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Aerobiology of air borne conidia of *Alternaria raphani* over the crop canopy of radish under field condition

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Movement of aerial spores of *Altemaria raphani* were trapped from sampled air over crop canopy of radish during growing season of 2006-07 and 2008-09.Spore depositions were counted and stepwise multiple regression was used to indentify the important meteorological variables from maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, rainfall, wind velocity, dew deposition and sunshine hours to predict the movement of air borne conidia of *Altemaria raphani* over the radish crop during the cropping season. It was observed that spore deposition was positively correlated with maximum temperature, minimum relative humidity and daily sunshine hours. Air borne spore of *Altemaria raphani* was maximum with increase in the temperature of 32°C, minimum relative humidity 60.0% and daily sunshine hours 4. The prediction equation of movement of air borne conidia of *Altemaria raphani* was y = (-) 95.28 + 2.773 T max + 0.331 RH min + 1.746 sunshine hour (R^2 = 0.9685) and in case of viable conidia deposition y = 112.513 - 0.699 T diff - 0.272 RH min + 0.511 Rh diff + 0.966 rainy days (R^2 = 0.89).

Key words : Aerobiology, conidia, *Altemaria raphani,* radish field

INTRODUCTION

Leaf blight of radish (*Raphanus sativus* L.) caused by *Alternaria raphani* is one of the most serious disease particularly for seed production. It also reduces the seed germinability. The disease appears on leaves and later spread to the seed stalks and seed pods. So, the study of aerobiology and spread of spores is important for fore-warning of disease appearance and reduction of maximum loss during seed production.

The role of aerobiology in plant pathology becomes significant when air borne organisms are involved in the disease development and require identification, enumeration, assessment of predictability of behavior, mode and time of reaching their host,causing infection, surviving and causing epidemic (Hirst, 1991). The aerobiology of leaf i.e. foliar bisease has not received due attention, though it is an important factor for epidemic of this disease. Because of the paucity of aerobiological information of newly important disease like foliar blight caused by *Alternaria raphani,* this experiment has been carried out to correlate the significance of the conidia, which are an important source of primary inoculum, with meteorological parameter

MATERIALS AND METHODS

The field experiment was conducted at the BCKV Instructional Farm, Jaguli, Mohanpur for consecutive two years, 2007 and 2008. The radish cultivar 'Kalyani white' was sown in the 1st week of December (5:12.2007) each year following normal agronomic practices. The plot size was 5 x 10 m. Randomized block design was followed using three replications. Seeds were sown on the ridges 45 cm apart (row to row) and plant thinned out to keep them at a distance of 6-8 cm for consumable purpose. The plant to plant distance was increased up to 25 cm in a row for seed production. The seed stalks appeared between 100-110 days.

Conidia were trapped using a rotatory sampler on ball bearing which was movable with air currents (Das, 1992). The trap was designed to hold a single slide. The trap rotated according to the wind direction and velocity. One trap was placed in the centre of the plot while nine other traps were placed in different places of the square field plots (920 m²), with their trapping surfaces at the same level just above the crop canopy. The slides on the spore traps, coated with cellophane strips, were changed regularly at 7 am and 5 pm daily after an exposure period of 24 hrs each.

In the laboratory, the conidia were counted and 10 observations per slide were recorded and computed into a number of spore/mm^2. The conidia were then washed in a sterile distilled water and inoculated on to PDA Petri plates and incubated at 25 ± 1°C in a B.O.D. incubator for two days. The germinated conidia were counted and its percentage calculated. The different meteorological factors like maximum and minimum temperature, maximum and minimum relative humidity, rainy days, wind velocity, dew deposition and sunshine hours were monitored from a meteorological observatory near the experimental field. The data were then analyzed for MRA (Multiple Regression Analysis) and correlation matrix was done to find out the relationship. A comparison was done with the predicted and observed value of conidia to obtain the viable prediction equation.

