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# *In-Vivo* Management of Purple Blotch of Onion Caused by *Alternaria porri* (Ellis) Cif. through Fungicides

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## Abstract

An experiment was carried out to study the outcome of environmental factors (Temperature, Relative Humidity, Rainfall) and management of the purple blotch disease of onion using five treatments (Rovral + Ridoil gold with 3,4,5,6 sprays and control). The Taherpuri variety was used during the 2015-2016 cropping seasons at BARI, Gazipur, Bangladesh. In the experiment, the purple blotch disease surfaced at the end of January 2016 and was severe in late February to March (PDI 76.12%) due to temperature and RH above 24˚C and 95%, respectively. As for the chemical control, the PDI for the treatments ranged from 50.66% to 83.33%. Significantly higher stem height was recorded by $T_4$ (68.06 cm), where six sprays of Rovral + Ridomil were applied. The minimum stem height was recorded in $T_5$ (59.23 cm). The maximum stem number per hill was recorded in $T_4$ (2.30) numerically but differed significantly with $T_5$ (2.00), where fungicides were not applied. The maximum lesion area was measured in $T_5$ (25.26 mm$^2$). Regarding PDI (Percent disease index), there was a significant difference among the treatments. The PDI value on purple blotch of onion ranged from 34.00 to 83.33. The lowest PDI was assessed in $T_4$ (34.00). Statistical analysis revealed that a significant decrease of PDI on purple blotch was recorded under treatments of $T_1$, $T_2$, $T_3$, and $T_4$ (39.20%, 45.60%, 49.59%, and 59.19%) on controlling the disease and giving the optimum yield but all of them significantly differed with $T_5$ (83.33%) where no fungicides were sprayed.

## Keywords

Purple Blotch, *Alternaria porri*, Fungicides, PDI, Yield

## 1. Introduction

Onion (*Allium cepa* L.) is the most important and familiar spice throughout the world. It is the most common spice in Bangladesh and also used as a popular vegetable. The major onion growing districts of Bangladesh are Faridpur, Cumilla, Dhaka, Dinajpur, Jessore, Pabna, and Rajshahi. Recently Bunching onion (*Allium fistulosum*) is becoming a popular vegetable in Bangladesh. It does not form bulbs but grows in clusters of long white stems [1]. It is an essential vegetable in Australia, Belgium, India, Japan, the United Kingdom, the USA, and some other countries. However, bulb onion is still the most popular here. Onion's current production is around 1.867 MT from 4,59,000 acres of land [2]. In Bangladesh, due to lack of any popular high yielding variety, still, local variety Taherpuri and Faridpurbhatti are commonly grown throughout the country.

A number of diseases are associated with onion crops [3] [4] [5] [6]. Among them, the well-documented disease is onion purple blotch incited by *Alternaria porri* (Ellis) cif. This is noted as a major disease globally, including Bangladesh [5] [6] [7] [8]. In India, the purple blotch of onion is a major devastating and widespread disease and causes severe yield reduction [9]. The disease is also a threat to onion's seed production [10] [11] [12].

The disease is characterized by small water-soaked lesions initially on leaves and seed stalk that quickly develop white centers. As lesions enlarge, they become zonate, brown to purple, surrounded by a yellow zone, and extend upward and downward for some distance. Under the humid condition, the lesion's surface 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 the leaf or seed stalks and tissues, distal to the lesions, will die. Usually, the affected leaves or seed stalks fall and die within four weeks if the environment favors the disease [13].

Damage of foliage and breaking of floral stalks due to purple blotch failing in onion seed production is typical [3]. The disease causes 41% - 44% yield loss in Bangladesh by purple blotch disease. Sharma 1986 [14] reported that the crop's complete failure occurs under favorable environmental conditions, and there will be no seed setting. In India, the disease causes a 20 to 25 percent loss in seed yield [15].

