hansch 2009).

Plant extracts of many higher plants have been reported to exhibit antifungal, antibacterial and insecticidal properties under laboratory trails (Ergene *et al*., 2006).The extracts from neem leaves and leaf extracts of *Eucalyptus globules,*have been used to control several fungal plant pathogens such as *Alternaria alternata*, *Alternaria porri, Aspergillus flavus,Fusariumoxysporum*. f. sp. *phaseoli, Fusarium solani, Moniliniafructicola, Rhizoctonia solani*and*Sclerotinia sclerotiorum.*

In Bangladesh, no resistant source is available against that disease. The varieties grown in the country are highly susceptible to the purple blotch disease complex. Furthermore, people globally are now very much conscious about environmental decay due to indiscriminate and enormous use of toxic chemicals. So, to save the nature and escape pollution of environment, a judicial use of fungicide is to be employed. Considering the above scenario, the present piece of research was undertaken to find out the effect of fungicide, micronutrient and botanical extracts to control purple blotch complex of onion. The following objectives were considered:

i) To evaluate the efficacy of selected fungicides, botanicals and micronutrients in controlling purple blotch disease complex of onion *in-vivo.*

ii) To determine the efficacy of selected fungicides, botanicals and micronutrients on yield and yield contributing characters of onion.

# REVIEW OF LITERATURE

Onion (*Allium cepa* L) is one of the most important and widely used vegetable and spices crops in Bangladesh as well as many countries all over the world.Researcher all over the world has been carrying out their research for the effective management of on the purple blotch complex of onion by using chemical, botanicalsand micronutrients. In Bangladesh very few works have been done in this respect. The available information in this connection over the world has been reviewed in this chapter.

## Fungicides

Paneru *et al*. (2020) reported that Hexaconazole and Mancozeb + Cymoxanil were proved to be best in controlling this complex with the Percent Disease Control (PDC) of 84.45 percent and 80.00 percent respectively.

Yadav*et al*. (2017) evaluated six systemic fungicides viz., Kitazin 48 EC (iprobenfos), Tilt 25 EC (propiconazole), Folicur 25 EC (tebuconazole), Score 25 EC (difenoconazole), Amistar Top 325 SC (azoxystrobin 18.2% + difenoconazole 11.4%) and Nativo 75 WG (trifloxystrobin 25% + tebuconazole 50%), and two non-systemic fungicides viz., Indofil M-45 75 WP (mancozeb) and Kocide 77 WP (copper hydroxide), under in vitro and field conditions for their efficacy to manage purple blotch complex of onion caused by *Alternaria porri* and *Stemphylium vesicarium*. Field efficacy of the fungicides at different concentrations were determined in controlling the purple blotch complex of onion under artificial epiphytotic conditions on bulb and seed crop (cultivar PRO-6) during the Rabi season 2014-2015 and 2015-2016, respectively. The triazole fungicides, tebuconazole and difenoconazole proved superior in inhibiting growth of *A. porri* and *S. vesicarium* under in vitro conditions, respectively. Further, foliar sprays (3 for bulb crop and 4 for seed crop) of tebuconazole 25 EC (Folicur) @ 0.1 per cent at fortnightly interval most effectively managed purple blotch complex of onion under field conditions with highest Benefit: Cost ratio (8.75:1 and 88.7:1) in bulb and seed crop, respectively. Seed-to-seed method of onion seed production recorded significantly lower disease severity and higher seed yield than that of bulb-to-seed method under natural epiphytotic conditions. The present findings can be instrumental in devising strategy for the integrated management of *A. porri, S. vesicarium* singly as well as in complex, serious limiting biotic factors in onion production.

Aujila*et al*. (2010) and Beig*et al*.(2008)who have also reported the superiority of tebuconazole, propiconazole,difenoconazole and hexaconazole over conventional fungicides in controlling the disease.

Ali (2008) reported that Rovral 50WP @ 0.2% reduced the highest mycelial 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 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.

Deshmukh *et al*. (2007) reported maximum disease control (79.28%) with foliar application of a mixture of hexaconazole (0.05%) + mancozeb (0.3%), followed by difenconazole (0.025%) + mancozeb (0.3%).

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, Ridomil Gold, Neem leaf extract, Allamanda leaf extract and Control were explored in the experiment. The highest bulb yield (8.767 $tha^{-1}$) was obtained with Rovral 50WP treated plot. The percent plant infection, percent leaf infection, percent Leaf Area Diseased (% LAD) and Percent Disease Index (PDI) were the lowest in foliar spray with Rovral 50WP and the highest in control treatment. Neem extract performed better than Allamanda extract.

Uddin*et al.* (2006) evaluated five fungicides viz., Dithane M-45 (Mancozeb), Bavistin 50 WP (Carbendazim), Ridomil MZ-72 (Metalaxyl + Mancozeb), Rovral 50 WP (Iprodione) and Tilt 250 EC (Propiconazole) were evaluated against purple blotch complex of onion (Var.-Taherpuri) caused by *Alternaria porri* and *Stemphyliumbotryosum* in field condition for seed production. Bulb treatment with either Dithane M-45 (0.45 %) or Rovral 50 WP (0.2 %) followed by foliar spraying with the same at 10 days interval reduced disease incidence (19.95 %, 13.63 %) and severity (38.87 %, 34.59 %), and increased seed yield by 64.82 % and 42.18 % respectively. In post harvest seed health test in the laboratory, less seed infection (7.04 %, 9.21 %) by *Alternaria porri* and the higher seed germination (88.48 %, 85.64 %) in compare to untreated control was recorded in the seed sample harvested from Dithane M–45 and Rovral 50 WP treated plot, respectively.

Pradhan (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) reported 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 disease 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 postharvest seed health test

Rahman (2004) observed the effect of three fungicides viz. Ridomil, Rovral and Tilt (0.2%) comprising 13 treatments in a 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 was the best. which gave the highest reduction in disease incidence and severity or leaf blotch and eventually increased the yield of onion.

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.

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.

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.

Rochecouste (1994) recommended use of Ridomil (Metalaxyl + Mancozeb) against *Puccinia allii*. *Alternaria porri* and *Peronospora destructor* of garlic and onion.

Srivastava *et al.* (1991) evaluated 3 fungicides viz, Copper oxychloride, Carbendazim and Thiram against and all the fungicides significantly reduced the disease incidence.

Tahir *et al*. (1991) tested 7 fungicides against *Alternaria porri* in a field 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.

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 filed conditions. all the test fungicides give significant reduction of severity but significant increase of onion yield was achieved only with Rovral, Dithane M-45 and Bordeaux mixture gave 61, 35 and 29%yield increase. respectively.

Sharma (1986) reported that the best control of *Alternaria porri* under field condition was given by Dithane M-45 (mancozeb) at 0.2% applied 6 times from the onset of infection, however 3 sprays were found optimum for maximizing bulb yields.

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

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, 97.4% control of *Alternaria porri* causing purple blotch of onion with Rovral (iprodione) was achieved. As foliar spray. Rovral (iprodione) was recommended for controlling Alternaria leaf spot of mustard and cabbage. Rovral has also been effective against other diseases of onion such as bulb rot.

Sharma (1984) observed comparative effectiveness of l0 fungicides to control *Alternaria* infection (*Alternaria* spp.) of mustard in India. He reported that among the tested fungicides Dithane M-45 gave the best control against the pathogen followed by Daconil. Difolatan and Dithane Z-78. The fungicides reduced the infection rate by 16.6 - 30. l %.

Georgy *et al*. (1986) observed the effect of several fungicides which were tested against *Peronospora destructor* and *Alternaria porri* on onion at Sakha, Kaba. Sid’s Malaway and 'shandwii research stations. during the growing seasons of 1979-80. 1980-81. Under natural infectioncondition, they found that disease severity reached up to 100% on plants in nonsprayeed plots. Fungicides differed significantly in their effectiveness. Ridomil MZ (Metalazyl + Mancozeb) proved to be the most effective in reducing disease severity and increasing bulb and seed yield.

Quadri *et al*. (1982) reported that out of eight fungicides, Difolatan. (Captafol), Dithane M-45 (Mancozeb) and Bavistin (Carbendazim) gave the best control of *Alternaria porri* (in vitro).

Khare and Nema (1982) also reported that the temperature ranged between 22 $^{0}$C to 25 $^{0}$C 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.

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 becomes the second.

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

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%.

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

Ashrafuzzaman and Ahmed (1976) tested 5 fungicides in a field experiment and observed that Benlate (Benornyl) and Dithane M-45 (Mancozeb) at 500 ppm gave the best control of *Alternaria porri* on onions and significantly increased the yield.

Patil *et al*. (1976) evaluated different fungicides against leaf blotch of onion. Kitazin. Cuman, Difolatan, Vitavax, Cap tan Hinosan, Durex. Miltox and Aureofungin inhibited the fungus m the culture media. As a prophy lactic spray. Kitazin was proved to be superior to all the other fungicides tested.

Bekhit *et al*. (l963) observed that Zineb and Caplan were superior to Bordeaux mixture for the control of *Alternaria porri*. where infection of seed onions was reduced by 50%.

**Micronutrients**

Biswas *et al*. (2020) conducted an experiment to evaluate the efficacy of micronutrients on performance of Onion cv. Sukhsagar at Nadia, West Bengal during 2017- 2018.The experiment was laid out in RBD having four replication with six treatments each having FYM @ 20 t $ha^{-1}$, viz. $T_1$ (RDF + soil application of Zinc Sulphate @ 10.0 kg $ha^{-1}$), $T_2$ (RDF+ foliar application of Zinc Sulphate @ 0.5% at 30 & 45 days after planting (DAP), $T_3$ (RDF+ soil application of Borax @ 10.0 kg ha-1), $T_4$ (RDF+ foliar application of Borax @ 0.25% at 30 & 45 DAP), $T_5$ (RDF+Foliar application of Micronutrient Mixture i.e. iron-2.5%, boron-0.5%,zinc -3%, copper -1%and manganese-1% @ 0.5% at 30 & 45 DAP) and $T_6$ (control). Highest plant height (63.72 cm), number of leaves/plant (12.71), polar diameter (58.62 mm), equatorial diameter (46.88 mm), average weight (61.72 g) of bulb, yield $ha^{-1}$ (266.80 q) and highest % (29.82) of A grade bulbs, were recorded with $T_5$ followed by T4. Hence, it is concluded foliar application of micronutrient mixture @ 0.25% followed by borax @ 0.5% at 30 and 45 DAPS is better in respect of bulb growth and yield.

