RESEARCH ARTICLE

European Journal of Agriculture and Food Sciences
www.ejfood.org

Evaluation the Effect of Fungicides, Micronutrients and Botanicals on Purple Blotch Complex of Onion in Bangladesh

Salvia A. Kanta, Hosna A. C. Nisha, Raihan Ferdous, Tosnia Tohura, and Md. Belal Hossain

ABSTRACT

Field research was conducted in the central research farm of Sher-e-Bangla Agricultural University (SAU), during the period from October 2020 to March 2021. The experiment was a layout with RCBD design to evaluate the effect of selected fungicides (Indofil, Mancer, and Ridomil Gold), micronutrients (Zinc, Boron, and Magnesium), and botanicals (neem and eucalyptus leave extract) on purple blotch complex of onion. Data were collected on percent disease incidence and percent disease index, the number of leaves per plant, leaf length, bulb diameter, bulb weight (fresh and dry), and yield. The local cultivar Faridpuri was used as a tested variety. Among the selected fungicides, Ridomil Gold gave a better result than other fungicides in controlling the percent disease incidence (52.67%) and percent disease index (49.00%) with the highest number of yield qualities per plant. In addition to this, the highest bulb diameter (18.23 cm), single bulb weight (47.98 g), fresh weight (3.16 Kg/plot), and dry weight (2.88Kg/plot) were also obtained in Ridomil Gold treated plots. This treatment also gave better yield performance (9.60 t ha-1) followed by Indofil (8.20 t ha-1) and Mancer (7.90 t ha-1), and increased yield by 54.34% over the control treatment. From the study, it was also found that among the micronutrients, boron gave more satisfactory results than botanicals.

Keywords: botanicals, fungicides, micronutrients, onion, purple blotch.

Submitted: December 18, 2022

Published: February 20, 2023

ISSN: 2684-1827

DOI: 10.24018/ejfood.2023.5.1.625

S. A. Kanta
Department of Plant Pathology, Sher-e-Bangla Agricultural University, Bangladesh
(e-mail: salviaaman08@gmail.com)
H. A. C. Nisha
Department of Plant Pathology, Sher-e-Bangla Agricultural University, Bangladesh
(e-mail: nisha3@sau.edu.bd)
R. Ferdous
Department of Plant Pathology, Sher-e-Bangla Agricultural University, Bangladesh
(e-mail: raihanf.agri-2011106@sau.edu.bd)
T. Tohura
Department of Agronomy, Sher-e-Bangla Agricultural University, Bangladesh
(e-mail: tosniarumi@gmail.com)
Md. Be. Hossain*
Department of Plant Pathology, Sher-e-Bangla Agricultural University, Bangladesh
(e-mail: dr.mbhossain@sau.edu.bd)

****Corresponding Author***

I. Introduction

Onion (*Allium Cepa* L.) often called "queen of the kitchen" is the most important spices crop. It contains strong antibiotic (quercetin) properties having fungicidal, bactericidal, antiviral, and nematicidal properties [1]. This antibiotic is a good source of antioxidants for human beings and contains lower cholesterol and acts against cancer [2]. Due to its medicinal value onion becomes a popular spices crop in the world as well as in Bangladesh. China is the largest onion producer country in the world with 26% and India produces 21% while Bangladesh produces only 2% of world production yearly [4]. According to BBS, [3] the production of onion in Bangladesh, is nearly 1802868 tons from 426157 ha of land. Mahmud [4] stated that the average standard production in Bangladesh is 18 tons per hectare but the average yield is only 11 tons per hectare. Bangladesh imports huge quantities of onion at the cost of foreign currency from India, Egypt, Turkey, Myanmar, and Pakistan. Unfortunately, in the very recent year, this crisis exceeded the previous year's condition, and the price has increased multifold. About 5 percent import duty has been imposed in the last few budgets in a couple of years [4]. Several factors have been identified for the low productivity of onions in Bangladesh. Among them, the fundamental reason behind the inadequate production of onion is the disease problem [5]. Among the diseases, purple leaf blotch (PLB) caused by *Alternaria porri* and Stemphylium leaf blotch (SLB) caused by *Stemphylium vesicarium* are the major diseases of onion worldwide affecting the foliage severely resulting in crop loss ranging from 30 to 100 percent both in seed and bulb [6]–[13]. It is considered that *Stemphylium vesicarium* initiates the infection, which facilitates subsequent infection of *Alternaria porri* causing purple blotch hence the disease is designated as a purple blotch complex.