Temperature and humidity are the most predominant factors for the development of purple blotch disease. The disease is favored by moderate temperature (24˚C - 30˚C) and high relative humidity (more than 90%) [10] [16] [17]. So, the present study was undertaken with the following objectives:

1) To determine the role of environmental factors on disease development of purple blotch of onion seed crop.

2) To determine the effect on the number of sprays of Rovral and Ridomil in controlling purple blotch disease of onion seed production.

## 2. Materials and Methods

The experiment was conducted at the Plant Pathology Division, Bangladesh

Agricultural Research Institute, Joydebpur, Gazipur during the 2015-2016 crop season. Two experiments were conducted for full filling the objectives.

### 2.1. Climate

The experimental area was under the sub-tropical climate, characterized by comparatively high rainfall, high humidity, high temperature, and relatively long days from April to September; scanty rainfall, low humidity, and low temperature and short day periods during October to March. The later period was favored for onion cultivation.

### 2.2. Preparation of Soil

The field soil was sandy loam. The land was prepared for good tilth using a tractor driven disc plow rotavator and harrow. Then the soil clods were broken by a hammer. After plowing, the field was left for seven days for sun and air drying. Later, fertilizers were mixed with soil. TSP, MP, Urea, and decomposed cow dung were applied.

### 2.3. Fertilizer Application

The soil was fertilized with Nitrogen (in the form of urea), Phosphorus (in the form of Triple super phosphate-TSP), Potassium (in the form of Muriate of potash-MP), Calcium (in the form of gypsum), Zinc (in the form of zinc oxide) and Boron (in the form of boric acid). Cow dung was applied during land preparation. The whole quantity of TSP, Gypsum, Zinc oxide, boric acid, and one-third of Urea were applied during final land preparation; the rest two-thirds of urea was applied later in two installments (40 and 60 days after planting). Half of the muriate of potash was applied at final land preparation, and the rest half was applied 40 days after planting. Cow dung was incorporated into the soil at 10 tons per hectare during the land opening.

### 2.4. Intercultural Operations (Irrigation, Gap Filling, Weeding, Mulching, and Providing Support)

A total of three times irrigation was done at 30, 60, and 90 days after transplanting by flood method. The dead or sick seedlings were replaced by healthy seedlings within a week after plantation. Border plants also replaced the damaged plants through gap-filling. Weeding and mulching were done when required to keep the crop free from weeds for better soil aeration and conserve soil moisture. Mechanical support was provided in each plot using a bamboo stick to keep the plant erect and to protect them from the damage caused by storm and high winds.

### 2.5. Collection of Data

Data were recorded on lesion area, disease severity, PDI (Percent disease index), stem height, number of stem per hill, umbel diameter, weight of seeds/umbel, weight of seeds per plot, yield per plot was converted into yield per hectare. The lesion area was expressed in millimeters by measuring the length and breadth of the leaves. Disease severity of purple blotch was assessed using a 0 - 5 scale [18], as follows, by selecting ten plants randomly from each plot and used for PDI (percent disease index) estimation.

0 = no disease symptoms

1 = a few spots towards the tip, covering less than 10% leaf area

2 = several dark purplish-brown patches covering less than 20% leaf area

3 = several patches with paler outer zone, covering up to 40% leaf area

4 = long streaks covering up to 75% leaf area or breaking of leaves/stems from the center

5 = complete drying of the leaves/stems or breaking of the leaves/stems from the base

The percent disease index (PDI) was calculated by using the formula given by [19] [20] as follows:

$$\text{PDI} = \frac{\text{Total sum of numerical ratings}}{\text{Number of observation} \times \text{maximum grading}} \times 100$$

Umbel diameter was taken by randomly selecting ten umbels from each replication. The weight of seeds/umbel was assessed by recording a seed weight of 10 umbels per replication.

## 2.6. Harvesting

The crop was harvested within 100 - 125 days after transplanting.

## 2.7. Weather Data

The weather data during the crop period were collected from Bangladesh Metrological Department, Agromet Division, Gazipur.