Alam (2010) conducted a field experiment was conducted to determine the effect of micronutrients on growth and yield of onion (*Allium cepa* L.) cv. Taherpuri in “High Ganges River Floodplain” soils of Bangladesh. There were 11 treatment combinations viz. $T_1$ (control), $T_2$ (Zn), $T_3$ (B), $T_4$ (Zn+B), $T_5$ (Zn+B+Mo), $T_6$ (Zn+B+Mn), $T_7$(Zn+B+Cu), $T_8$ (Zn+B+Cl), $T_9$ (Zn+B+Mo+Mn), $T_{10}$ (Zn+B+Mo+Mn+Cu) and $T_{11}$ (Zn+B+Mo+Mn+Cu+Cl), laid out in RCBD with three replications. The six micronutrients Zn, B, Mo, Mn, Cu and Cl were applied at the rate of 3-3-0.5-4-1-20 kg/ha and also N, P, K, and S were applied at 150-50-100-20 kg/ha respectively as basal dose. Results were found to be significant in most of the yield contributing parameters of onion. The number of leaves per plant (14.63), plant height (61.30 cm), diameter of bulb (14.97 mm), fresh weight of leaves (31.42 g), fresh weight of bulb (9.21g), diameter of bulb (4.36 cm) and bulb yield (13.38 $tha^{-1}$)

were maximum in treatment $T_4$, while $T_6$ and $T_7$ showed maximum fresh weight of roots (1513 mg) and splitting of bulb (9.72) respectively. The combination Zn+B increased the maximum bulb yield by 49.66% over control. On the other hand, Zn and B alone increased the bulb yield by 28.64% and 27.74% over control respectively. The results suggested that the response of micronutrients for onion growth and yield in calcareous soils can be expressed by the following orders: (Zn+B)>Zn>B>Mo.

Patil *et al*. (2009) reported the application of micronutrients in onion increased the production of more leaves/plant than control. This might be due to their role in cell division, meristematic activity of plant tissue and expansion of cell.

Nasiruddin *et al*. (1993) conducted experiment on the effect of potassium and sulphur on growth and yield of onion at Mymensingh, Bangladesh. They reported that application of both potassium and sulphur either individually or combinedly increased the plant height, leaf production ability of the plants, bulb diameter, bulb weight as well as bulb yield. They recommended 100 kg potash and 30 kg sulphur per hectare for cultivation of onion on BAU farm soil.

Mondal *et al*. (1989) found that a higherdoses of N (150 or 200 kg urea/ha) in combination with higher doses of P (Triple super phosphate) and with 80 kg muriate of potash/ha increased the number of leaves and seed stems/plant and reduced the number of diseased (*Alternaria porri*) inflorescence stalks and infected umbels. The practice increased yields up to 23.4% over controls.

Soto (1988) carried out an experiment with critical level for P, K and S and response to N rates were 100 kg/ha each of N, $P_2O_5$ and $K_2O$ and 50 kg/ha, N was applied at 0, 50, 100 and 150 kg/ha. He mentioned that 50 kg/ha gave the best yield response.

Rashid (1983) recommended 10 tons cowdung, 175 kg urea, 125 kg TSP and 150 kg MP per hectare for successful onion cultivation in Bangladesh.

Sandhu *et al*. (1982) reported that in field trials against *Alternaria porri* the disease intensity was decreased at lower N levels.

Awad *et al*. (1978) found that applications of nitrogen fertilizer at twice the normal dose increased the percentage and severity of infection, while a double dose of calcium super phosphate reduced infection.

**Botanical extracts**

Kalsoom *et al*.(2019) reported that extracts can be used synergistically with fungicides. The combinations will protect the environment by reducing the amount of fungicide

Gurjar *et al*. (2012) reported leaf extracts of *Datura stramonium*, *Eucalyptus globules*, *Rosmarinus officinalis*, *Salix* spp., *Ocimum* spp., *Foeniculum vulgare* and *Cydonia* oblonga have been used successful to control several fungal diseases in plants.

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 significantly the best performance in reducing the disease incidence and giving higher yield.

In a study in vitro, Hossain, (2000) found that Kalojira (*Nigrella sativa*) extract completely inhibited the mycclial growth and sclcrotial formation of *Rhizoctonia solani*.

Sarvamangala and Datta (1993) reported the antifungal activity of leaf extracts of*Azadirachta indica*. *Calotropis gigantea*. *Catharanthus roseus*, *Eucalyptus* sp., *Parthenium hysterophorus* and *Pangamia pinnata* against *Ceroteliumfici* and *Cercosporamoricola* in vitro causing leaf rust and leaf spot diseases or mulberry, respectively. *Azadirachta indica* was more effective. inhibiting spore germination by 91.2% whereas extracts or *Eucalvptus*sp. and *gigantea* proved highly toxic to *C. moricola* inhibiting conidial germination by 91.5 and91.3 %respectively.

Rao and Ratnasudhakar (1992) reported the antifungal activity or leaf extracts *Datura alba* and *Cannabis saliva* efficiently reduced the seed mycoflora of *Eleusine coracana* at all concentrations. *Aspergillus flavus* was completely inhibited at 10% and *D. rostrata* at 20%.

Ashrufuzzaman and Hossain (1992) demonstrated bioefficiency of some plant extract against *Bipolarissorokiniana* and reported about Pudina (*Mentha viridis*) extract which inhibited mycelial growth as well as spore germination. Extracts of Castor (*Ricinu*s *communis* and *Dandhakalas* (*Leucas aspera*) were also found inhibitory against mycelial growth and spore germination of *Bipolarissorokiniana*.

Bashar and Rai (1991) evaluated the fungitoxicity of 26 species of higher plants against *Fusarium oxysporum*, *F. ciceri* in vitro by poisoned food technique at the concentrations of 5. 10 and 20% in Czapek-dox agar (COA) medium. All the extracts inhibited the linear growth of the fungus to varied degrees and their inhibitory effects increased with their increasing concentrations. *Clematis gouriana* was found to be most inhibitory to the fungus followed by *Allium sativum*, *Datura stramonium*. *Eucalyptus globulus*, *Asparagus acendens,Curcuma longa* and *Anagallis arvnsis*. The bulb and leaf extracts of *A. sativum* caused 99.33% and 67.53% inhibition. respectively at 20% concentration.Bulb extract of *A. sativum* revealed greater fungal effect than *A. cepa* where sclerotia germination was reduced significantly by 27 % as compared to control.

Bhowrnick and Vardhan (1991) reported the relative efficacy of leaf extracts of some plants on growth. sporulation and spore germination of *Curvularialunata* manifesting different types of leaf spot diseases. Among the leaf extracts. *Cinnamonumcamphora* and *Catharanthus rosens* completely checked the radial growth and spore germination of the test fungus followed by *Azadirachta indica*, *Clerodendrumviscosum* and *Vitex megundo*. Leaf extracts of *Nyctanthesarbortristis*. *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 *Phyllanthusfraternize,* moderate sporulation by*Lantana camara* var. aculeata and *Nyctanthesarbortristis* 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*), AIlium cepa* and *A. sativum* (leaf ant bulb) against vegetative growth and sclerotial viability of *Macrophominaphaseolina* and found that bulb extract of *A. sativum*was more effective than its leaf extract. Even 0.1 %, concentration extracts checked the growth of *M. phaseolina* 54.2%. Similarly. berk extract or *A. arabica* exhibited two-fold greater inhibitory effect on fungal growth than the fruit extracts.

Singh *et al*. (1991) evaluated the effectively of ginger rhizome extracts stored at different temperature to control powdery mildew of pea. Although both stored as well as fresh extracts had shown significant effect on the reduction of disease intensity and thereby increasing the yield. the fresh extract had shown better performance over others. The Yield was significantly reduced in both the controls (sterile water spray and no spray).

Lakshmanan *et al*. (1990) reported that Aqueous extracts of Neem (*Azadirachta indica*)and Baganbilash (*Bougainvillea spectabilisi*) inhibited mycelial growth and sclerotia germination of *Thanatephoruscucummeris*.

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 growth or either one or more pathogens over control. *Sapium indicum* was effective against *Gerlachiaoryzae*, *Pyriculariaoryzae* and *Rhizoctonia solani* with 92.5, 76 and 78.8 % growth inhibition respectively Over control. Percent inhibition of *Sarocladiumnoryzae* was obtained by *Tagetes erecta*, which also inhibited growth of *G. oryzae* by 76%. *Polyalthia longifolia* effectiveness was 52.9 and 58.4% for *G. oryzae* and *Fusarium moniliformae*. respectively. *Leucaena leucocephala* was found effective against *G. oryzae* (79.7%). *F. moniliformae* (60.7%). *F. oxysporum* (50.9%) and *R. solani* (80.69%) in inhibiting mycelial growth. More than 40% inhibition of growth was obtained with *Butea frondosa* against *F. moniliformae* and *R. solani,Zingiber officinale* and *Curcuma longa* against *G. oryzae, Blumealacera* against *G. oryzae* and *P. oryzae* and *S. indicum* against *F. moniliformae.*

Murty and Nagarajan (1986) suggested that the germination percentage of seeds treated with Vitavax-200 and garlic paste were significantly higher: and the percentage of seeds infested both by pathogens and saprophytes were lower than control. Similarly. in the experiments carried out in the greenhouse. both in sterilized and unsterilized soil. garlic paste treated seeds showed almost similar results to those or Vitavax treated seeds both in germination and in reducing the post-emergence death or seedlings.

Ahmed and Sultana (1984) reported that the bulb extract of garlic (*Allium sativum*) at different concentrations inhibited the spore germination of some important fungal pathogens of jute including those of major seed-borne diseases caused by *Macrophominaphaseolina*. *Botryodiplodiatheobromae* and *Colletotrichum corchori*.

All the three concentration of garlic solution (5, 7 .5 and 1 %) inhibited the germination of spores of all the fungi except *B.theobromae* where the germ tube showed stunted and abnormal growth with toxic symptoms at 5 and 7 .5% concentration.

