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AREA UNDER DISEASE PROGRESS CURVE AND INFLUENCE ABIOTIC FACTORS ON WILT OF POMEGRANATE

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ABSTRACT
Wilt of pomegranate caused by *Ceratocystis fimbriata*is the most destructive disease in pomegranate growing areas of the world. The field experiment was conducted in fixed plot to know the AUDPC,apparent rate of infection (r) and influence of weather factors on disease incidence. The per cent disease incidence was 10.00 in the month of October 2015 and it reached 82.50 at the end of September 2016. As the per cent disease increased the apparent rate of infection (r) value was also increased from 0.080 to 0.130. The area under disease progress curve reached 142.50 at the end of September 2016. The weather data collected during the experiment was subject to multiple regression and step wise multiple regression analysis.The data revealed that weather parameters influence R^2 value of 44.00 per cent on per cent disease incidence. Step wise multiple regression analysis showed that among the weather parameters maximum variation was explained by rainfall (30.66 %).

INTRODUCTION

Pomegranate (*Punicagranatum* Linnaeus.) called as "Fruit of paradise" is an ancient fruit belonging to the family Lythraceae. In India, pomegranate crop is being cultivated over an area of 143 thousand hectare with production of 1774 thousand tonneswith an average productivity of 10.75 tonnes/ha (Anonymous, 2015).It is one of the most adaptable subtropical minor fruit crop and its cultivation is increasing very rapidly. The fruit is very much liked for its cool and refreshing juice. The arils of the well matured fruit are consumed as such and also in processed form like juice or concentrate, syrup and jelly. The fresh juice contains moisture, total sugar, pectin, carbohydrate, acidity (as citric acid), minerals like calcium, phosphorus, iron, magnesium and vitamins (Dutta ray *et al.,* 2014).Seeds with fleshy portions of sour pomegranates are dried and marketed as 'Anardana', which is used as a condiment and for souring curries.However, pomegranate cultivation is facing several constraints and among them wilt caused by *Ceratocystis fimbriata* Ellis and Halst.is a major tailback in its successful cultivation.At present, the crop is severely affected by wilt pathogen and day by day the disease is increasing at faster rate. It was first noticed in two areas of the Vijayapura district of Karnataka, India in 1990 around 1993, rapid spread of this disease was observed in the entire Vijayapura district. The cause was not identified until 1995. In 1996, the fungus *C.fimbriata* was isolated from discolored stem, root and branch tissues on wilted plants. Disease is characterized by the initial symptoms *viz.,* yellowing and wilting of leaves on one to several branches leading to death of affected plants in a few weeks. Cross sections of diseased plants revealed brown discoloration in the outer xylem from roots to the main trunk (Somasekhara and Wali, 1999). The work pertaining to spread of the disease and influence of weather parameters on wilt of pomegranate has not been studied. At present there is a need to know about rate of spread of the disease and which is the foremost weather parameter influence for the per cent disease incidence. Hence the present study was aimed to know the AUDPC, apparent rate of infection and influence of weather factors on wilt of pomegranate.

MATERIALS AND METHODS

An experiment was carried out during 2014-16 at Department of Plant Pathology College of Horticulture, Bagalkot. The field experiment was planned at farmers to know area under disease progress curve, apparent rate of infection and influence of abiotic factors on wilt of pomegranate.

Area under Disease Progress Curve (AUDPC) of wilt of pomegranate

For the calculation of AUDPC the per cent disease incidence of *C. fimbriata* was recorded at fifteen days interval in farmer's field at Govindakoppa village of Bagalkot taluk during October 2015 to September 2016. The area under disease progress curve was calculated using the equation given by Shanner and Finney (1977).

$$AUDPC = \sum_{i}^{n-1} (y_i + y_{i+1}/2)\ (t_{i+1} - t_i)$$

where y*i* is the percent disease incidence (PDI) observed for the i^{th} treatment, *ti* is the date of the observation and observations were made on *n* dates.

The apparent rate of infection 'r' at different intervals was calculated by using the formula given by Van der Plank (1963), r value is calculated by using the equation

$$r = \frac{1}{t_2 - t_1} \log e \frac{X_2 (1 - X_1)}{X_1 (1 - X_2)}$$

Where, t is time interval, x is the values of PDI and the loge is written as Inverse (IN)

Influence of abiotic factors on disease development of *C. fimbriata* with multiple and step wise regression models

The per cent disease incidence of *C. fimbriata* was recoded at fifteen days interval from October 2105 to September 2016. The monthly meteorological data on weather parameters *viz.,* rainfall (mm), maximum and minimum temperature (^{0}C) and relative humidity (%) were obtained from the Agro meteorological observatory of Main Horticulture Research and Extension Center (MHREC), UHS, Bagalkot, Karnataka.

The data on per cent disease incidence were subjected to multiple regression with various abiotic factors to know the overall influence of abiotic factor on per cent disease incidence. Step wise regression was carried out to see the per cent role of each abiotic factor on per cent disease incidence (Pearson, 1896).