## 2.8. Studies on the Disease Development of Purple Blotch of Onion

### 2.8.1. Experimental Design and Sowing Procedure

The experiment was laid out following Randomised Complete Block Design (RCBD), having three replications. The unit plot size was 2.1 × 1.2 m. The row to row and bulb to bulb spacing was maintained 30 cm and 15 cm, respectively. Altogether three plots were maintained. The bulb was sown on 30.11.2015. Bulbs of onion variety, Taherpuri were used under the study.

### 2.8.2. Data Collection Procedure

Five plants were selected randomly and tagged. Data on different parameters were initiated just after the onset of the disease symptom in the experimental plot. As many as five observations were taken from 01.02.2016 to 05.03.16 at an interval of eight days (01.02.16, 09.02.16, 17.02.16, 25.02.16, and 05.03.16). The apparent infection rate (“r”) of the disease progression was calculated as follows using the formula as suggested by Vander Plank [15]

$$r = \frac{2.3}{t_2 - t_1} \log 10 \frac{x_2(1 - x_1)}{x_1(1 - x_2)}$$

where $t_1$ and $t_2$ are dates on which disease are estimated and $x_1$ and $x_2$ are the proportion of disease at dates $t_1$ and $t_2$, respectively.

### 2.9. Effect of Spray Number of Rovral and Ridomil in Controlling Purple Blotch Disease of Onion Seed Crop

#### 2.9.1. Fungicides Used

A mixture of Rovral (Iprodione) and Ridomil gold (Metalaxyl) were used at the rate of 2g of each of the fungicides per 1000 ml of water.

#### 2.9.2. Treatments

There were five treatments, as mentioned below:

$T_1$ = 3 sprays of Rovral + Ridomil gold

$T_2$ = 4 sprays of Rovral + Ridomil gold

$T_3$ = 5 sprays of Rovral + Ridomil gold

$T_4$ = 6 sprays of Rovral + Ridomil gold

$T_5$ = Control

In the control treatment, plain water was sprayed. The spray was initiated just after the onset of disease symptoms in the experimental plot. The spray was continued at ten days interval. The desired quantity of fungicides was added in requisite water quantity and ensured well mixing in the spraying machine.

### 2.10. Analysis of Data

Data were analyzed statistically using MSTAT computer Program. Data were transformed, whenever necessary, following Arcsine transformation. Means of treatments were separated using Duncan's Multiple Range Test (DMRT).

## 3. Results

### 3.1. Studies on the Disease Development of Purple Blotch Disease of Onion

During the 2015-16 crop season, the subsequent disease development of purple blotch of onion caused by *Alternaria porri* was assessed at eight days interval on five dates of observations (01. 02. 16, 09. 02. 16, 17. 02. 16, 25. 02. 16 and 05. 03.16). Trace infection of leaf blotch was first detected in experimental plots on 28.01.16. On 01.02.16, 50% of leaves were attacked by the disease, where spots per leaf were counted 7.78. The average lesion area was estimated at 8.44 mm$^2$ per spot, and the PDI (Percent disease index) was calculated 10.61 (Table 1 & Plate 1). After eight days of first observation, that means on 09.02.16, the corresponding values of leaf infection, number spots per leaf, lesion area, and PDI value were recorded respectively, 53.83%, 10.16, 15.60 mm$^2$, and 25.20. The "r" value (apparent infection rate) was estimated 0.0073025/unit/day. At the third observation, more than 60.0% leaf infection was observed with mean spot

**Table 1.** Disease development of purple blotch disease of onion under field condition.

| Date | Leaf infection (%) | No. of spot/leaf | Lesion area ($mm^2$) | PDI | "r" value |
|---|---|---|---|---|---|
| 01.02.16 | 50.00 | 7.78 | 8.44 | 10.61 | - |
| 09.02.16 | 53.83 | 10.16 | 15.60 | 25.20 | 0.0073025 |
| 17.02.16 | 60.73 | 12.79 | 20.15 | 55.36 | 0.0027903 |
| 25.02.16 | 65.50 | 15.67 | 26.33 | 73.64 | 0.0005756 |
| 05.03.16 | 70.57 | 16.99 | 29.66 | 76.12 | 0.0000624 |