**Yield**

Ali *et al*. (2016) reported that application of Rovral 50 WP @ 0.2% along with micronutrients showed significant effect in reducing disease incidence and severity which significantly increased bulb yield and yield contributing characters

Acharya *et al*. (2015) were found to be significant in most of the yield contributing parameters of multiplier onion. The plant height (50.30 cm), number of leaves per plant (51.3), leaf girth (8.1 mm), fresh leaf weight (22.7 g), fresh bulb weight (85.4 g), total dry matter production (5.31 t $ha^{-1}$), bulb yield per plot (10.1 kg) and bulb yield per hectare (16.9 t $ha^{-1}$) were highest in zinc sulphate 0.5% foliar spray. While 10 kg $ha^{-1}$ borax soil application showed highest polar (26.0 mm) and equatorial diameter (27.2 mm) and borax (5 kg $ha^{-1}$ soil + 0.25% foliar), highest number of bulblets per clump (8.8) in borax (10 kg $ha^{-1}$ soil).

Das (2010) reported that at seedling stage in net house no disease incidence of white blotch of onion (*Stemphylium vesicarium*) were recorded in case of BARI piaz-3, Indian big and Indian small. The lowest disease incidence and highest yield also recorded in BARI piaz-3, Indian big and Indian small among nine onion cultivars viz. BARI piaz-1, BARI piaz-2, BARI piaz-3, Thakurgaon local, Foridpur local, Manikgong local, Indian big, Indian small and Taherpuri. BARI piaz-1 showed lower performance in respect of all parameters.

Kibria (2010) reported that BARI piaz-3 gave lowest disease incidence and highest yield (12.67 $tha^{-1}$) against purple blotch of onion (*Alternaria porri*) among nine onion cultivars viz. BARI piaz-1, BARI piaz-2, BARI piaz-3, Thakurgong local, Foridpur local, Manikgong local, Indian big, Indian small and Taherpuri. In case of disease reaction 8.00% observed in BARI piaz-3 and was graded as resistant.

Alam *et al*. (2010) expressed the response of micronutrients for onion growth and yield in calcareous soils as the following orders (Zn + B) > Zn > B > Mo.

Hoque (2008) also reported that micronutrients alone without spraying of fungicides had significant effect compared to control.

Khatun (2007) reported that 6 foliar spraying of Rovral 50 WP (0.2%) or Dithane M-45 (0.45%) at 10 days interval starting from 20 DAP successfully minimized disease incidence and severity of stemphylium blight of onion caused by *Stemphylium vesicarium*.

Rahman *et al*. (1988) evaluated six fungicides for controlling leaf blotch of onion (*Alternaria porri*) and found Rovral 50 WP and Dithane M-45 effective both in laboratory and field conditions against the pathogen.

Sharma (1986) reported that the best control of *Alternaria porri* under field conditions was performed by Dithane M-45 (Mancozeb- 0.2%) maximizing bulb yields.

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%.

Borkar and Patil (1995) tested different fungicides for controlling *Alternaria porri* in onion cultivation in a severe disease outbreak. Mancozeb reduced disease intensity by 6%, increased yield by 10.99% and also had a higher cost:benefit ratio than the other fungicides.

Sugha *et al*. (1993) stated that five sprays of metalaxyl + mancozeb, at 15 days intervals from the appearance of disease, gave the most effective control of purple blotch of onion.

Achimu and Schloesser (1992) and others confirmed that neem leaf have high antifungal properties.

Sharma (1987) obtained the best control of *A. porri* by applying fungicide six times fungicide from infection onset. He suggested three times spray for maximizing bulb yields.

Barnoczki-Stoilova *et al*. (1989) sprayed Rovral 50 WP (Iprodione) and Ridomil plus 50 WP (Methyl + Copper oxychloride) fungicides at different blooming stages of flowers and reported that both fungicides showed less harmful and effective in controlling disease in onion seed production.

Georgy *et al*. (1986) also reported that the Iprodione group and Ridomil MZ (Metalaxyl + Mancozeb) proved most effective in reducing the disease severity and increasing bulb and seed yield.

# MATERIALS AND METHODS

Materials used and Methodology followed in this experiment are included in this chapter as a heading and sub heading-

## 3.1. Experimental Site

The experiment was conducted at the Central Farm and Plant Pathology Laboratory of Sher-e-Bangla Agricultural University (SAU), Dhaka- 1207.The location of the experimental site was at 230 46’ N latitude and 900 22’ E longitudes with an elevation of 8.24 meter from sea level details are given in Appendix I.

## 3.2. Experimental duration

The experiment was carried in Rabi season during October 2019 to March 2020.

## 3.3. Soil characteristics and climatic condition

The soil of the experimental site belongs to Tejgaon series under the Agro-ecological zone, Madhupur Tract (AEZ-28). The experimental area was under the sub-tropical climate which characterized with the comparatively high rainfall, high humidity, high temperature, relatively long day during April to September and scantly rainfall, low humidity, low temperature and short-day period during October to March. The later period is favorable for onion cultivation. Details were given in appendix II.

## 3.4. Preparation of soil

Land was prepared using a disc plough and harrow. Then the soil clouds were broken by a wooden hammer. After ploughing, the field was left for few days (seven days) for sun drying. When the weeds were sufficiently dried off, the crop residues were removed, from the field, fertilizers applied and the land was prepared finally after a light irrigation to ensure the moist condition of the soil to have a good tilth.

### 3.5. Fertilizer application

Soil was fertilized with organic fertilizer 1sack, Cow dung 150 kg, Urea 4.8 kg, Triple Super Phosphate (TSP) 4.4 kg, Muriate of Potash (MP) 3 kg and Gypsum 2.2 kg respectively. Cow dung was applied during final land preparation. Whole quantity of TSP and Gypsum and half MP was applied at final land preparation. The rest of half urea and half MP were applied 40 days after transplanting.

### 3.6. Variety used in this experiment

A local onion cultivar namely, faridpuriwas used in this experiment as planting material. The variety, Faridpuri is a popular local variety, which is commonly cultivated inChuadanga, Meherpur, Faridpur, Manikgonj and other onion growing areas of Bangladesh due to its attractive size and shape, demand and higher market price as well.

### 3.7. Treatments

The following treatments were codified in this experiment

$T_0$ = Control

$T_1$ = Indofil M-45 (1g/L)

$T_2$ = Mancer (0.8g/L)

$T_3$ = Ridomil gold MZ 68 WDG (5g/L)

$T_4$ = Zinc (1g/L)

$T_5$ = Boron (1.5g/L)

$T_6$ = Magnesium (1.56g/L)

$T_7$ = Neem leaf extract (1:4 w/v)

$T_8$ = Eucalyptus leaf extract (1:4 w/v)

### 3.8. Design and layout of the experiment

The experimental units were arranged in Randomized Complete Block Design (RCBD) with three (3) replications. The unit plot size was 1.5m x 2m. One block is separated from other by 1.0 m. and within a block each unit plot separated from each other by 0.5 m. Details of layout were given in appendix III.

### 3.9. Collection of onion seedlings

Forty-five days old healthy seedlings(figure 1)of onion were collected from Chuadanga. Seedlings were collected and transplanted in the experimental plot in evening.

**Figure 1.** Onion seedlings for transplantation

### 3.10. Transplanting of seedling

The healthy seedlings were selected for transplanting in experimental (Figure 2)The seedlings were transplanted maintaining row to row distance 20 cm and plant to plant distance 15 cm. The seedlings were transplanted on 11th December, 2019.

**Figure 2**.Transplanting of seedlings in the main field

### 3.11. Intercultural operations

#### 3.11.1. Irrigation

Light irrigation was given two times for each day (in morning and evening) up to 7 days after transplanting. After that, the irrigation was given as per requirement of the soil with regular intervals. First deep irrigation was given after 25 days of transplanting and continued up to harvesting of the crop when necessary.

#### 3.11.2. Weeding

Weeding and mulching were done as per requirement to keep the crop free from weeds and for better aeration and moisture retention of soil.

**3.11.3. Gap filling** The dead and damaged seedlings were replaced by healthy ones within 10 days after transplanting. The in the subsequent period were also replaced by the seedling maintained as border plants.

### 3.12. Collection of chemicals

The chemicals used in this experiment were collected from Siddik bazar, Dhaka.

### 3.13. Preparation of chemicals

At recommended dose, suspension/solution of fungicides was prepared by mixing thoroughly with requisite quantity of chemical with normal clean water. The concentrations of the spray solution of the fungicides were given in table 1.

**Table 1. The concentration of the spray solution of fungicides**

| SL. No. | Trade name | Group | Concentration |
|---|---|---|---|
| 1. | Indofil M45 | Mancozeb(50%) | 1 g/L |
| 2. | Mancer | Carbendazim 12% &Mancozeb 80% | 0.8g/L |
| 3. | Ridomil Gold MZ 68 WDG | Mancozeb + Metalaxyl 68 % a.i/Kg | 5g/L |


**Plate1.** Fungicides a) Mancer b) Ridomil Goldand c) Indofil M45 used in the experiment

### 3.14. Collection of botanicals

Botanicals leaf extract (**Eucalyptus, Neem Leaf Extract**) were collected from Sher-e-Bangla Agricultural University campus, Dhaka.

### 3.15. Preparations of botanical extract

The botanical extracts were prepared following the method of Ashrafuzzaman and Hossain, (1992). For preparation of extracts, collected leaves were weighted in an electric balance and then washed in the water. After washing the big leaves were cut into small pieces. For getting extract, weighted plant parts were blended and then distilled water was added into the jug of the blender. The pulverized mass was squeezed through 3 folds of fine cotton cloth. For getting 1:4 (w/v) ratio 400 ml of distilled water was added with 100 g plant parts (table 2).

**Table 2.The concentration of the spray solution of botanicals extract**

| Treatments | Concentrations |
|---|---|
| Neem | 1:4 (leaf: water) |
| Eucalyptus | 1:4 (leaf: water) |


**Plate 2.** Botanical leaf extracts a) neem and b) eucalyptus used in the experiment

### 3.16. Collection of micronutrients

Micronutrients were collected from central farm of Sher-e-Bangla Agricultural University, Dhaka.

### 3.17. Preparation of micronutrients

For getting 1.5g/L concentration, 1.5g of Boron was added in 1L distilled water and same procedure was applied for making the concentration of Zinc (1g/L) and Magnesium (1.56g/L).


