



Epidemiological studies on *Stemphylium vesicarium* causing stemphylium blight disease of onion (*Allium cepa*)

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ABSTRACT

The experiment was conducted on epidemiological studies of *Stemphylium vesicarium* (Wallr.) Simmons causing stemphylium blight disease on onion (*Allium cepa* L.) variety Agrifound Light Red during *rabi* (winter) season, 2006-07, 2007-08 and 2008-09 at Research Farm, National Horticultural Research and Development Foundation, Nashik. Data of field studies revealed that stemphylium blight disease appeared during 5th standard week on onion crop under field conditions in consecutively three years in *rabi* season. The data shows a progressive increase and maximum percent disease index (PDI) of stemphylium blight was recorded in the 12th (24.50%), 14th (12.40% and 15th (13.15%) standard weeks during *rabi* season, 2006-07, 2007-08 and 2008-09 respectively. The average temperature ranged from 16.25°C to 22.5°C and relative humidity varied in between 85% to 90% was prevailed during 4th and 5th standard week during all the three years. Disease infection rate (r) lowers at the initial stage but increased progressively under congenial weather conditions. The data under disease progress curve (AUDPC) showed towards the disease pressure being higher in the year, 2006-07 followed by 2008-09 and 2007-08. Stepwise multiple regression equation was drawn for the disease prediction based on the data recorded consecutively three years by taking the average of percent disease index (PDI). The four weather parameters, viz. maximum temperature, minimum temperature, maximum RH and minimum RH were contributed in stemphylium blight disease prediction with 95.95 % precision during *rabi* season, 2006-07. Similarly, all the four weather parameters contributed for disease prediction with 75.56% and 77.33% precision during *rabi* season, 2007-08 and 2008-09 respectively. Thus the present findings can help for onion growers by alerting for prophylactic spray of fungicides to control the stemphylium blight and boost up the production.

Keywords: *Allium cepa*, Epidemiology, Intensity, Onion, PDI, *Stemphylium vesicarium*

Onion (*Allium cepa* L.) is an export oriented important vegetable crop grown in India. Onion is growing round the year in *kharif*, late *kharif* (Rangda) and *rabi* (winter) season particularly in Maharashtra. Stemphylium blight of onion is caused by *Stemphylium vesicarium* (Wallr.) Simmons is worldwide in occurrence and known to be one of the destructive disease of onion in India. Gupta *et al.* (1994) have identified stemphylium blight (*S. vesicarium*) and purple blotch (*A. porri*) as diseases of national importance, whereas, colletotrichum blight was found to be localized in Maharashtra. The typical symptoms of stemphylium blight appears as small yellowish to orange flecks or streaks in the middle of the leaves, which soon develop into enlarged spindle shaped spots surrounded by pinkish margin. These spots turn gray at the centre and later brown to dark brown with the formation of conidia of the pathogen.

Stemphylium blight was first reported by Miller *et al.* (1978) to cause significant damage during 1976, both alone

and in combination with purple blotch (*Alternaria porri*). Stemphylium blight is also a serious problem in northern parts of the state especially in the seed crop (Rao and Pavgi 1973 and 1975). Suheri and Price (2000) reported that *S. vesicarium* was potentially important pathogen of winter (*Rabi* season) grown *Allium* crops. Among the various disease and disorders, foliar blight of onion has emerged as a major bottleneck in achieving the full genetic potential of the crop (Shahnaz *et al.* 2007). The field study was carried out at Nashik, Maharashtra which is situated at 20° N latitude, 73° E longitude and altitude approximate 492 meters above mean sea level. The relationship between infection, incidence and disease development with weather parameters is of paramount importance for effective disease management especially foliar diseases especially stemphylium blight of onion. Keeping in view the importance of the crop and economic losses in onion bulb yield caused by stemphylium blight disease. Moreover not much studies on epidemiological aspects have been reported on stemphylium blight disease. Therefore, the present experiment was undertaken on epidemiological studies of

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Stemphylium vesicarium causing stemphylium blight disease of onion in Nashik, Maharashtra.