Purple blotch disease development on 01.02.16


Purple blotch disease development on 09.02.16


Purple blotch disease development on 25.02.16

**Plate 1.** Purple blotch disease development on onion on different days.

numbers of 12.79, lesion area of 20.15 $mm^2$, and the PDI value was assessed as 55.36. The "r" value, calculated on that observation date, was 0.0027903. Although the diseased parameters on 17.02.16 were higher than 09.02.16, those increasing rate parameters were slower per unit per day. On the fourth observation (25.02.16), the disease progressed to 65.50%, 15.67, 26.33 $mm^2$, and 73.64% were recorded, respectively, for leaf infection, several spots per leaf, lesion diameter, and PDI value. The estimated "r" value 0.0005756 per unit per day was fewer than that of the date of the previous observation 17.02.16. About 70.57% leaf infection, 16.99 numbers of spots per leaf, 29.66 $mm^2$ lesion area, and PDI value of 76.12 were recorded on 05.03.16. The apparent infection rate (r) per unit per day was recorded as only 0.0000624 indicated the disease was very slow in progress compared to immediately previous observation time (25.02.16).

When metrological parameters were considered, it was found that the disease prevailed in the experimental plot when the minimum and the maximum air temperature was 11.21˚C and 24.14˚C, respectively, with relative humidity more than 95% (Table 2). The disease infection's progress continued untilthe last observation (05.03.16), but the infection rate varied among the observation dates. However, the disease infection rate was very fast up to 09.02.16 when the air temperature was a maximum of 25.62˚C, accompanied by 95.71% relative humidity. The disease infection rate gradually declined when the air temperature increased, and relative humidity decreased gradually with succeeding observation dates.

### 3.2. Effect of Spray Number of Rovral and Ridomil in Controlling Purple Blotch Disease of Onion Seed Crop

Results obtained on the effect of spray numbers of Rovral plus Ridomil in controlling purple blotch of onion caused by *Alternaria porri* and yield contributing parameters are presented in **Table 3** and **Table 4**. The sprays were given after the iniciation of purple blotch disease at 10DAS. There were significant differences among the treatments on stem height and the number of stem per hill. Significantly higher stem height was recorded by $T_4$ (68.06 cm), where six sprays of Rovral + Ridomil were applied, and it appeared statistically similar to $T_3$ (five

**Table 2.** Data on climatic factors recorded during the experimental period (January-March 2016).

| Date | Minimum temp. (˚C) | Maximum temp. (˚C) | Minimum R.H. (%) | Maximum R.H. (%) | Rainfall (mm) |
|---|---|---|---|---|---|
| 01.02.16 | 11.21 | 24.14 | 58.00 | 95.14 | 0.00 |
| 09.02.16 | 14.39 | 25.62 | 61.28 | 95.71 | 0.00 |
| 17.02.16 | 12.73 | 27.70 | 65.42 | 92.86 | 0.005 |
| 25.02.16 | 15.04 | 28.64 | 52.57 | 92.29 | 0.001 |
| 05.03.16 | 19.51 | 32.51 | 55.71 | 93.86 | 0.00 |

-Data on each observation indicates the mean value of the preceding seven days.