In Bangladesh, limited attempts have been made to find out suitable control measures for this disease in bulb production as well as seed production [14]–[16]. Furthermore, globally people are now very much aware of environmental deterioration due to the indiscriminate and enormous use of highly toxic chemicals. So, to save nature

European Journal of Agriculture and Food Sciences
www.ejfood.org

and escape the contamination of the natural environment, the judicial use of chemicals is to be employed. Some of the fungicides used worldwide and found effective are Chlorothalonil 75% WP, Mancozeb 75% WP, Propineb 70% WP, Difenoconazole 25% EC, Propiconazole 25% EC, and Hexaconazole 5% EC [17]. But a good number of fungicides are yet to be assayed against this disease. Nutrients play a crucial role in the growth and development of plants as well as disease management. All the essential nutrients can affect disease intensity, and some showed high sensitivity in onion production viz. Zn, B, Mn and Mo [18], [19]. Zinc and boron play a vital role in improving plant growth, through the biosynthesis of endogenous hormones which are responsible for the advancement of plant growth [20]. Besides fungicides and nutrients, extracts from many parts of higher plants have been reported to exhibit antifungal, antibacterial, antiviral, and insecticidal properties under laboratory trials [21]. Extracts from leaves of neem and Eucalyptus globules have been used to control several fungal plant pathogens such as *Alternaria alternata*, *Alternaria porri*, *Aspergillus flavus*, and *Fusarium oxysporum*. f. sp. *phaseoli*, *Fusarium solani*, *Monilini afructicola*, *Rhizoctonia solani* and *Sclerotinia sclerotiorum*. Considering the above factors, the present study was undertaken to test selected fewer toxic fungicides, micronutrients, and botanicals for the management of the purple blotch complex of onion.

II. Materials and Methods

A. Experimental Site and Duration

The field experiment was done in the central research field and the lab experiment was in the mycology laboratory in the Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka. The experiment was conducted during the winter season from October 2020 to March 2021.

B. Land Preparation

The experimental field was prepared according to agronomic practices and fertilizers were applied according to the recommended doses. Intercultural operations (gap-filling, irrigation, and weeding) were done while and when necessary.

C. Experimental Design

The field experiment was carried out following the randomized complete block design (RCBD) with three replications. The unit plot size was 1.5m x 2m. The distance between block to block and within the block was 1.0 m and 0.5 m respectively.

D. Treatments

In total nine treatments were codified to the study as present in Table I.

TABLE I: List of the Treatments Used in the Experiment

T_0=Control	T_3 =Ridomil gold MZ 68 WDG (5g/L)	T_6 =Magnesium (1.56g/L)
T_1=Indofil M-45 (1g/L)	T_4 =Zinc (1g/L)	T_7 =Neem leaf extract (1:4 w/v)
T_2=Mancer (0.8g/L)	T_5 =Boron (1.5g/L)	T_8 =Eucalyptus leaf extract (1:4 w/v)

E. Planting Materials

A local onion variety namely, Faridpuri was used as planting material due to its attractive size, demand, and higher market price.

F. Transplanting of Onion Seedlings

Forty-five days old healthy onion seedlings were transplanted into the experimental plots by maintaining row to row distance of 20 cm and plant to plant distance of 15 cm. Seedling transplantation was done in the evening.

G. Preparation of Fungicidal Spray Solution

At the recommended dose, a fungicidal solution was prepared by mixing the requisite quantity of chemicals with sterilized water. The concentrations of the spray solution of the fungicides were given in Table II.

TABLE II. The Concentration of the Fungicidal Spray Solution

SL. No.	Trade name	Fungicidal 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

H. Preparation of Botanical Extract

The botanical extracts were prepared by following the method described by Ashrafuzzaman and Hossain [22]. 400 ml of distilled water was added with 100 g of plant parts to maintain a 1:4 (w/v) ratio (Table III).