MATERIALS AND METHODS

The present study was conducted in Research Farm, Regional Research Station, Chitegaon Phata, National Horticultural Research and Development Foundation, Nashik (Maharashtra) which is situated at 20° N latitude, 73° E longitude and altitude approximate 492 meters above mean sea level. The trial was conducted consecutively 3 years during *rabi* season, 2006-07, 2007-08 and 2008-09 with selected onion variety Agrifound Light Red for stemphylium blight occurrences, incidence and disease progress under field conditions. The selected onion variety grown in a plot size of 3.6 m × 1.8 m, and a total of 9 plots were transplanted with spacing of 15 cm × 10 cm. The 8 weeks old seedlings were transplanted on 15.12.2006, 23.12.2007 and 30.12.2008 in the plots in *rabi* season in continuous three years respectively. The recommended agronomical practices were uniformly followed as per schedule. No fungicides were sprayed in the trial plots and the plants were allowed to infection under natural epiphytotic conditions for stemphylium blight disease. Deltamethrin @ 0.1 % was sprayed at 15 days intervals in the trial plots for the control of onion thrips. The ten plants were randomly selected in each plots and tagged for recording the data on occurrence, disease incidence and development under natural epiphytotic conditions. The observations of stemphylium blight disease incidence and intensity were recorded daily for the appearance of first symptoms and subsequently at weekly intervals. Disease scoring was made on 0-5 scale (Sharma 1986) and percent disease index (PDI) was estimated according to the formula given by Wheeler (1969) as follows:

Disease scoring was done on a 0-5 scale:

where 0, no disease symptoms; 1, a few spots towards the tip, covering less than 10 % leaf area; 2, several dark brown patches covering less than 20% leaf area; 3, large patches with paler outer zone, covering up to 40% leaf area; 4, long streaks covering up to 75% leaf area or breaking of leaves from the centre; 5, complete drying of the leaves or breaking of the leaves from the base.

$$\text{Percent Disease Index (PDI)} = \frac{\text{Total sum of numerical ratings} \times 100}{\text{Number of observations} \times \text{Maximum disease rating}}$$

Average infection rate (r) was calculated by the formula given below:

$$r = \frac{1}{t_2 - t_1} \log_e \frac{x_2}{x_1}$$

where t_2 is time at regular intervals of disease intensity recorded, t_1 time at first disease intensity recorded, x_2 is disease severity at time t_2 and x_1 is disease severity at time t_1 .

AUDPC is calculated by the Trapezoidal method as described below:

$$A_k = \sum_{i=1}^{N_i-1} \frac{(y_i + y_{i+1})}{2} (t_{i+1} - t_i)$$

The correlation between disease severity and between other individual weather factors were drawn and the regression coefficient of these factors were worked out using multiple least square method by following equation, $Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + u$, where, Y is the disease severity and is dependent variables, x_1 is maximum temperature, x_2 is minimum temperature, x_3 is maximum relative humidity, x_4 is minimum relative humidity- all are weather parameters and independent variable, a is the intercept, b_1 to b_4 are regression coefficient and u is error term.

The weather parameters on temperature (°C), relative humidity (%) and rainfall (mm) were recorded from the Automatic Meteorological Station established at Research Complex, Regional Research Station, Chitegaon Phata, National Horticultural Research and Development Foundation, Nashik. The average of all the weather parameters during each standard weeks were considered while calculating their effect on stemphylium blight disease intensity in terms of regression and correlation analysis. In order to analyzed the regression coefficient, maximum temperature, minimum temperature, maximum relative humidity and minimum relative humidity were denoted as X_1 , X_2 , X_3 and X_4 respectively.

RESULTS AND DISCUSSION

Intensity of stemphylium vesicarium and weather parameters

A perusal of the data recorded during *rabi* season 2006-07, 2007-08 and 2008-09 revealed that stemphylium blight disease was recorded in the consecutive three years in onion crop under natural epiphytotic conditions. The initiation of infection of stemphylium blight disease on onion bulb crop was first noticed on 5 February 2007 with disease intensity (0.22%), 2 February 2008 (0.26%) and 31 January 2009 (0.53%) comes under the 5 standard week during *rabi* season for consecutively three years. The climatic conditions were favorable for the infection of stemphylium blight disease during early stage of onion crop (Fig 1 and Fig 2).

The data presented in Fig 1 showed that the symptoms of stemphylium blight disease infection in onion first recorded in numerical on 5 February, 2007 during 5 standard week with disease intensity (0.22%) in *rabi* season, 2006-07. The climatic conditions are congenial for the infection and development of stemphylium blight disease in onion during 4th week. The temperature ranged from 11.5-30°C with mean of 20.75°C as well as high relative humidity (89.0%) was appears in the climate during 5th standard week in *rabi* season, 2006-07 (Fig 2). The disease progresses as increasing the age of the crop and highest disease intensity (24.5 %) was recorded in 12th standard week.