**Table 3.** Effect of number of spray of Rovral plus Ridomil in controlling purple blotch of onion seed crop at 10 DAS.

| Treatment | Stem ht. (cm) | Stem/hill | Lesion area ($mm^2$) | PDI |
|---|---|---|---|---|
| $T_1$ = 3 Spray | 62.36 bc | 2.10 ab | 21.70 b | 50.66 b (7.11) |
| $T_2$ = 4 Spray | 64.07 ab | 2.30 a | 20.80 b | 45.33 bc (6.73) |
| $T_3$ = 5 Spray | 67.10 a | 2.20 a | 18.53 c | 42.00 c (6.48) |
| $T_4$ = 6 Spray | 68.06 a | 2.30 a | 18.30 c | 34.00 d (5.83) |
| $T_5$ = Control | 59.23 c | 2.00 b | 25.26 a | 83.33 a (9.12) |

-Means bearing the same letter(s) within the same column do not differ significantly at the 5% level following DMRT. -Figures in parenthesis indicate transformed value.

**Table 4.** Effect of spray number of Rovral plus Ridomil on yield contributing characters of the purple blotch of onion seed crop.

| Treatment | Umbel diameter (mm) | Weight of seed (g)/umbel | Seed yield (gram)/plot |
|---|---|---|---|
| $T_1$ = 3 Spray | 52.33 b | 1.13 c | 104.00 c |
| $T_2$ = 4 Spray | 52.50 b | 1.34 b | 120.06 b |
| $T_3$ = 5 Spray | 54.06 b | 1.98 a | 145.90 a |
| $T_4$ = 6 Spray | 58.44 a | 2.14 a | 152.40 a |
| $T_5$ = Control | 52.33 b | 1.00 c | 76.70 d |

-Means bearing the same letter(s) within the same column do not differ significantly at the 5% level following DMRT.

sprays) and $T_2$ (Four sprays) but varied significantly with $T_1$ (three sprays) and control. The effect of the number of spray under $T_2$ was statistically insignificant with $T_1$ but differed significantly with $T_5$. The minimum stem height was recorded in $T_5$, and it was statistically similar to $T_1$. The maximum stem number per hill was recorded under $T_5$ and $T_2$ (2.30). Although the highest number of stem per hill was recorded in $T_4$ numerically, it showed statistically similar to the rest number of fungicide spray schedules but differed significantly with $T_5$, where fungicides were not applied. The number of stem/hill under the treatments $T_1$ and $T_5$ showed a statistically similar effect. The maximum lesion area was measured in $T_5$ (25.26 $mm^2$), and it gradually decreased with the gradual increase of spray number of fungicides. The effects of $T_4$ and $T_3$ on lesion plot were insignificant, but both of them significantly differed from the rest of the treatments, including control. The effects of $T_1$ and $T_2$ on decreasing lesion plot were statistically alike, but they differed significantly with the rest of the treatments.

Regarding PDI (Percent disease index), there was a significant difference among the treatments. The PDI value on leaf blotch of onion ranged from 34.00 to 83.33. The lowest PDI was assessed in $T_4$ (34.00) (**Plate 2**), which was followed by $T_3$ (42.00), $T_2$ (45.33), $T_1$ (50.66), and $T_5$ (83.33). Statistical analysis revealed that a significant decrease of PDI on purple blotch was recorded under treatment, $T_4$, which differed significantly from the rest of the treatments. The effects of $T_3$ and $T_2$ in reducing PDI values were insignificant. Again the effects of $T_2$ and $T_1$ in minimizing the PDI value were statistically insignificant, but all of them significantly differed with $T_5$, where no fungicides were sprayed. About 39.20%, 45.60%, 49.59%, and 59.19% PDI of purple blotch of onion were reduced due to the spray number of Rovral plus Ridomil presented by $T_1$, $T_2$, $T_3$, and $T_4$, respectively (**Figure 1**).

The influence of spray numbers of fungicides on umbel diameter varied from 52.33 - 58.44 mm. Maximum umbel diameters were recorded in $T_4$, which differed significantly from the rest of the treatments. The treatment, $T_3$ (54.00 mm), ranked next to $T_4$, followed by $T_2$ (52.50 mm), $T_1$ (52.33 mm), and $T_5$ (52.33 mm). When those treatments ($T_1$, $T_2$, $T_3$, and $T_5$) were analyzed statistically, it was found that they did not differ significantly among themselves.