**Plate 3. Micronutrients (a) Zinc (b) Boron and (c) Magnesium**

### 3.18. Application of treatments

All the treatments were applied as foliar spray. Spraying was started from 15 days after transplanting (60 days old plant). Total three spraying were done at 10 days intervals with a hand sprayer. One liter of suspension of each spray material was used to spray the plants under each treatment. A control treatment was maintained in each block where spraying was done with water only.

### 3.19. Isolation of pathogens

Isolation and Identification of pathogens were confirmed by-

I) Direct observation

II) Tissue planting method

#### 3.19.1. By direct observation

The diseased onion leaves were collected and kept in polythene bags and tagged. The samples were then taken to the laboratory. Then slides were prepared from the diseased samples, observed under microscope and identified the pathogen according to CMI Description.

#### 3.19.2. Tissue planting method

The diseased leaves were cut into small pieces (4mm diameter) and surface sterilized with 0.1% $HgC1_2$ for 1 min. Then the cut pieces were washed in sterile water thrice and were placed on blotter paper. The plates containing leaf pieces were kept at room temperature for seven days. When the fungus grew well and sporulated, then slides were prepared from pathogenic structures and was observed under microscope (figure 3) and identified with the help of relevant literature (CMI description).

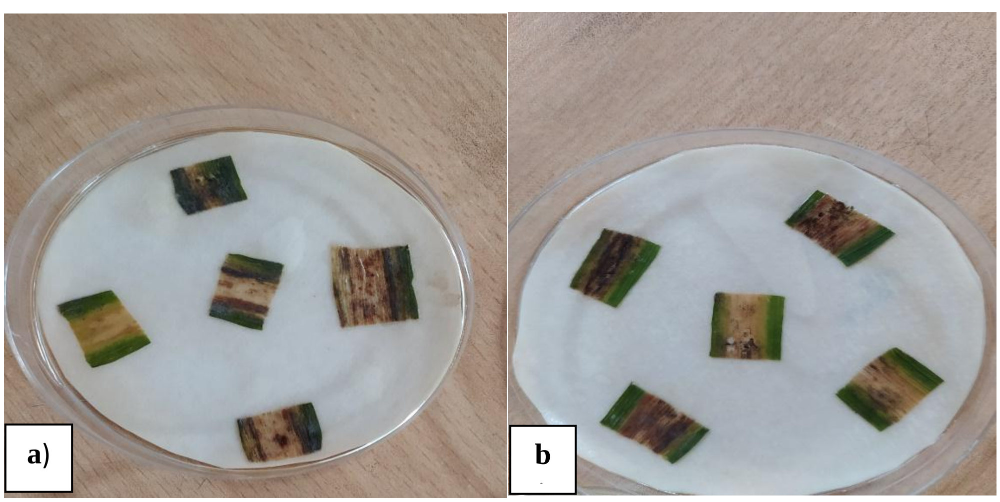


**Plate 4.** Leaf sample with symptoms on moist blotter paper (a-b)

### 3.20. Data collection

Ten plants were selected randomly from unit plot and marked with the help of sticks. All the, 10 plants were evaluated for data recording for each unit plot. Data recording was started after the onset of the disease and continued up to maturity with 10 days intervals. The following parameters were considered for data collection.

#### 3.20.1. Estimation of disease incidence

Number of plants infected per unit plot were recorded and selected for calculation of disease incidence. The leaf with characteristic spot or blighted tip was persuaded as diseased leaf.

Disease incidence data were calculated following standard formulae (Agrios, 2005 and Kranz, 1988):

$$\text{Disease incidence (\%)} = \frac{\text{Numbers of infected plants}}{\text{Numbers of inspected plants}} \times 100$$

#### 3.20.2. Estimation of Percent disease index

The disease severity was calculated by using “0-5” scale (Harsfall and Barratt, 1945) and the scale is given bellow-

| % Leaf Area Diseased (LAD) | Grade/rating |
|---|---|
| 0 | 0 |
| 0.1-5 | 1 |
| 5.1-12 | 2 |
| 12.1-25 | 3 |
| 25.1-50 | 4 |
| >50 | 5 |

Percent disease index (PDI) was measured by the following formula-

$$PDI = \frac{\text{Sum of total disease ratting}}{\text{Total no. of observation X Maximum grade in the scale}} X100$$


**Figure 3.**Percent leaf area diseased (0-5) scale

### 3.20.3. Number of leaves per plant

Number of leaves per plant was counted from ten randomly selected plants at 10 days intervals starting from 70 days after transplanting (DAT) and continued up to 90 DAT and their average was recorded.

### 3.20.4. Leaf length (cm)

Leaf lengths were measured using centimeter scale. Starting from 70 days after transplanting (DAT) and their average data was recorded.

### 3.20.5. Bulb diameter (cm)

Diameter of 10 randomly selected bulbs from each plot was determined using measuring tape. Then average diameter was determined from the average.

### 3.20.6. Bulb fresh weight

Freshly harvested bulb was used for bulb weight calculation. It was done by using weight machine and data was recorded in kg.

### 3.20.7. Bulb dry weight (kg)

Dry bulb weight was measured after sun drying of fresh sample for few days continuously.

### 3.20.8. Individual bulb weight per plot(kg) and yield per plot

Weight of individual bulb weight for each treatment and yield per plot was recorded.

## 3.21. Statistical analysis of data

The recorded data on different parameters were statistically analyzed to find out the significant differences among the treatment means. Data were analyzed using STATISTIX-10 computer based software. The significance of the difference among the treatment means was estimated by LSD at 5% level of probability.

# RESULTS

A field experiment was conducted to manage the purple blotch complex by using selected chemicals, Micronutrients and Botanicals. Parameter considered, data recorded and results found from the study are included in this chapter. Results are presented in graphical and tabulated form.

## 4.1. Symptomology of purple blotch complex of onion

The characteristics symptoms of purple blotch complex were investigated in the experimental field where symptoms were appeared under natural field conditions. At first small, water-soaked lesions were appeared that quickly turned into whitish color. As they aged, the lesions turned into brown to purple in color which surrounded by yellow halo margin. Lesions were coalescing and girdle the leaf, and causes tip dieback (Figure 5). Occasionally, bulbs scales were also infected and showed the neck wounding symptoms.

**Figure 4.** Symptoms of purple blotch complex of onion

### 4.1.1. Identification and characterization of purple blotch complex pathogen of onion

For identification and characterization of the pathogen of purple blotch complex of onion, pathogen was isolated from infected leaf. From the microscopic study it was revealed that the identified pathogen was *Stemphylium vesicarium* because mycelial color of this pathogen was creamy white to brown, conidiophores were pale to medium brown with dark bands, smooth or minutely verruculose, conidia oblong to ovoid, densely verruculose with 1–5 transverse and several longitudinal septa.

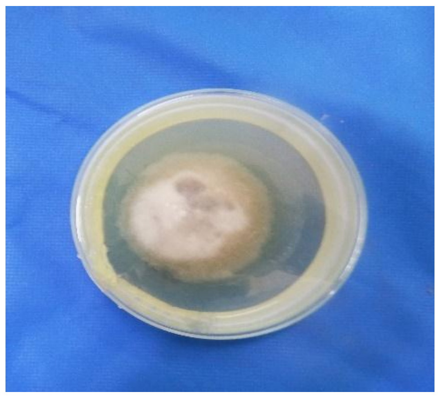

**Figure 5.**Pure culture of *Stemphylium vesicarium*

**Figure 6.** Conidium of *Stemphylium vesicarium* observed under compound microscopic (10X)

The conidia of *A. Porri* are normally ovoid, obclavate, ellipsoid, sub cylindrical with multiple transverse and longitudinal septa under compound microscope. The body of the conidium is oblong with its formal end protruded out and the terminal part tapered into a beak, and is produced from a bud formed by the conidiophores. Conidia are generally euseptate, solitary or in short to medium sized long chains.

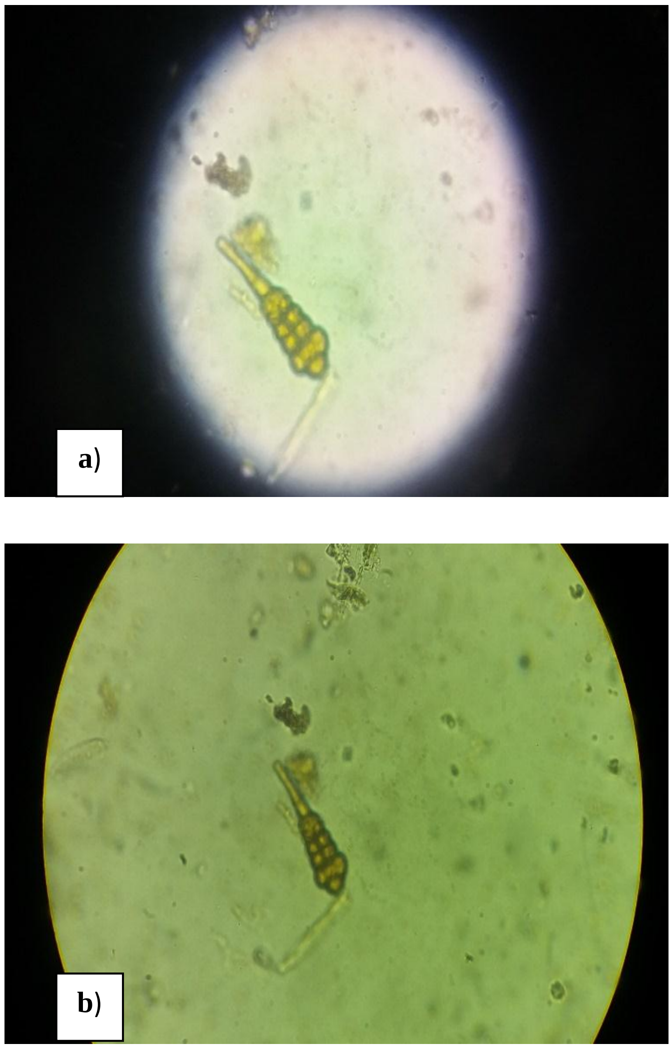


**Figure 7.** Conidia of *Alternaria porri* observed under compound microscopic (10X)

### 4.1.2. Effect of different treatments on Disease Incidence (%)

In the study, all the selected treatments showed statistically significant variation in respect of percent disease incidence recorded at 70, 80 and 90 DAT **(**Table 3**).**At 70 DAT, among the treatment, the highest disease incidence (71.00 %) was recorded in untreated control. On the other hand, the lowest disease incidence (42.00 %) was estimated from $T_3$ (Ridomil Gold)treatment. The moderate disease incidence(46.67%) was recorded in $T_1$(Indofil M-45,) treatment which was statistically identical with the $T_2$(Mancer, 48.67%) treatment preceded by$T_5$(Boron, 51.33%), $T_4$(Zinc,54.00%), $T_8$(Eucalyptus leaf extract, 58.00%), $T_6$(Magnesium, 61.33 %) and $T_7$ (Neem leaf extract, 63.00 %) treatments.