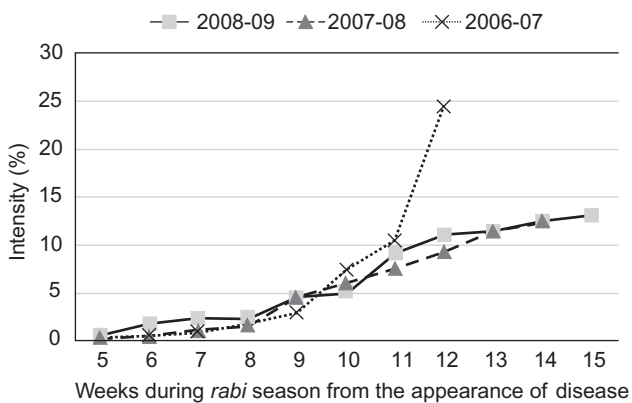


Fig 1 Intensity (Percent disease index) of stemphylium blight during rabi season, 2006–07, 2007–08 and 2008–09

Jakhar *et al.* (1996) conducted epidemiological trial and reported that the disease intensity of stemphylium blight in onion seed crop increased from 5.2 % to 22.4 %, when the mean temperature was moderate ranged from 16.1-24.6°C and relative humidity varied between 78-91%. The disease symptoms of stemphylium blight on garlic leaves develops, where temperature ranged from 22-26°C (Boiteux *et al.* 1994).

The perusal of the data recorded on stemphylium blight in onion during rabi season, 2007-08 revealed that the disease first noticed on 28.01.2008 in trace during 4th week. The intensity (0.26 %) of stemphylium blight was recorded on 5.02.2008 during 5th standard week (Fig 1). The incidence and intensity of disease increases as increasing the crop age with highest disease intensity, i.e. 12.4 was recorded at 14th week in onion crop. The congenial temperature and relative humidity prevailing which favors the infection of *Stemphylium vesicarium* in onion during 4th standard week in rabi season. The climatic conditions were congenial with temperature varied between 4.5°C-28°C as well as mean temperature of 16.25°C and high relative humidity (85%)

prevailing during 5th standard week in rabi season, 2007-08.

Data presented in Fig 1 revealed that stemphylium blight disease appears during 5th standard week on onion in consecutively 3rd year under field conditions in rabi season, 2008-09. The intensity (0.53 %) of stemphylium blight in onion was recorded on 31.01.2009 during 5th standard week. The favorable climatic conditions were also prevailed during 3rd, 4th and 5th standard week for infection and development of stemphylium blight disease. The temperature ranged from 13-32°C with mean of 22.5°C as well as appear high relative humidity (90%) during 5th standard week in rabi season, 2008-09. The disease progresses as increasing the crop age. The highest intensity 13.15 % was recorded at 15 standard week in onion (Fig 1).

Infection rate

The stemphylium blight disease infection rate in generally increased during the start of natural epiphytotic from 6th to 13th weeks in the year, 2006-07 (Fig 3). It may be attributed to the weather factors (2) which favor the disease development, wherein relative humidity remained high ranging from 70 to 90% as well as temperature ranged from 27.6°C to 35.8°C with mean temperature varied between 18.3°C to 24.9°C. However, sharp decline in the disease infection rate was recorded from 13th weeks. As there was at and after 13th weeks, prevailing high temperature increases upto 38.7°C and lowering the relative humidity, i.e. 62%.

The disease infection rate in generally increased during the 9th week and then slightly decline after 9th week in the year, 2007-08 (Fig 3). The infection rate almost remain constant from 10 weeks to 13th week and steep decline was recorded at 14 weeks. During the cropping period the temperature and relative humidity fluctuating with slightly up and down in the rabi season, 2007-08.