TABLE III. Concentration of the Botanicals Extract Spray Solution

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

I. Application of Micronutrients

Micronutrients, zinc, boron, and magnesium have applied concentrations @ 1.0 g/L, 1.5 g/L, and 1.56 g/L respectively. For the preparation of the micronutrient solution, 1.5 g of Boron was added to 1 Litre of distilled water and the same procedure was applied for making the concentration of Zinc (1.0 g/L) and Magnesium (1.56 g/L).

J. Application of Treatments and Isolation of Pathogens

The selected treatments were applied as foliar spraying methods. Spraying started 45 days after transplanting (DAT). Three sprays were done at 10 days intervals consecutively. A control treatment was maintained in each block where spraying was done with distilled water only. Pathogens were isolated from diseased leaves following the tissue planting method and re-isolation was done to get pure culture.

K. Data Collection

Ten plants were selected randomly from each of the unit plots. 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.

L. Measurement of Disease Incidence and Severity

Disease incidence was calculated by the following formulae [23], [24].

$$\text{Disease incidence (\%)} = \frac{\text{Numbers of infected plants}}{\text{Numbers of inspected plants}} \times 100 \quad (1)$$

Disease severity was calculated by using a "0–5" scale [25]. After that, the percent disease index (PDI) was measured by the following formula:

$$\text{PDI} = \frac{\text{Sum of total disease ratting X 100}}{\text{Total no.of observation X Maximum grade in the scale}} \quad (2)$$

M. Counting of Leaves Number and Length Per Plant

Randomly ten plants were selected for the collection of data on both parameters. Whereas leaf lengths were measured using a centimeter scale. In both cases, data was taken after 70 days of transplanting (DAT) and continued up to 90 DAT at 10 days intervals.

N. Measurement of Yield Attributes of Onion

Bulb Diameter (cm), Weight (fresh and dry) and Yield per Plot-

With the help of slide calipers, the diameter was recorded from ten randomly selected bulbs of each plot. After harvesting, data on the freshly collected bulb weight (kg) of each plot was recorded. Dry bulb weight (kg) was measured after sun drying of fresh sample for a few days with the help of a weight machine.

O. Statistical Analysis of Data

Data were analyzed using STATISTIX-10 computer-based software. The significance of the difference among the treatment means was estimated by LSD at a 5% level of probability.

III. Results

A. Identification and Characterization the Pathogens of Purple Blotch Complex

Two fungal pathogens namely, *Alternaria porri* and *Stemphylium vesicarium* were identified and characterized on the basis of their mycelial and conidial characteristics. Significant variations were found in mycelial characters regarding surface and subsurface color, shape and texture on PDA media. From the results of mycelial characters, it was found that surface and subsurface color was greyish to black, mycelial growth circular and texture cottony. Variation was found in transverse and longitudinal septation of conidia. The maximum transverse septation was recorded in *Stemphylium vesicarium* and longitudinal septation was observed in *Alternaria porri.* Conidial beak was found prominent in *Alternaria porri* and reduced or absent in *Stemphylium vesicarium* (Fig. 1).