At 80 DAT, the highest disease incidence (77.33 %) was again recorded in control treatment and the lowest disease incidence (46.00 %) was recorded in $T_3$ (Ridomil Gold) treatment which was statistically identical with $T_1$ (Indofil, 50.67 %) treatment preceded by $T_2$ (Mancer, 52.33%) treatment. Remaining treatments were showed moderate disease incidence (%) at 80 DAT.

At 90 DAT, a remarkable significant variation was found. The lowest disease incidence (52.67 %)was recorded in the $T_3$ (Ridomil Gold)treatment and $T_1$ (Indofil M-45) and$T_2$ (Mancer) treatment gave statistically similar results which was58.33% and 61.33% respectively. Treatment $T_5$(Boron), $T_8$(Eucalyptus leaf extract), $T_6$ (Magnesium) and $T_7$ (Neem leaf extract) showed moderate disease incidence at 90 DAT that were69.67%, 78.00%, 78.67% and 81.33 % respectively which were statistically identical with each other. Finally, the highest (90.00 %) disease incidence was recorded from control treatment.

**Table 3. Efficacy of selected treatments on percent Disease Incidence of purple blotch disease of onion**

| Treatments | Disease Incidence (%) at | | |
|---|---|---|---|
| | **70 DAT** | **80 DAT** | **90 DAT** |
| $T_0$(Control) | 71.00a | 77.33a | 90.00a |
| $T_1$(Indofil) | 46.67h | 50.67ef | 58.33e |
| $T_2$(Mancer) | 48.67gh | 52.33e | 61.33e |
| $T_3$(Ridomil Gold) | 42.00**i** | 46.00**f** | 52.67**f** |
| $T_4$(Zn) | 54.00ef | 65.00c | 75.33c |
| $T_5$(B) | 51.33fg | 59.33d | 69.67d |
| $T_6$(Mg) | 61.33cd | 67.00c | 78.67bc |
| $T_7$(Neem leaf extract) | 63.00bc | 69.00bc | 81.33b |
| $T_8$ (Eucalyptus leaf extract) | 58.00de | 66.33c | 78.00bc |
| LS | ** | ** | ** |
| LSD $_{(0.05)}$ | 4.653 | 5.483 | 4.634 |
| CV (%) | 4.83 | 5.11 | 3.69 |

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

LS = Level of significance, ** = Significant at 1% level of probability

### 4.1.3. Effect of different treatments on Percent Disease Index (PDI)

In the study, all the treatments showed significant variation in terms of percent disease index recorded at 70,80,90 DAT (Table 4). At 70 DAT, the lowest (42.67 %) PDI was recorded from $T_3$ (Ridomil Gold) treatment whereas the highest (71.67 %) PDI was found from treatment $T_0$ (Control). Treatment $T_1$ (Indofil, 47.67%) and $T_2$(Mancer, 49.67%) gave statistically identical PDI respectively.

After 80 DAT days of sowing, the lowest PDI (46.00 %) was recorded from $T_3$ (Ridomil Gold) treatment followed by $T_1$ (Indofil, 51.67%), $T_2$ (Mancer, 54.00 %), $T_5$ (B, 56.00 %), $T_4$ (Zn, 61.67 %), $T_6$ (Mg, 68.33 %) and $T_7$ (Neem leaf extract, 70.00 %) respectively. On the other hand, the highest PDI(78.33 %) was recorded from $T_0$ (Control)treatment.

At 90 DAT, the highest (88.00 %) PDIwas recorded from treatment $T_0$ (Control) and the lowest (49.00 %) percent disease index was recorded from $T_3$ (Ridomil Gold) treatment. There was no significant variation among treatment $T_1$(Indofil56.33%), $T_2$ (Mancer, 58.67%) and $T_5$(B, 60.00%). Similarly, treatment $T_4$(Zn, 67.00%), $T_8$(Eucalyptus leaf extract, 71.00%), $T_6$(Mg, 75.00%)and $T_7$(Neem leaf extract, 77.00%) were identical in the terms of PDI.

**Table 4. Efficacy of different management treatment on Percent Disease Index of purple blotch disease of onion**

| Treatments | Percent disease Index (%) at | | |
|---|---|---|---|
| | 70 DAT | 80 DAT | 90 DAT |
| $T_0$(Control) | 71.67a | 78.33a | 88.00a |
| $T_1$(Indofil) | 47.67e | 51.67f | 56.33e |
| $T_2$(Mancer) | 49.67e | 54.00ef | 58.67e |
| $T_3$(Ridomil Gold) | 42.67**f** | 46.00**g** | 49.00**f** |
| $T_4$(Zn) | 55.67cd | 61.67d | 67.00d |
| $T_5$(B) | 50.67d | 56.00e | 60.00e |
| $T_6$(Mg) | 61.33c | 68.33bc | 75.00bc |
| $T_7$ (Neem leaf extract) | 62.33bc | 70.00b | 77.00b |
| $T_8$ (Eucalyptus leaf extract) | 58.33cd | 64.67cd | 71.00cd |
| LS | ** | ** | ** |
| $LSD_{(0.05)}$ | 4.655 | 4.267 | 5.477 |
| CV (%) | 4.80 | 3.99 | 4.68 |

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

LS = Level of significance, ** = Significant at 1% level of probability

### 4.1.4. Effect of different treatments on number of leaves per plant

Effect of different treatments on number of leaves per plant of onion is presented in table 3. At 70 DAT, onion plant showed lower no. of leaves (6.27) per plant in control treatment. The higher no. of leaves was found in $T_3$ (8.31) followed by $T_1$(7.71), $T_2$ (7.62), $T_5$(7.50),$T_4$(7.47), $T_8$(7.41),$T_6$(7.14) and $T_7$ (7.11).

At 80 DAT, the lower (6.96) no. of leaves was found in control whereas, the higher number of leaves (9.25) per plant was recorded from treatment $T_3$. At 90 DAT, the higher number of leaves (9.77) per plant was also recorded from treatment $T_3$while the lower number of leaves per plant (7.27) was recorded from treatment $T_0$ (Control).The moderate no. of leaves was found in treatment $T_6$ (8.30) preceded by $T_7$ (8.37), $T_4$ (8.70),$T_8$(8.73),$T_5$(8.83),$T_2$ (8.97) and $T_1$(9.03).

**Table 5. Efficacy of different management treatment on numbers of leaf of onion**

| Treatments | Number of leaves at | | |
|---|---|---|---|
| | **70 DAT** | **80 DAT** | **90 DAT** |
| $T_0$(Control) | 6.27**c** | 6.96**e** | 7.27**e** |
| $T_1$(Indofil) | 7.71ab | 8.57b | 9.03b |
| $T_2$(Mancer) | 7.62ab | 8.50b | 8.97b |
| $T_3$(Ridomil Gold) | 8.31**a** | 9.25**a** | 9.77**a** |
| $T_4$(Zn) | 7.47ab | 8.28bc | 8.70bc |
| $T_5$(B) | 7.50ab | 8.34bc | 8.83b |
| $T_6$(Mg) | 7.14bc | 7.89cd | 8.30d |
| $T_7$(Neem leaf extract) | 7.11bc | 7.89cd | 8.37cd |
| $T_8$ (Eucalyptus leaf extract) | 7.41ab | 8.31bc | 8.73bc |
| LS | ** | ** | ** |
| LSD $_{(0.05)}$ | 0.986 | 0.463 | 0.368 |
| CV (%) | 7.83 | 3.31 | 2.50 |

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

LS = Level of significance, ** = Significant at 1% level of probability

### 4.1.5. Effect of different treatments on length of leaf (cm)

Effect of different treatments on leaf length of onion was recorded at 70, 80 and 90 DAT and presented in figure 6. At 70 DAT, leaf length varied from 26.55 cm to 34.13cm. Whereas treatment $T_3$gave higher (34.13 cm) leaf length and control gave lower size (26.55 cm) leaves. Moderate size leaves were recorded in $T_7$(28.66cm)preceded by$T_6$ (29.23cm), $T_8$ (29.74cm), $T_4$(29.95cm), $T_5$ (30.82cm),$T_2$ (31.26 cm) and $T_1$ (32.12cm).

At 80 DAT, the range of leaf length was 31.37cm to 40.74cm. The leaf length was higher (40.74 cm) in treatment $T_3$ whereas, control treatment had lower (31.37cm) size leaf.