RESULTS AND DISCUSSION

Movement and deposition of conidia of *Alternaria rephani* was found to depend on the different meteorological factors such as temperature, relative humidity, total rainy days, dew deposition, wind velocity and sunshine hours. Effect of individual factors on conidia count over crop canopy was assessed. Two years pooled mean data showed that the conidia were present in the air in high numbers between the 1st week of March to July, when the temperature attained a maximum of 30-35C° and minimum of 20-23°C, maximum relative humidity of 92-95% and a minimum between 40-65%, sunshine hours of 4 hrs/day and a wind velocity 3-5 km/hr. The data were then sujected to multiple regression analysis (7 days average of spores and meteorological data). This analysis was done to find out the statistical correlation between conidia lodging and meteorological parameters.

The two years pooled data analysed for multiple regression analysis and correlation matrix showed a positive correlation between conidia lodging over crop canopy and maximum temperature (ryx_1 = 0.943), minimum temperature (ryx_2 = 0.944) and wind velocity (ryx_9 = 0.801) whereas differnce in temperature (ryx_3 = (-)0.641)and maximum relative humidity (ryx_4 = (-) 0.387) were negatively correlated. Other meteorological parameters like maximum and minimum relative humidity, number of rainy days and sunshine hours were found to have no correlation with conidial numbers trapped over crop canopy. Maximum temperature, however, interacted positively with minimum temperature and wind velocity but negatively with difference in temperature and maximum relative humidity. Similarly negative correlation was observed with all the factors mentioned above except wind velocity in case of minimum tempeture. The difference in temperature was positively correlated with maximum relative humidity where as negatively correlated with minimum relative humidity, number of rainy days and wind velocity. On the other hand the negative correlation of dew deposition did not interact statistically with wind velocity and sunshine hours, where as it positively correlated with wind velocity and interacted positively with sunshine hours. Mini

Table 1 : Correlation matrix of *Alternaria* conidia count with abiotic factors

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
Y	0.943	0.944**	-0.641**	-0.387**	0.120	-0.028	0.047	-0227	0.801**	0.333
T. Max (X_1)	1.000									
T. Min (X_2)	0.958	1.000								
Diff. Temp(X_3)	-0.557	-0.771	1.000							
Rh Max (X_4)	-0.396	-0.442	0.402	1.000						
Rh Min (X_5)	-0.273	-0.071	-0.401	0.146	1.000					
Diff.Rh (X_6)	0.118	-0.097	0.545	0.234	-0.928	1.000				
Rainy days (X_7)	-0.008	0.163	-0.490	-0.061	0.601	-0.613	1.000			
Dew (X_8)	-0.253	-0.195	0.005	-0.033	0.138	-0.148	0.153	1.000		
Wind (X_9)	0.761	0.760	-0.513	-0.464	-0.170	-0.008	0.164	-0.088	1.000	
Sun shine (X_{10})	0.244	0.112	0.220	0.023	-0.404	0.406	-0.191	0.189	0.385	1.000

Table 2: Correlation matrix of viable *Alternaria* conidia lodging with meteorological factors.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
Y	0.162	0.296	-0.501**	-0.280	0.449**	-0.547**	0.485**	0.335	0.220	-0.176
T. Max (X_1)	1.000									
T. Min (X_2)	0.958	1.000								
Diff. Temp(X_3)	-0.557	-0.771	1.000							
Rh Max (X_4)	-0.396	-0.442	0.402	1.000						
Rh Min (X_5)	-0.273	-0.071	-0.401	0.146	1.000					
Diff.Rh (X_6)	0.118	-0.097	0.545	0.234	-0.928	1.000				
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Sun shine (X_{10})	0.244	0.112	0.220	0.023	-0.404	0.406	-0.191	0.189	0.385	1.000

Correlation coefficient > 0.349 are significant at 5% level of significance
Correlation coefficient > 0.449 are significant at 1% level of significance

Table 3 : Daily mean concentration of observed and predicted no. of conidia deposited on slides through predicition equation