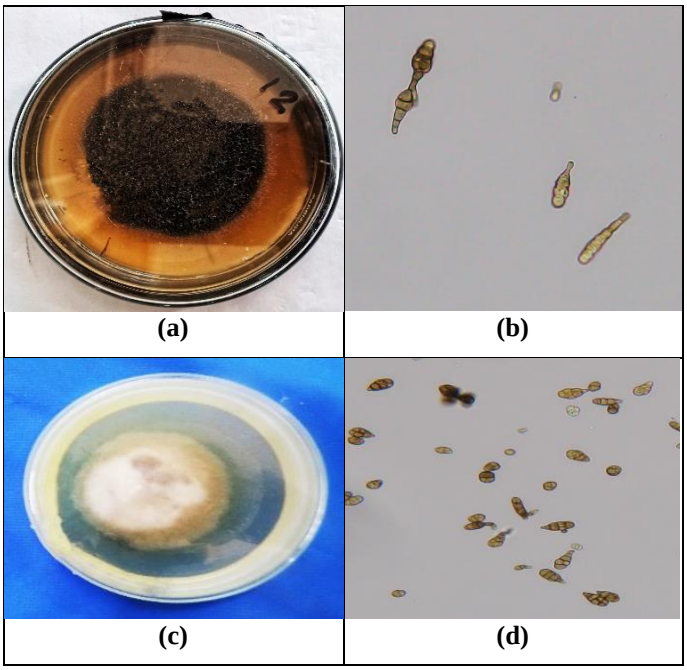


Fig. 1. Pure culture [(a) &(c)] and conidial structures [(b) & (d)] of *Alternaria porri* and *Stemphylium vesicarium* (10X).

B. Effect of Different Treatments on Percent Disease Incidence (PDI) and Disease Severity Index (DSI)

From the results on percent disease incidence and disease severity index, it was found that plants treated with chemical fungicides, (Ridomil Gold) were comparatively healthier than other treated plants by having the minimum disease incidence and severity index. The percent disease incidence and severity index were 52.67 and 49.00 respectively at the last observation (90 DAT) and the highest disease incidence and severity index was recorded in the untreated control (Table IV).

TABLE IV: Efficacy of Different Treatments on DI and PDI of Purple Blotch Disease of Onion

Treatments	DI (%) @			DSI (%) @		
	70 DAT	80 DAT	90 DAT	70 DAT	80 DAT	90 DAT
T_0 (Control)	71.00 a	77.33 a	90.00 a	71.67 a	78.33 a	88.00 a
T_1 (Indofil)	46.67 h	50.67 ef	58.33 e	47.67 e	51.67 f	56.33 e
T_2 (Mancer)	48.67 gh	52.33 e	61.33 e	49.67 e	54.00 ef	58.67 e
T_3 (Ridomil Gold)	42.00 i	46.00 f	52.67 f	42.67 f	46.00 g	49.00 f
T_4 (Zn)	54.00 ef	65.00 c	75.33 c	55.67 cd	61.67d	67.00 d
T_5 (B)	51.33 fg	59.33 d	69.67 d	50.67 d	56.00 e	60.00 e
T_6 (Mg)	61.33 cd	67.00 c	78.67 bc	61.33 c	68.33 bc	75.00 bc
T_7 (Neem leaf extract)	63.00 bc	69.00 bc	81.33b	62.33 bc	70.00 b	77.00 b
T_8 (Eucalyptus leaf extract)	58.00 de	66.33 c	78.00 bc	58.33cd	64.67cd	71.00 cd
CV (%)	4.83	5.11	3.69	4.80	3.99	4.68

C. Effect of Different Treatments on the Number of Leaves Per Plant

Different treatments showed significant variance in respect to the number of leaves per plant. The highest number of leaves per plant (8.31, 9.25, and 9.77) was counted from the plot's plants treated with Ridomil gold and the lowest number of leaves (6.27, 6.96, and 7.27) was recorded from untreated control at 70, 80, and 90 DAT respectively. The remaining treatments counted a moderate number of leaves in all observations. (Table V).

D. Effect of Different Treatments on Leaf Length (cm)

Different treatments showed significant variance in respect of leaf length. In all cases, Ridomil gold showed the best result with large-sized leaves (34.13, 40.74, and 43.43cm) whereas control treated plants had the smallest sized leaf (Fig. 2).