At 90 DAT, the larger sized leaf (43.43cm) was recorded from treatment $T_3$followed by$T_1$ (40.25cm), $T_2$ (39.51cm),$T_5$ (38.37cm),$T_4$ (38.22cm),$T_8$ (37.83cm) and$T_6$ (37.09cm). Finally, the lower sized leaf (33.15 cm) was recorded from treatment $T_{0.}$

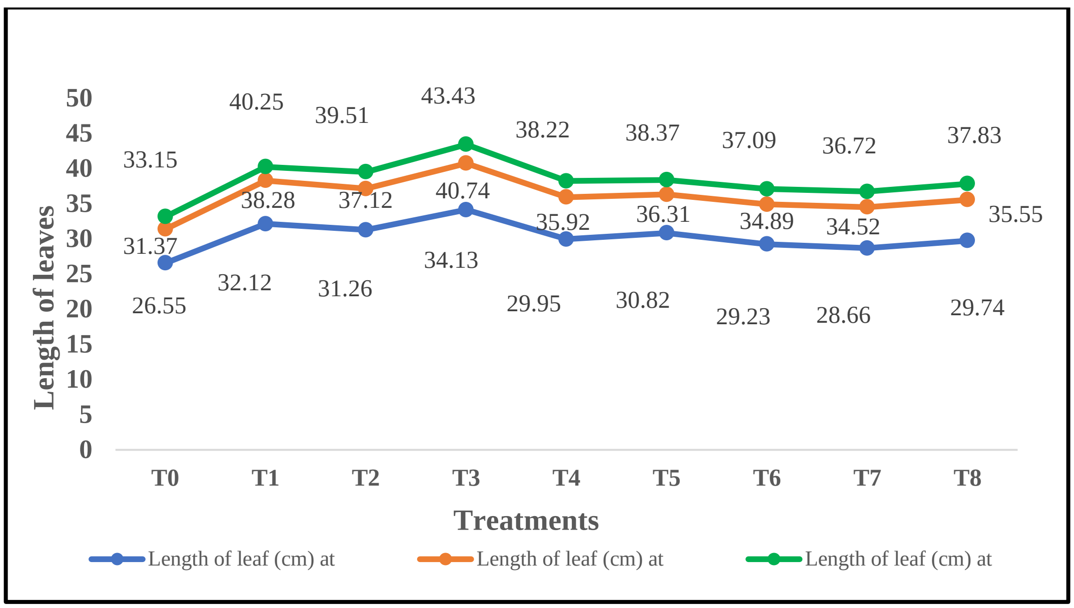


**Figure 8.** Effect of different treatments on leaf length of onion

$T_0$=Control,$T_1$=Indofil,$T_2$=Mancer,$T_3$=Ridomilgold,$T_4$=Zinc,$T_5$=Boron,$T_6$=Magnesium, $T_7$=Neem leaf extract, $T_8$=Eucalyptus leaf extract

**4.1.6. Effect of different treatments on bulb diameter (cm)**

Effect of treatments on bulb diameter is presented in table 6. The highest bulb diameter (18.23 cm) was recorded from treatment $T_3$ which was statistically similar with $T_1$ (16.92 cm) and the lowest bulb diameter (13.52 cm) was recorded from treatment $T_0$ (Control). Moderate size bulb was produced in treatment $T_2$ (15.26 cm) followed by $T_5$ (14.58 cm) and statistically similar with $T_4$ (14.52 cm),$T_8$ (14.31 cm), $T_6$ (14.27 cm) and$T_7$ (14.15 cm).

**4.1.7. Effect of different treatments on single bulb weight (g)**

Effect of treatments on **s**ingle bulb weight is presented in table 6. The highest bulb weight (47.98 g) was recorded from treatment $T_3$ which was statistically similar with $T_1$ (43.02 g) and the lowest single bulb weight (27.17 g) was recorded from $T_0$treatment.

**4.1.8 Effect of different treatments on fresh weight (kg plot$^{-1}$)**

Effect of treatments on bulb fresh weight is presented in table 6.The highest fresh weight (3.16 kg plot$^{-1}$) was recorded from treatment $T_3$and the lowest fresh weight (2.01 kg plot$^{-1}$) was recorded from treatment $T_0$. Moderate fresh weight was recorded in treatment $T_1$ (2.71 kg) followed by $T_2$ (2.61 kg) and they were statistically similar with $T_5$ (2.53kg), $T_4$ (2.48kg), $T_8$ (2.39kg), $T_6$ (2.35kg) and $T_7$ (2.33kg).

**4.1.9. Effect of different treatments on dry weight (kg plot$^{-1}$)**

Effect of treatments on bulb fresh weight is presented in table 6. The highest dry weight (2.88 kg) was recorded from treatment $T_3$whereas the lowest dry weight (1.83 kg plot) was recorded from treatment $T_0$. Moderate dry weight was recorded in treatment $T_1$ (2.46kg) followed by$T_2$ (2.37kg) and they were statistically identical with $T_5$ (2.30kg), $T_4$ (2.26kg), $T_8$ (2.17kg), $T_6$ (2.14kg) and $T_7$ (2.12kg).

### 4.1.10. Effect of different treatments on yield (t $ha^{-1}$)

Effect of treatments on yield is presented in table 6 and figure 4. The lowest yield of onion (6.22 t $ha^{-1}$) was recorded in treatment $T_0$preceded by $T_7$ (7.07 $tha^{-1}$), $T_6$ (7.13 $tha^{-1}$), $T_8$ (7.25 $tha^{-1}$), $T_4$ (7.52 $tha^{-1}$), $T_5$ (7.65 $tha^{-1}$),$T_2$ (7.90 $tha^{-1}$) and$T_1$ (8.20 $tha^{-1}$). Finally, the highest yield (9.60 t $ha^{-1}$) was recorded from treatment $T_{3.}$

Yield of onion increased per hectare over control (Table 6)showed variation for different treatment in this experiment. The maximum yield (54.34 %) increased over control was recorded from treatment $T_3$ (Ridomil Gold) followed by $T_1$ (31.83 %), $T_2$(27.01 %), $T_5$ (22.99 %), $T_4$ (20.90 %), $T_8$ (16.56%), $T_6$ (14.63%) and $T_7$ (13.67 %).

**Table 6. Efficacy of different management treatment on yield attributes and yields of onion**

| Treatments | Bulb diameter (cm) | Single bulb weight (g) | Fresh weight (kg plot$^{-1}$) | Dry weight (kg plot$^{-1}$) | Yield (t ha$^{-1}$) | Yield increased over control (%) |
|---|---|---|---|---|---|---|
| $T_0$(Control) | 13.52**c** | 27.17**f** | 2.01**g** | 1.83**g** | 6.22**g** | - |
| $T_1$(Indofil) | 16.92**a** | 43.02ab | 2.71b | 2.46b | 8.20b | 31.83 |
| $T_2$(Mancer) | 15.26b | 41.17bc | 2.61bc | 2.37bc | 7.90bc | 27.01 |
| $T_3$(Ridomil Gold) | 18.23**a** | 47.98**a** | 3.16**a** | 2.88**a** | 9.60**a** | 54.34 |
| $T_4$(Zn) | 14.52bc | 37.62be | 2.48ce | 2.26ce | 7.52ce | 20.90 |
| $T_5$(B) | 14.58bc | 39.25bd | 2.53cd | 2.30cd | 7.65cd | 22.99 |
| $T_6$(Mg) | 14.27bc | 34.98de | 2.35ef | 2.14ef | 7.13ef | 14.63 |
| $T_7$(Neem leaf extract) | 14.15bc | 33.25e | 2.33f | 2.12f | 7.07f | 13.67 |
| $T_8$(Eucalyptus leaf extract) | 14.31bc | 35.90ce | 2.39 df | 2.17df | 7.25df | 16.56 |
| LS | ** | ** | ** | ** | ** | ** |
| LSD $_{(0.05)}$ | 1.552 | 5.902 | 0.141 | 0.129 | 0.434 | |
| CV (%) | 6.04 | 9.24 | 3.32 | 3.33 | 3.35 | |

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

LS = Level of significance, ** = Significant at 1% level of probability

### 4.2. Relationship between percent disease index and yield of onion at 70 DAT

Correlation study was done to establish the relationship between the percent disease index and yield of onion at 70 DAT (figure.8), 80DAT (figure.9) and 90DAT (figure. 10) among different treatments. From the figure 8-10, it was revealed that negative correlation was observed between the parameters. It was evident that the equation $y = -0.0908x + 12.65$, $y = -0.0824x + 12.682$ and $y = -0.0694x + 12.28$ gave a good fit to the data and the co-efficient of determination ($R^2 = 0.8603$, $R^2 = 0.873$ and $R^2 = 0.8704$) fitted regression line had a significant regression co-efficient at 70, 80 and 90 DAT, respectively. It may be concluded from the figure that percent disease index at different DAT was strongly as well as negatively correlated with yield of onion.