Disease infection rate increased during the start of

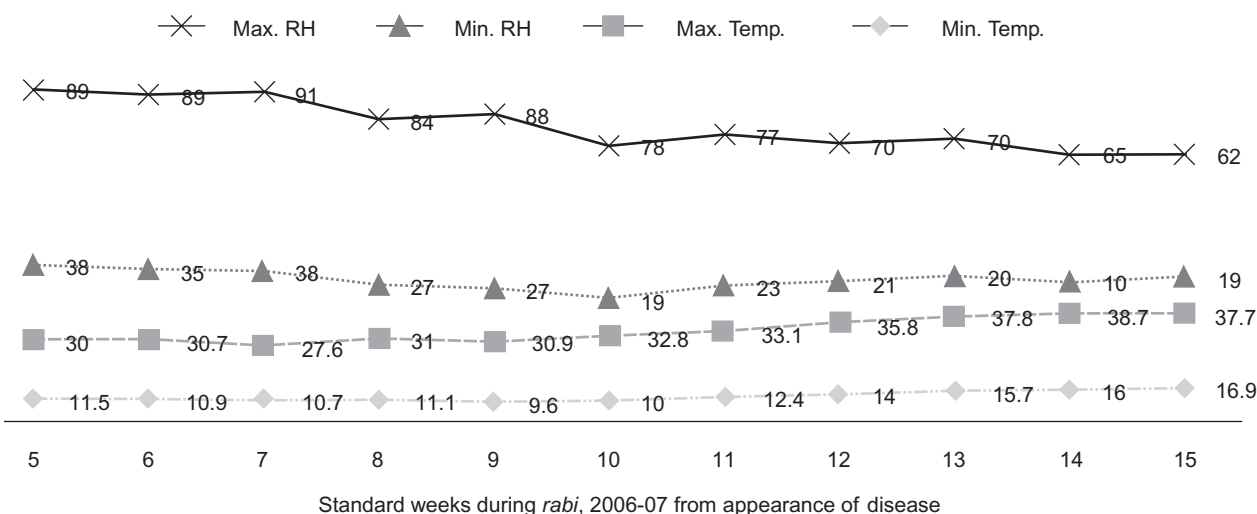


Fig 2 Maximum temperature, minimum temperature (°C), maximum relative humidity and minimum relative humidity (%) during rabi, 2006-07

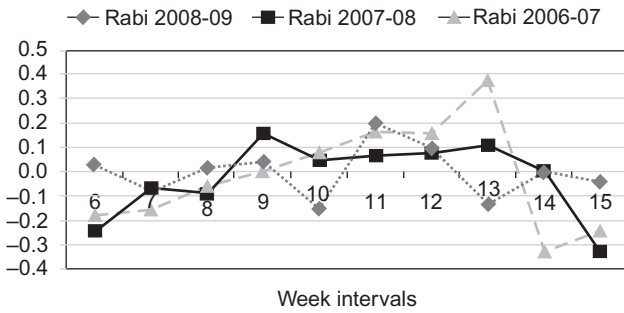


Fig 3 Infection rate of stemphylium blight for rabi 2006-07, 2007-08 and 2008-09

natural epiphytotic from 6th to 9th weeks in the year, 2008-09 (Fig 3). It could be attributed to the weather factors which were congenial for the disease development, wherein relative humidity remained high ranging from 76 to 95% as well as temperature ranged from 27.2°C to 35.7°C with mean temperature varied between 18.7°C to 25.0°C. However, steep decline in the infection rate was recorded from 10th week (Fig 3). As there was at 9th and 10th weeks, the temperature increases and ranged from 35.7°C to 36.3°C and low relative humidity, i.e. 50 %. However, after 10th week there was increase infection rate at 11th week (Fig 3), because of increasing the RH and simultaneously slightly decreasing the temperature, further decline was recorded in infection rate due to decreasing of RH and increasing the temperature.

Area Under Disease Progressive Curve (AUDPC)

The area under the disease progressive curve (AUDPC) is a useful quantitative summary of disease intensity over time for comparison across years. The most commonly used method for estimating the AUDPC, the trapezoidal method, is to discretize the time variable (Weeks) and calculate the average disease intensity between each pair of adjacent time points. After calculating the Area Under Disease Progressive Curve (AUDPC) to quantify disease progress (Fig 4), it was observed that the stemphylium blight disease pressure was more in the rabi season, 2006-07 (622.6) followed 2008-09 (476.42) and 2007-08 (423.85). Which may be attributed to the fact that overall relative humidity (RH) remained higher during the cropping season in rabi, 2006-07. The weather factors (Fig 2) which favor