E. Effect of Different Treatments on Yield Attributes of Onion

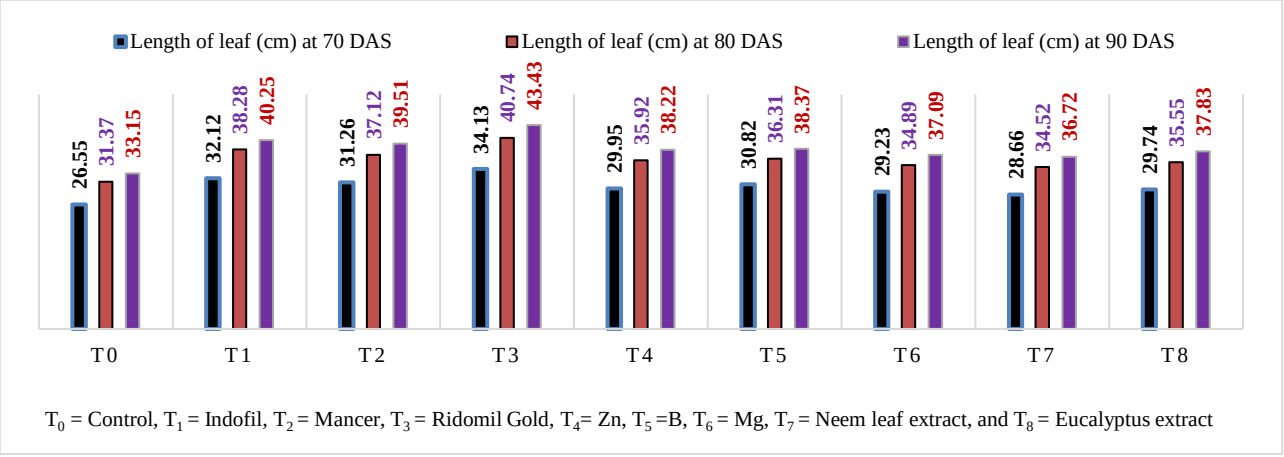
The effect of selected treatments on onion single bulb weight and diameter, fresh and dry bulb weight, and yield varied significantly (Table VI). The highest single bulb weight (47.98 g) and diameter (18.23 cm) were recorded in treatment T_3 (Ridomil gold) which were statistically akin to treatment T_1 (Indofil) (bulb weight 43.02 g and diameter 16.92 cm respectively). The highest fresh (3.16 kg plot-1) and dry bulb weight (2.88 kg) and yield (9.60 t ha-1) were also recorded in treatment T_3 (Ridomil gold). On the other hand, the lowest single bulb weight (27.17 g) and diameter (13.52 cm), fresh (2.01 kg plot-1) and dry weight (1.83 kg plot), yield (6.22 t ha-1) were recorded in the control treatment. Based on yield performance, the increment of yield over control was measured, in the case of treatment T_3 (Ridomil gold) increased the yield of the onion by 54.34%.

F. Relationship between Percent Disease Index (PDI) and Yield of Onion at 70 DAT

A correlation study was done to establish the relationship between the disease severity index (%) and yield of onion at different observation. From Fig. 3–5, it may be concluded that the disease severity index (%) at different DAT was increased as well as negatively correlated with the yield of onion.

TABLE V: EFFICACY OF DIFFERENT MANAGEMENT TREATMENTS ON NUMBERS OF LEAVES 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)	7.71 ab	8.57 b	9.03 b
T_2(Mancer)	7.62 ab	8.50 b	8.97 b
T_3(Ridomil Gold)	8.31 a	9.25 a	9.77 a
T_4(Zn)	7.47 ab	8.28 bc	8.70 bc
T_5(B)	7.50 ab	8.34 bc	8.83 b
T_6(Mg)	7.14 bc	7.89 cd	8.30 d
T_7(Neem leaf extract)	7.11 bc	7.89 cd	8.37 cd
T_8 (Eucalyptus leaf extract)	7.41ab	8.31 bc	8.73 bc
CV (%)	7.83	3.31	2.50



T_0 = Control, T_1 = Indofil, T_2 = Mancer, T_3 = Ridomil Gold, T_4= Zn, T_5 =B, T_6 = Mg, T_7 = Neem leaf extract, and T_8 = Eucalyptus extract

Fig. 2. Effect of different treatments on leaf length of onion

TABLE VI: EFFICACY OF DIFFERENT TREATMENTS ON YIELD ATTRIBUTES AND YIELDS OF ONION

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

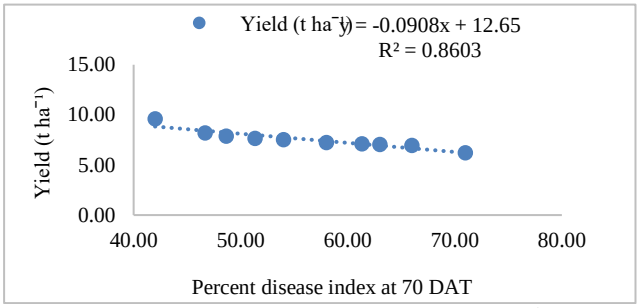


Fig. 3. Relationship between Percent disease index and yield of onion at 70 DAT.