(a) (b) (c) (d) (e)

**Plate 2.** Comparative effectiveness of a number of Rovral with Ridomil spray-on purple blotch disease of onion. (a) Control. (b) 3 Spray. (c) 4 Spray. (d) 5 Spray. (e) 6 Spray.

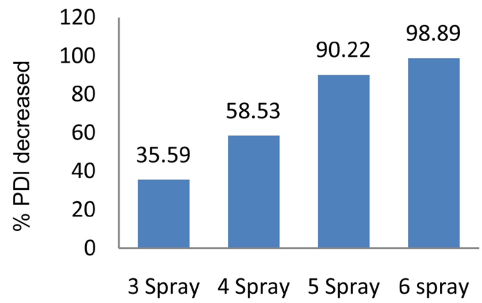


**Figure 1.** PDI decreased over control due to number of Rovral and Ridomil sprays.

The number of seeds per umbel harvested from different treatments that may be arranged in order of descending is $T_4$ (2.14 g), $T_3$ (1.98 g), $T_2$ (1.34 g), $T_1$ (1.13 g), and $T_5$ (1.0 g), respectively. The treatment $T_4$ gave a significantly higher amount of seed per umbel, and it differed significantly from the rest of the treatments except $T_3$. The treatment, $T_3$, produced the second-highest seed yield per umbel, and it differed significantly from all the other treatments. The effect of the treatments under $T_1$ and $T_5$ showed that they are statistically insignificant on the number of seeds per umbel.

The seed yield per plot appeared that it ranged from 76.70 - 152.40 g, with the minimum and the maximum is given respectively by $T_5$ and $T_4$. Although the treatment $T_4$ gave the highest seed yield per plot numerically, it was statistically similar to $T_3$. The treatment, $T_2$, produced the third-highest yield, but it was significantly lower than $T_3$ and $T_4$ and significantly higher compared to those of $T_1$ and $T_5$. The effects of $T_1$ and $T_5$ on seed yield were significantly different. The results showed that the treatment $T_4$ gave the maximum increase (98.69%) followed by $T_3$ (90.22%), $T_2$ (56.53%), and $T_1$ (35.57%) per plot over the control (Figure 2).

## 4. Discussion

The present investigation on disease development of purple blotch of onion caused by *Alternaria porri* revealed that the disease appeared in the last week of January when air temperature rose to more than 24˚C and relative humidity was more than 95%. The disease parameters increased gradually up to the last observation date 05.03.16. However, the disease increase rate was not uniform, and it varied from one observation time to succeeding observation time. The disease progress was found faster on 09.02.16 among the observation dates when the maximum "r" value (apparent infection rate) was estimated at 0.0073025/unit/day. On that day, leaf infection, spot number per leaf, lesion area, and PDI were recorded at 53.83%, 10.16, 15.60 mm$^2$, and 25.20%, respectively. The environmental factors like temperature (25.62˚C) and humidity (95.71%) were congenial. On the next observation (on 09.02.16), the diseased parameters increased steadily but slowly, where PDI's apparent infection rates were calculated as 0.0027903, 0.005756, and 0.0000624 unit/day, respectively, on