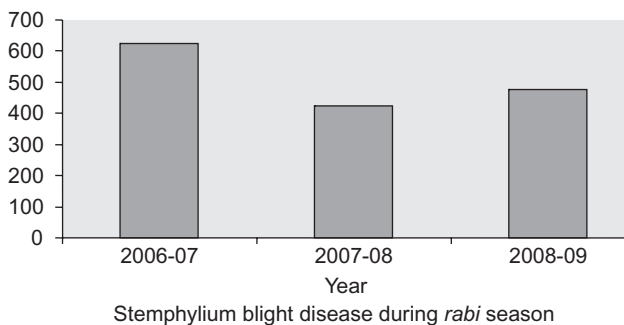


Fig 4 Area Under Disease Progressive Curve (AUDPC) of stemphylium blight disease during rabi season

Table 1 Stepwise multiple regression equation for prediction of stemphylium blight severity during rabi season, 2006-07, 2007-08 and 2008-09

Prediction equation	R ² (%)
<i>Year 2006-07</i>	
Y = -103.908 + 0.0953X ₁ + 5.085X ₂ + 0.902X ₃ - 0.971X ₄	95.95
Y = -77.683 + 1.581X ₁ + 2.113X ₂ + 0.097X ₃	94.03
Y = -67.742 + 1.357X ₁ + 2.046X ₂	93.97
Y = -56.566 + 2.480X ₁ - 0.354X ₃ - 0.430X ₄	91.21
Y = -52.466 + 2.218X ₁ - 0.154X ₃	88.80
<i>Year 2007-08</i>	
Y = -33.931 + 0.337X ₁ + 0.708X ₂ + 0.281X ₃ - 0.029X ₄	75.56
Y = -38.511 + 0.393X ₁ + 0.722X ₂ + 0.306X ₃	75.35
Y = -4.018 + 0.072X ₁ + 0.604X ₂	66.54
Y = -20.450 + 0.735X ₁ + 0.069X ₃ - 0.099X ₄	49.57
Y = -35.881 + 0.961X ₁ + 0.144X ₃	46.95
<i>Year 2008-09</i>	
Y = -4.647 + 0.112X ₁ + 0.870X ₂ - 0.055X ₃ - 0.063X ₄	77.33
Y = -9.178 + 0.217X ₁ + 0.876X ₂ - 0.066X ₃	77.14
Y = -19.667 + 0.324X ₁ + 1.010X ₂	74.64
Y = -14.731 + 0.851X ₁ - 0.085X ₃ - 0.083X ₄	69.11
Y = -20.859 + 0.997X ₁ - 0.099X ₃	68.78

X₁, Maximum temperature (°C); X₂, Minimum temperature (°C); X₃, Maximum Relative humidity (%); X₄, Minimum Relative humidity (%)

the disease development , wherein relative humidity ranging from 70 to 90 % as well as mean temperature varied between 18.3°C to 24.9°C.

Multiple regression equation for prediction of stemphylium blight

Stepwise multiple regression equation drawn for the prediction of stemphylium blight disease on the basis of mean data collected for all the three seasons by taking the overall mean of the percent disease index during rabi season, 2006-07, 2007-08 and 2008-09. The data indicates that in the rabi season, 2006-07 four weather parameters, viz. maximum temperature, minimum temperature, minimum relative humidity and maximum relative humidity contributed in stemphylium blight disease prediction with 95.95% precession (Table 1) while, two weather parameters, viz. maximum temperature and maximum relative humidity explained 88.80% variability, whereas maximum temperature and minimum temperature shows 93.97% variability. Similarly, in the four above weather parameters contributed disease prediction with 75.56% in 2007-08 and disease prediction with 77.33% precession in rabi season, 2008-09.

CONCLUSION

In this paper, the experiment was conducted on epidemiological studies of *Stemphylium vesicarium* causing stemphylium blight disease of onion to understanding the

nature of disease correlation of weather parameters. The field observation data collected from the study site revealed that stemphylium blight disease appeared during 5th standard week on onion crop under field conditions in consecutively three years in *rabi* season under natural epiphytotic condition where temperature ranged from 16.25°C to 22.5°C and relative humidity varied in between 85% to 90% which favors the infection and disease development. The maximum percent disease index (PDI) of stemphylium blight was recorded in the 12th (24.50%), 14th (12.40% and 15th (13.15%) standard weeks during *rabi* season, 2006-07, 2007-08 and 2008-09 respectively. The four weather parameters, viz. maximum temperature, minimum temperature, maximum RH and minimum RH was contributed in stemphylium blight disease prediction. Thus the present findings can help for onion growers by alerting for prophylactic spray of fungicides to check the infection of stemphylium blight disease and boost up the production of onion but also minimizes the use of pesticides.

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