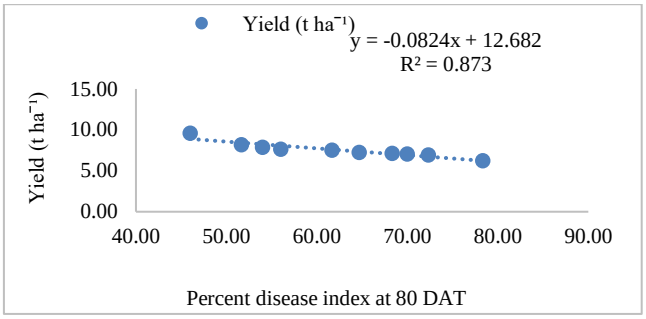


Fig. 4. Relationship between PDI and yield at 80 DAT.

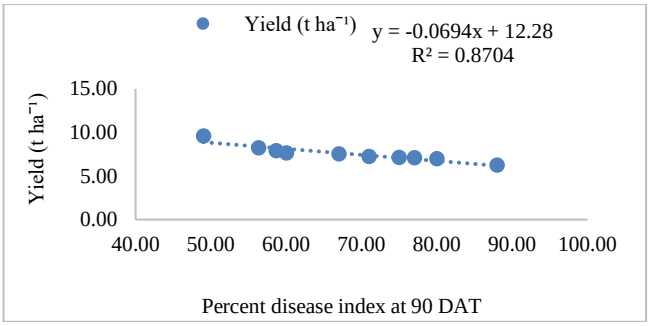


Fig. 5. Relationship between PDI and yield at 90 DAT.

IV. Discussion

In the present study, selected treatments were evaluated on percent disease incidence and disease severity index (PDI) along with the number of leaves per plant and leaf length at 70, 80, and 90 DAT. From the results, it was found that the lowest disease incidence and disease severity index were found in the plots plants sprayed with Ridomil Gold (T3) followed by Indofil (disease incidence=46.67%, 50.67%, 58.33%; PDI=47.67%, 51.67%, 56.33%) and Mancer (disease incidence=48.67%, 52.33%,61.33%; PDI=49.67%,54.00% and 58.67%). Whereas the highest disease incidence and disease severity index were recorded in untreated control in all of the observations. Related results were recorded in some previous studies [26] and found Ridomil MZ (Metalaxyl + Mancozeb) was the most effective fungicide in reducing disease incidence and severity of purple blotch complex of onion. Paneru, N *et al.*, [27] also reported analogous findings, they reported that Hexaconazole and Mancozeb+Cymoxanil were proved to be the best in controlling the onion purple blotch complex disease with the percent disease control (PDC) of 84.45% and 80% respectively.

Besides the disease-related parameters, individual bulb weight and diameter, fresh and dry weight, and yield were also measured for the evaluation of the selected treatments. The highest single bulb weight (47.98 g), bulb diameter (18.23 cm), fresh weight (3.16 Kg/plot), dry weight (2.88 Kg/plot), and bulb yield (4.60-ton ha-1) were obtained from the plots treated with Ridomil Gold whereas the lowest was from untreated control (Table VI). Paneru, N *et al.*, [27] found similar findings and they reported that Hexaconazole and Mancozeb+Cymoxanil gave the highest yield (878.7 kg/ha and 878.3kg/ha) and the highest thousand seed weight (3.72 gm and 3.64 gm) respectively. Sultana *et al.*, [28] observed 71.95% disease reduction with 10.6% and 50.9% increased bulb weight and yield in fungicide-sprayed plots over control. Among three micronutrients boron gave a satisfactory performance in controlling the purple blotch complex of onion followed by Zn and Mg considering all parameters. Biswas, P *et al.*, [29] also found almost similar findings, they reported 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.