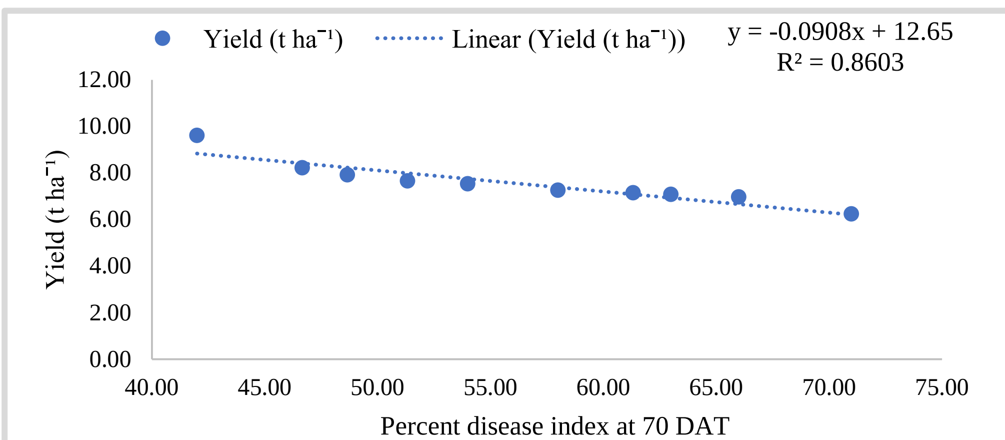


**Figure 9**. Relationship between Percent disease index and yield of onion at 70 DAT

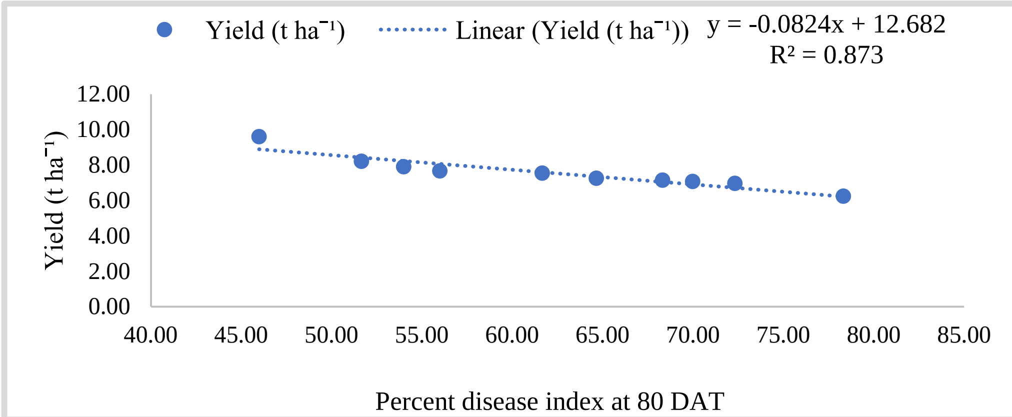


**Figure 10.** Relationship between Percent disease index and yield of onion at 80 DAT

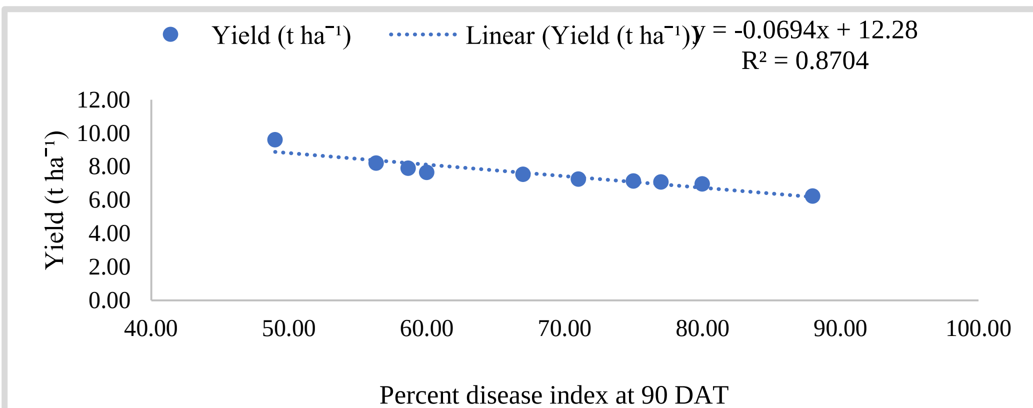


**Figure 11.** Relationship between Percent disease index and yield of onion at 90 DAT

# DISCUSSION

Onion (*Allium cepa* L.) is one of the most important spices crop in Bangladesh as well as in all over the world. Now a day's onion production is affected by different diseases in Bangladesh. Purple blotch complex of onion is one of the infectious diseases that caused by of *Alternaria porri and Stemphylium vesicarium*. It reduces the bulb yield and quality of onion seeds. The present experiment was conducted to determine the effectiveness of different treatment against purple blotch complex of onion.

In this experiment, different treatments (Indofil M-45, Mancer, Ridomil gold, Zinc, Boron, Magnesium, Neem leaf extract and Eucalyptus leaf extract) were evaluated on percentdisease incidence and percent disease index along with number of leaves per plant and leaf length at 70, 80 and 90 DAT respectively. Besides these parameter bulb diameter, individual bulb weight and total yield were also recorded to evaluate the treatments effects in controlling purple blotch complex of onion.

From the study it was found that the highest disease incidence (71.00 %, 77.33 % and 90.00 %) and disease index (71.67 %, 78.33% and 88.00 %) were recorded in untreated control at different DAT. The lowest disease incidence(42.00 %,46.00 % and 52.67 %) and diseases index (42.67 %, 46.00 % and 49.00 %) was found in plots sprayed with Ridomil Gold ($T_3$)followed by Indofil and Mancer. Similar findings were recorded by Georgy *et al*. (1983) and they found Ridomil MZ (Metalazyl + Mancozeb) was the most effective fungicide in reducing disease incidence and severity, and increasing the bulb and seed yield. Similar findings were also reported by Paneru*et al*., (2020) and they reported that Hexaconazole and Mancozeb + Cymoxanil were proved to be best in controlling this complex disease of onion with the percent disease control (PDC) of 84.45%and 80% respectively. Rochecouste (1994) recommended Ridomil (Metalaxyl + Mancozeb) against *Puccinia allii*,*Alternariaporri* and *Peronospora destructor* of garlic and onion.

The results are in agreement with Gupta *et al*., (1981) who reported mancozeb was most effective against *Alternaria porri* under *invitro* condition. Mancozeb 75 WP (@ 0.2%was found effective against Stemphylium blight (*S. vesicarium*), purple blotch (*A. porri*) of onion and *Alternaria spp*. causing blights in other crops, as earlier reported by several workers (Deshmukh *et al*., 2007; Pandey *et al*., 2008; Ilhe*et al*., 2008 and Pal *et al*., 2008, Ali (2008), Akter (2007), Uddin (2006). Rahman (2004) reported that eight spraying of Rovral 50WP (0.2 %) or Ridomil MZ-72 (0.2) with 7 days interval minimized the disease incidence and disease severity of purple blotch complex of onion and increased the bulb yield.

Sharma (1986) reported that the best control of *Alternaria porri* under field conditions was performed by Dithane M-45 (Mancozeb- 0.2%). Khatun (2007) reported that 6 foliar spraying Dithane M-45 (0.45%) at 10 days interval starting from20 DAP successfully minimized disease incidence and severity of stemphylium blight of onion caused by *Stemphylium vesicarium*. Similar findings reported by Sugha*et al*. (1993) stated that five sprays of metalaxyl + mancozeb, at 15 days intervals from the appearance of disease, gave the most effective control of purple blotch of onion.

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 DithaneM-45 reduced the disease by 23.6% and increased the yield by 35%.Borkar and Patil (1995) tested different fungicides for controlling *Alternaria porri* in onion cultivation in a severe disease outbreak. Mancozeb reduced disease intensity by 6%, increased yield by 10.99% and also had a higher cost: benefit ratio than the other fungicides.

In this experiment, three micronutrients were used and among them boron was gave better performance in controlling the purple blotch complex of onion followed by Zn and Mg in all considering parameters. Similar findings were found by Biswas *et al*.,

(2020) they concluded that foliar application of micronutrient mixture @ 0.25% followed by borax @ 0.5% at 30 and 45 DAPS is better in respect of bulb growth and yield.Alam*et al*., (2010) expressed the response of micronutrients for onion growth and yield in calcareous soils as the following orders (Zn + B) > Zn > B >Mo.Hoque (2008) also reported that micronutrients alone without spraying of fungicides had significant effect compared to control.

Between two botanicals used in the study, eucalyptus leaf extract was found better than neemleaf extract in all considering parameters. Kumari *et al*.,(2006) and Sharma *et al*., (2007) found neem, mehandi and gingerextractseffective in controlling Stemphylium blight of onion, garlic and blights caused by *Alternaria spp*. in other crops. Similar findings were done by kalsoom*et al*., (2019) and they reported that extracts can be used synergistically with fungicides. The combinations will protect the environment by reducing the amount of fungicide. Mishra *et al*., (2008) reported that datura leaves extract showed the highest efficacy in reducing onion blight disease caused by *Stemphylium vesicarium* under greenhouse condition.

In this experiment it was also observed that the highest bulb diameter (18.23cm), single bulb weight (47.98 g), fresh weight (3.16 Kg/plot), dry weight (2.88Kg/plot) and bulb yield (4.60 ton $ha^{-1}$) were obtained from Ridomil Gold whereas the lowest was from control. Similar findings were recorded by Paneru*et al*., (2020) and they reported that, Hexaconazole and Mancozeb + Cymoxanil were the best in giving the highest yield (878.7 kg/ha and 878.3kg/ha) and highest thousand seed weight (3.72gm and 3.64gm) respectively. Sultana *et al.,* (2008) observed 71.95% disease reduced in the fungicide spraying plot over control. Weight of bulb (g) and yield/plot also increased by 10.6% and 50.9% in fungicide sprayed plot over control.

## SUMMARY AND CONCLUSION

An experiment was conducted in the central farm of Sher-e- Bangla Agricultural University, Dhaka, during the period of 11th December 2019 to March 2020 to study on the management of purple blotch complex of onion caused by *Stemphylium vesicarium* and *Alternaria porri*. The experiment was laid out in the randomized completed block design with three replications. Faridpurivariety was used for this experiment.The treatments were $T_0$ = Control, $T_1$ = Indofil M45 (1.04g/L), $T_2$ = Mancer (0.8g/L), $T_3$ = Ridomil gold MZ 68 WDG (5g/L), $T_4$ = Zinc (1g/L), $T_5$ = Boron (1.5g/L), $T_6$ = Magnesium (1.56g/L), $T_7$ = Neem leaf extract (1:4 w/v) and $T_8$ = Eucalyptus leaf extract (1:4 w/v) to explore the possibility of controlling purple blotch complex of onion. Data were analyzed using STATISTIX-10 Computer based software.The significance of the difference among the treatment means was estimated by LSD at 5% level of probability.

At 70, 80, 90 DAT, the observation was made on the effect of the codified treatments on percent disease incidence, percent disease index, post emergence mortality. The lowest disease incidence (42.00%, 46%, 52.67%)was found in Ridomil Gold treated plotswhere plants sprayed with 10 days interval followed by foliar spray with Indofil(46.67%, 50.67%, 58.33%) and Mancer (48.67%, 52.33%, 61.33%) at the same interval. The highest disease incidence(71.00%, 77.33%, 90.00%)was recorded in control treatment at different observation.

The lowest percent disease index (PDI) was also estimated from Ridomil Gold(42.67%, 46.00%, 49.00%) treated plots followed by foliar spray with Indofil (47.67%, 51.67%, 56.33%), Mancer (49.67%, 54.00%, 58.67%), Boron (50.67%, 56.00%, 60.00%), Zinc (55.67%, 61.67%, 67.00%), Magnesium (61.33%, 68.33%, 75.00%), Eucalyptus leaf extract (58.33%, 64.67%, 71.00%), Neem leaf extract (62.33%, 70.00%, 77.00%).The highest disease index (71.67%, 78.33%, 88.00%)was recorded from untreated control.

At 70, 80 and 90 DAT, number and length of leaves were recorded in order to evaluate the effect of treatments on onion plant. The highest number of leaves(8.31,9.25 and 9.77) and higher leaf length (34.13 cm,40.74cm and 43.43cm) were obtained from $T_3$ (Ridomil Gold) treatment in all days compared to control.