Month	Observed		Predicted		Prediction eduation of spore lodging
	2007-08	2008-09	2007-08	2008-09	
December	1.10	0.90	1.15	1.10	
January	1.50	1.12	1.60	1.20	
February	1.65	2.08	2.30	2.26	
March	5.75	6.20	5.90	6.60	Y =95.28+2.773x_1+0.331x_4+ 1.746x_8(R^2=0 9685)
April	7.60	8.15	6.10	7.25	Viable spore lodging 112.51-0.699 T. diff 0.272
May	9.20	8.75	8.60	9.00	RH min +0.511 RH diff. +0.966 rainy (R^2=0.388)
June	8.65	9.60	8.90	10.00	
July	6.60	7.75	5.85	8.15	

mum relative humidity was positively correlated with number of rainy days and negatively correlated with difference in relative humidity and sunshine hours. These observations were strongly supported by a very high co-efficient determination R^2 = 0.925 (Table 1).

Successful infection and disease development need the conidia present in the air to survive. So, the conidia which were trapped were also tested for their viability. Multiple correlation was done with meteorological factors and per cent of viable number of conidia present in the air (Table2). It was observed that viable number of conidia deposited on slide positively correlated with minimum temperature (r_yx_2 = 0.296) and wind velocity (ryx_9 = 0.220) and negatively correlated with difference in temperature (r_yx_3 = (-) 0.501). Here also maximum temperature positively corrlated with minimum temperature and wind velocity and negative correlated with differrence in temperature and maximum relative humidity. Negative correlation of all the stated factors compounded each other particularly the difference in temperature and maximum relative humidity except wind velocity in case of minimum temperature.Some other factors also positively and negative interacted with each other in determining the viable conidia load. So the factors like minimum temperature, difference in temperature,wind velocity interacted with each other in determining the viable conidia load. R^2 value (0.89) confirmed the above observation.

The best prediction equation from the multiple regression function with different meteorological parameters over the two years was obtained from the step down equation considering all the ten factors under test and the most suited prediction equations of the most suited prediction equations of the conidia lodging were $y = (-)\ 95.28 + 2773x_1 + 0.331x_4 + 1.476x_8$ ($R^2 = 0.9685$) and in case of viable conidia deposition $y = 112.513 - 0.699 - 0.272 + 0.966$ ($R^2 = 0.89$).

The linear regression equation between conidia lodging (observed prediction) with temperature (maximum and minimum and their difference), dew deposition and wind velocity were also done and it was found that they were positively correlated individually. However, when observed conidia lodging and predicted or expected conidia lodging were compared, it was found that the prediction equation provided the best model as they matched very well with actual data. This result also confirmed by high R^2 values (Fig1).The viable conidia which were lodged in the slides also showed the same pattern as earlier and the regression equation between observation and predicted or expected viable conidia with minimum temperatures, temperature difference, relative humidity and wind velocity was also confirmed by high R^2 values (Fig. 2).

Thus multi-colinearity was apparent in determining the conidia load over the crop canopy. In many fungi diurnal periodicity appears to be a result of the effect of environmental conditions in triggening spore release mechanisms (Hirst, 1953). Hirst also stated that changes in wind velocity, temperature, humidity, sunshine, rainfall or dew were clearly responsible for some modifications of diurnal periodicity of air spores. Ali and Ahmad (1992) reported that relative humidity was negatively correlated with prevalence of air borne conidia. Wind velocity had an important role in conidia deposition as dislodging of conidia from the conidiophores with air turbulence and dissemination and deposition was higher (Hjelmroos, 1993). It was also observed that in case of *Alternaria triticina* conidia that deposition increases abruptly during the monty of March i.e during the later stages of crop growth. Marchegay *et al.*(1990) confirmed this observation. Prabhu and Prasad(1966) reported that the susceptibility of wheat plants to *Alternaria triticina* increased with the age of the crop. This observation was also confirmed in the present investigation. Thus from the present work, it was observed that correlation and changes of conidia load with different weather parameters recorded above the crop canopy can provide useful information about the epidemiology and spread of the disease. This study also indicated that the factors controlled the fluctuations of conidia load over the crop canopy of radish.

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