V. Conclusion

From the study, it may be concluded that considering the overall results, the application of botanical extracts and judicious use of micronutrients may be recommended as an ecofriendly approach for controlling the purple blotch complex of onion.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

References

[1] Purseglove JW. *Tropical crops: Monocotyledons*. Longman Press, London. 1972.

[2] Uddin N, Naseer A, Shahid M, Muhammad N, Ali N. In vitro evaluation of fungicides and plant extracts to control Purple Blotch disease of onion in Pakistan. *Plant Pathol. J.* 2020; 19(2):77–88. doi: 10.3923/ppj.2020.77.88.

[3] www.bbs.gov.bd Bangladesh Bureau of Statistics. *Yearbook of Agricultural Statistics*. [Internet] 2020. [updated 2021 May]; Available from: http://www.bbs.gov.bd/site/page/3e838eb6-30a2-4709-be85-40484b0c16c6/Yearbook-of-Agricultural-Statistics.

[4] Mahmud I. The Prothom Alo. *Increased onion production brings hope to farmers.* [Internet] 2020. [updated 2020 Sep 17]; Available from: https://en.prothomalo.com/business/local/increased-onion-production-brings-hope-to-farmers.

[5] Bangladesh Bureau of Statistics. *Yearbook of Agricultural Statistics*. [Internet] 2006. Available from: http://www.bbs.gov.bd.

[6] Awad MA, El-Shenawy Z, Omran AF, Shatla MN. Cultural practices in relation to purple blotch disease of onion. *Sci. Hort.* 1978; 9(3): 237–243.

[7] Everts KL, Lacy, ML. The influence of dew duration, relative humidity and leaf senescence on conditional formation and infection of onion by *Alternaria porri*. *Phytopathol*. 1990; 80(11):1203–1207.

[8] Everts KL, Lacy ML. The influence of environment on conidial concentration of *Alternaria Porri* in air and on purple blotch Incidence on onion. *Phytopathol.* 1990; 80:1387–1391. doi: 10.1094/Phyto-80-1387.

[9] Brar SS, Rewal HS, Singh H. Development of purple blotch of onion in relation to thrip injury. *Plant Dis. Res.* 1990; 5:133–135.

[10] Aveling TAS. Stemphylium leaf blight of garlic in South Africa. *Phytophylactica*. 1993; 25:293–294.