In terms of bulb diameter, the highest bulb diameter (18.23 cm) was recorded from treatment $T_3$ (Ridomil Gold) which was statistically similar with $T_1$ (Indofil) (16.92 cm) and the lowest bulb diameter (13.52 cm) was recorded from treatment $T_0$ (control).In case of bulb weight, Ridomil Gold ($T_3$) also gave the highest single bulb weight (47.98 g) whereas the lowest weight (27.17 g) was recorded from control.

In this experiment, onion plants showed highest fresh and dry weight (3.16 kg and 2.88 kg) when treated with Ridomil Gold and the lowest fresh and dry weight (2.01 kgand1.83 kg) was recorded from control. The highest yield of onion (9.60 t $ha^{-1}$) was recorded from Ridomil Gold and the lowest yield onion 6.22 t $ha^{-1}$was recorded control. However, the maximum yield increased (54.34%) over control was also recorded from Ridomil Gold followed by (Indofil) (31.83 %).

From the present study it may be concluded that Ridomil Gold performed better in all considering parameters than other treatments. Thus, Ridomil Gold is effective against purple blotch complex of onion. Among the micronutrients, boron performed better in reducing disease incidence and percent disease index which ultimately increased yield followed by magnesium and Zinc. Between the botanical extracts, eucalyptus found effective against purple blotch complex of onion than neem leaf extract.On the basis of findings from the present study, it may be suggested that the onion growers mayuse Ridomil gold MZ 68 WDG (5g/L**)** to control purple blotch complex of onion.However, further studies need to be carried out in different Agro-ecological zonesto justify the present findings.

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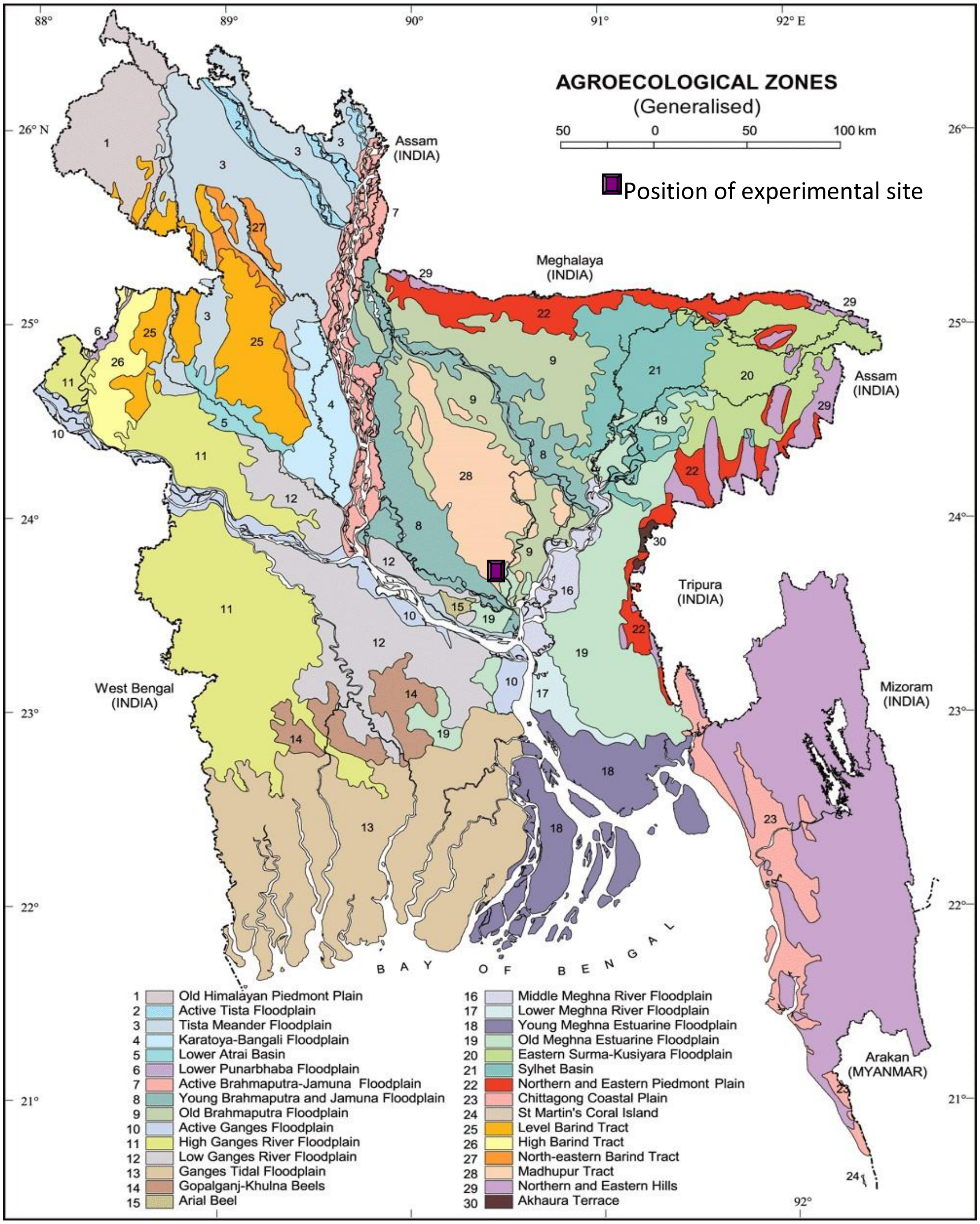
# APPENDICES

## Appendix I. The experimental site under study



**Appendix II.Physiochemical properties of soil and climatic condition used in the experimental location**

**Physiochemical properties of soil:**

| Characteristics | Value |
|---|---|
| Particle size analysis | |
| % Sand | 25.68 |
| % Silt | 53.85 |
| % Clay | 20.47 |
| Textural class | Silt-loam |
| pH | 5.8-7.1 |
| Organic carbon (%) | 0.31 |
| Organic matter (%) | 0.54 |
| Total N (%) | 0.027 |
| Phosphorus(µg/g soil) | 23.66 |
| Exchangeable K (me/100 g soil) | 0.60 |
| Sulphur (µg/g soil) | 28.43 |
| Boron (µg/g soil) | 0.05 |
| Zinc (µg/g soil) | 2.31 |

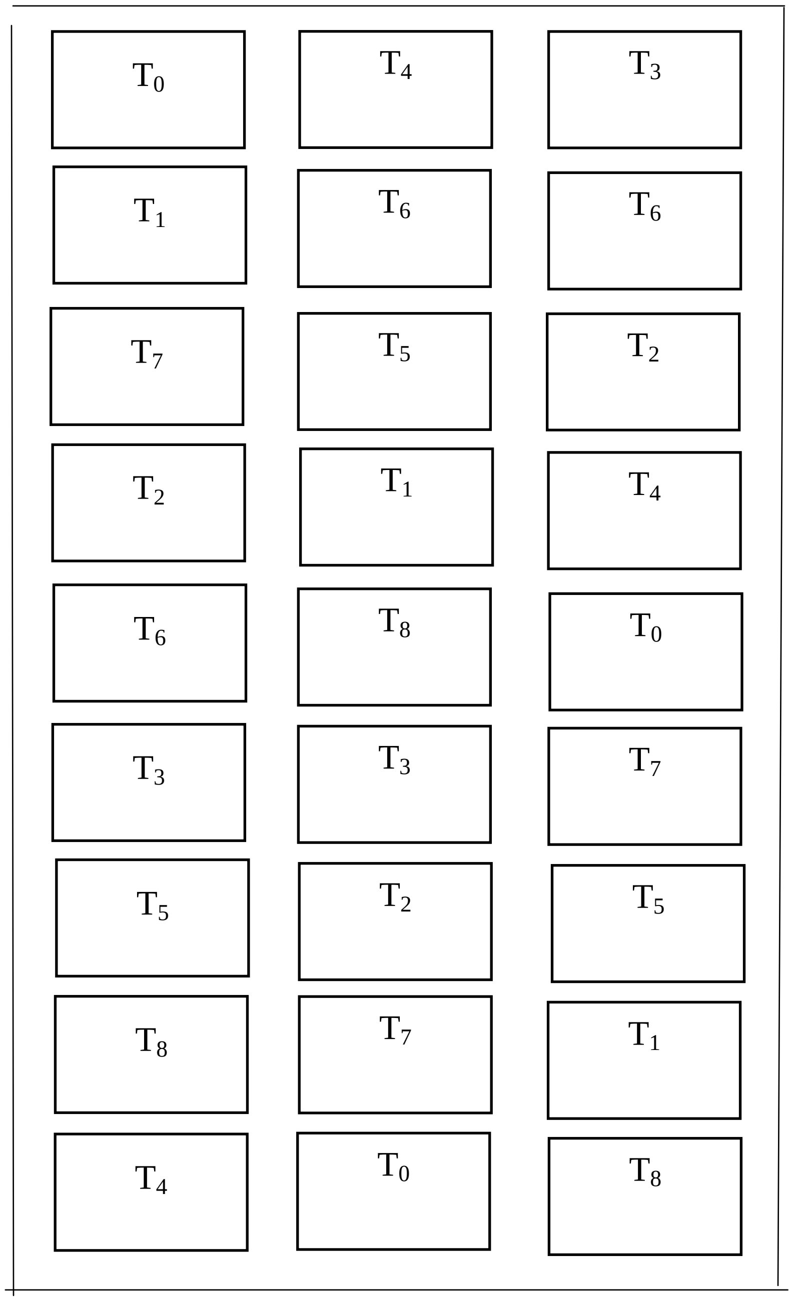
**Source: Soil Resources Development Institute (SRDI), Dhaka-1207.**

**Climatic condition: Monthly average relative humidity, temperature and rainfall of the experimental period (October 2019 to March 2020).**

| Month | Average RH (%) | Average Temperature (ºC) | Total Rainfall (mm) |
|---|---|---|---|
| October | 78 | 27.6 | 88 |
| November | 74 | 24.9 | 37 |
| December | 74 | 19.3 | 5 |
| January | 76 | 18.5 | 21 |
| February | 59 | 21.6 | 1 |
| March | 57 | 26.4 | 30 |

**Source: Bangladesh Meteorological Department (Climate Division), Agargaon, Dhaka-1207.**

**AppendixIII: Experimental Field Layout**




Legend,

Size of the plot = 3.15 $m^2$, Space around the land = 1m, Space between the block = 75cm, Space between the plot = 50 cm