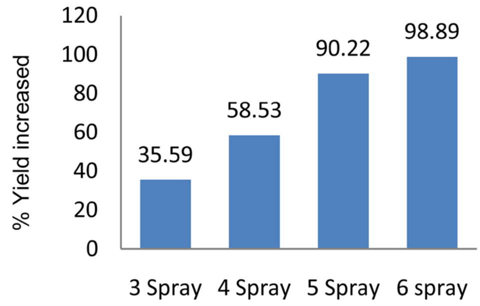


**Figure 2.** Yield increased over control due to number of Rovral and Ridomil sprays.

17.02.16, 25.02.16, and 05.03.16. This might have happened due to the increasing trend of air temperature (>26˚C) and a decreasing trend of relative humidity (<93%) onwards 09.02.16. Many workers worked on the disease development of *Alternaria* spp. Including *A. porri* and reported that 22˚C to 25˚C is the most favorable range of temperature for its germination. Penetration and symptom production of onion, both *in vivo* and *in vitro, was* also reported by the different researchers [16] [17], [21] [22] [23] [24], which was in very close agreement with the present findings. Khare and Nema [22] stated that cent percent spore germination of *A. porri* occurred *in vitro* at 22˚C while the maximum germination occurred at 25˚C on the host surface. According to them, the temperature between 22˚C to 25˚C is the best for leaf blotch disease development in onion. Relative humidity plays a vital role in disease development. Under the study above, 95% relative humidity was found most favorable for leaf blotch, which was in accordance with different scientists [10] [16] [17] [20] [21] [25]. According to Gupta and Pathak [10], inoculated onion plants in 100% relative humidity for 120 hours resulted in the maximum disease severity and the incubation period of *A. porri* in the shortest. Based on five years survey, Srivastava *et al.* [20] opined that the high incidence of a purple blotch of onion occurred when high humidity prevailed.

The investigation on the number of sprays of Rovral plus Ridomil in controlling purple blotch of onion on seed crops revealed that all the treatments reduced the disease parameters significantly and increased the yield contributing factors. Almost in all cases, the treatments, $T_3$ (five sprays) and $T_4$ (six sprays) gave a statistically similar effect in reducing the lesion area, PDI value, umbel diameter, weight of seed/umbel, and seed yield/plot compared to the rest of the treatments. The results obtained in the present study are in close agreement with many researchers who worked with different *Alternaria* spp. and claimed that more than four sprays of fungicides (including Rovral plus Ridomil) were highly influential for onion seed crop in minimizing purple blotch disease of onion [10] [14] [19] [26]-[32]. Sharma [18] 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. Sugha *et al.* [31] 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. Srivastava *et al.* [30] recommended five times fortnightly sprays of 0.25% mancozeb or 0.25% Rovral to control *A. porri* for seed growers in North India.

## 5. Conclusions

An investigation was made on the disease development of purple blotch of onion caused by *Alternaria porri* using onion variety Taherpuri, during 2015-2016 crop seasons at BARI, Gazipur. Five plants from each plot were tagged. Successive purple blotch disease development was recorded from 01.02.16 to 05.03.16 at eight days intervals. Observations were made on 01.02.16, 09.02.16, 17.02.16, 25.02.16 and 05.03.16. Results revealed that the disease appeared in the last week of January when air temperature rose to more than 24˚C and relative humidity to more than 95%. The disease parameters (lesion area, disease severity, PDI, etc.) increased gradually up to 05.03.16. Nevertheless, the rate of disease progress varied significantly among observations. The disease progress was faster on 09.02.16 when the maximum "r" value was estimated at 0.0073025/unit/day when air temperature and humidity were recorded respectively, 25.62˚C and 95.71%.

Another study on the determination of spray numbers for Rovral + Ridomil in controlling purple blotch of onion. There were five treatments viz. $T_1$ = 3 sprays of Rovral + Ridomil, $T_2$ = 4 sprays of Rovral+Ridomil, $T_3$ = 5 sprays of Rovral + Ridomil, $T_4$ = 6 sprays of Rovral + Ridomil and $T_5$ = control. The treatments were replicated thrice. All the treatments significantly reduced disease parameters and increased the yield contributing characters over control. The treatment $T_4$ (6 sprays) and $T_3$ (5 sprays) showed a statistically similar effect in reducing the lesion area, PDI value, umbel diameter, seed weight/umbel, and seed weight/plot compared to the rest of the treatments.

Based on the findings of the present investigation, the following conclusions may be made.

1) Purple blotch disease of onion increased when the air temperature rises more than 25˚C combined with high relative humidity (95%).

2) At least five times spray of Rovral plus Ridomilis needed to minimize the disease incidence of the onion seed crop.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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