[11] Aveling TAS. Studies on *Alternaria porri* and *Stemphylium vesicarium* on *Allium* spp. Ph.D. Dissertation, University of Natal, South Africa; 1994.
[12] Chaput J. *Identification of diseases and disorders of onions. FACTSHEET*. Queens Printers for Ontario. Ontario, Canada, 1995, pp. 1–9.
[13] Cramer CS. Breeding and genetics of fusarium basal rot resistance in onion. *Euphytica.* 2000; 115:159–166. https://doi.org/10.1023/A:1004071907642.
[14] Rahman ML. Efficacy of fungicides in controlling purple leaf blotch (*Alternaria porri*) of onion (*Allium cepa*). M.S. Thesis in Plant Pathology, 1990.
[15] Ashrafuzzaman M, Ahmed MU. Control of foliage disease of onion by spray fungicides. *Bangladesh Hort.* 1976; 4(2): 25–30.
[16] Rahman ML, Ahmed HU, Mian IH. Efficacy of fungicides in controlling purple leaf blotch of onion. *Bangladesh J. Plant Path*. 1988; 4(1&2): 71–76.
[17] Bachkar SACP, Bhalckar MN. Control of *Alternaria porri* causing purple blotch of onion during kharif season. *J. Allium Res.* 2018; 1: 57–59.
[18] Huber DM, Graham RD. The role of nutrition in crop resistance and tolerance to disease. In: Rengel Z. Ed. *Mineral nutrition of crops fundamental mechanisms and implications*. Food Product Press, New York, 1999, pp. 205–226.
[19] Havlin JL, Beaton JD, Tisdale SL, Nelson WL. Soil fertility and fertilizers: An introduction to nutrient management. 6th ed. *Prentice Hall, Upper Saddle River*; 2007; pp. 244–289.
[20] Bhatt B, Srevastava K, Singh MP. Studies on the effect of foliar application of micronutrients on growth, yield and economics of tomato (*Lycopersicon esculentum* Mill). *Progressive Horticulture.* 2004; 36: 331–334.
[21] Ergene A, Guler P, Tan S, Mirici S, Hamzaoglu E, Duran A. Antibacterial and antifungal activity of *Heracleum sphondylium* subsp. *artvinense*. *African J. of Biotech*. 2006; 5: 1087–1089.
[22] Ashrafuzzaman MH, Khan AR. Antifungal activity *in-vitro* of some plant extracts on *Rhizoctonia solani*. *Bangladesh J. Sci. Res*. 1992; 10(2): 243–244.
[23] Agrios GN. *Plant Pathology*. 5th ed. Elsevier Academic Press, Burlington, Mass, 2005, pp. 952.
[24] Kranz J. Measuring Plant Disease. In: *Experimental techniques in plant disease epidemiology*, Springer, Berlin Heidelberg, 1988, pp. 35–50.
[25] Horsfall JG, Barratt RW. Grading system for measuring plant disease. *Phytopathol.* 1945; 35: 655.
[26] Georgy NI, Radwan JA, Mohamed HA, Shabi AE. Chemical control of downy mildew and purple blotch of onion in Egypt. *Agril. Res. Rev*. 1983; 61: 25–41.
[27] Paneru N, Pragya A, Puja T. Management of purple blotch complex of onion (*Allium Cepa* Cv red creole) under field condition in Rukum-West, Nepal. *MJSA*. 2020; 4(2): 71–74.
[28] Sultana N, Ayub A, Islam M. Yield loss assessment of onion bulb due to purple blotch disease. *Annual Research Report. Plant Pathology Division, BARI, Joydevpur*, 2008, pp. 40–41.
[29] Biswas P, Das S, Bar A, Maity TK, Mandal AR. Effect of micronutrient application on vegetative growth and bulb yield attributes of rabi onion (*Allium cepa* L.). *Int. J. Curr. Microbiol. App. Sci*. 2020; 9(3): 556–565.

Raihan Ferdous was born into a reputable Muslim family on 7th August 1995 at Akkelpur Upazilla, Joypurhat District in Bangladesh. He has completed B.Sc.Ag. (Hons.) from the University of Rajshahi and pursuing an MS in Plant Pathology from Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. He has got the National Science and Technology (NST) Graduate Fellowship Award, 2020–2021 for MS Program. He also completed the course "Crop Pest Diagnosis Practitioner and Foundation Certificate" and "Crop Pest Management Foundation Certificate" from CABI Academy Powered by PlanrwisePlus in 2022. Now he is working on some research projects as a bacteriologist at Dr. M.A. Wazed Miah Research Center, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. He has attended many national and international seminars, symposiums, and workshops. He has published some scientific research papers in different international peer-review indexing and impact factor journals. He is also a Graphics Designer.

Dr. Md. Belal Hossain was born in a respected muslim family under Upazilla and District Thakurgaon on 21st August,1980 in Bangladesh. He has completed B.Sc.Ag(Hons.) and MS in Plant Pathology from Sher-e-Bangla Agricultural University, Dhaka, Bangladesh and obtained 1st class and CGPA 3.73 out of 4 scale respectively. After completion of his MS Degree he joined as a Lecturer in the same Department and University in 2006. After completion of his lecturer tenure, he got promotion as Assistant Professor in 2008. He has got CEMB-TWAS Postgraduate Fellowship'2008 for his PhD program and he successfully completed his PhD in Molecular Biology in 2014. After completion his PhD he was backed in Bangladesh and joined the same Department and University. He got promotion as Associate Professor in 2014 and Professor in 2018. Now he is working as Professor in the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. He has attended many international seminars, symposiums, workshops, and conferences. He has published many scientific papers in different national and international peer-review indexing and impact factor journals. He is also the editor and reviewer of national and international peer-review journals.