RESULTS AND DISCUSSION

Area under Disease Progress Curve (AUDPC) of wilt of pomegranate

For the calculation of AUDPC the per cent disease incidence was recorded in a fixed plot at every month for one year. The data is presented in Table 1.

The data from the Table 1 and Fig 1 revealed that the per cent disease incidence of wilt was increased over time. The result indicated that the per cent disease incidence was 10.00 in the month of October, 17.50 in the month of November and 22.50 in the month of December 2015. During January 2016 the disease incidence was increased to 25.00 per cent. In the month of February it was 30.00 per cent, in March it was 37.50 per cent, whereas in April it was observed 42.50 per cent. During the month of May the disease incidence reached to 50.00 per cent. During June, July and August months the per cent disease incidence was recorded 62.50, 70.00 and 77.50, respectively. In the month of September the disease incidence reached to 82.50 per cent.

The AUDPC value was calculated by using the formula as explained in "Material and Methods" by using the values of per cent disease incidence in different time intervals and presented in Table 1. The result indicated that the AUDPC value was 112.50 in the month of October, 75.00 in the month of November and 37.50 in the month of December 2015 respectively. During 2016 January the AUDPC value was 75.00. In the month of February it was 112.50, in March it was 75.00, whereas in April it was observed 112.50. During the month of May the AUDPC value reached to 187.50. During June, July and August months the AUDPC value was 112.50, 112.50 and 75.00 respectively. In the month of September the AUDPC value reached to 142.50 per cent.

The apparent rate of infection 'r' value was calculated by using the formula as explained in "Material and Methods" and presented in Table 1 and Fig. 2. The 'r' value recorded 0.080 in the month of October, 0.088 and 0.091 in the month of November and December of 2015 respectively. In January 2016 the 'r' value was 0.097393, in February it was 0.104053, in March it recorded 0.107, and in April it was 0.112628. During the month of May the apparent rate of infection 'r' value was reached to 0.119199. During June, July and August months the 'r' was recorded 0.122, 0.125 and 0.127 respectively. In the month of September the apparent rate of infection 'r' value reached to 0.130.

The data revealed that during the year 2015-16 the per cent disease incidence of *C. fimbriata* was ranged from 10.00 to 82.50 per cent. The apparent infection rate is an estimate of

Table 1: Per cent disease incidence and AUDPC of pomegranate wilt caused by *C. fimbriata* during 2015-16

Months	Per cent disease incidence	Apparent rate of infection 'r'	AUDPC
October	10.00	0.080	112.50
November	17.50	0.088	75.00
December	22.50	0.091	37.50
January	25.00	0.097	75.00
February	30.00	0.104	112.50
March	37.50	0.107	75.00
April	42.50	0.112	112.50
May	50.00	0.119	187.50
June	62.50	0.122	112.50
July	70.00	0.125	112.50
August	77.50	0.127	75.00
September	82.50	0.130	142.50

Table 2: Multiple regression between abiotic factors and per cent disease incidence of wilt of pomegranate

Months	Regression Equation	F-test	R^2
October 2015 toSeptember 2016	Y= 117.784 + 0.452RF – 6.162Tmax + 6.914Tmin – 0.605RH	$F_{4,59}$ = 1.429	0.449

Table 3: Step wise multiple regression models for per cent disease incidence of wilt of pomegranate with abiotic factors

Regression models	F-test	R^2 in per cent	Per cent role of each character
$Y = 32.25 + 0.32X_1$	$F_{1,10} = 4.42$	30.66	30.66
$Y = 71.24 + 0.35X_1 - 1.21X_2$	$F_{2,9} = 2.34$	34.30	3.64
$Y = 36.58 + 0.26X_1 - 3.35X_2 + 5.32X_3$	$F_{3,8} = 1.97$	42.54	8.24
$Y = 117.784 + 0.452X_1 - 6.162X_2 + 6.914X_3 - 0.605x_4$	$F_{4,7} = 1.42$	44.94	2.40

X_1 = Rainfall (mm); X_2 = Maximum temperature (^{0}C); X_3 = Minimum temperature (^{0}C); X_4 = Relative humidity (%).

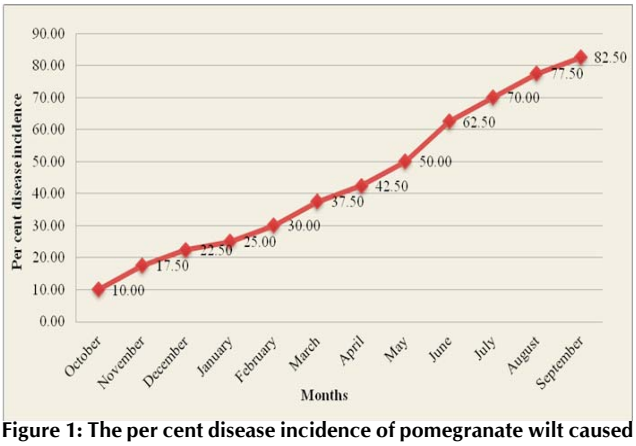

Figure 1: The per cent disease incidence of pomegranate wilt caused by *C. fimbriata* at different time intervals

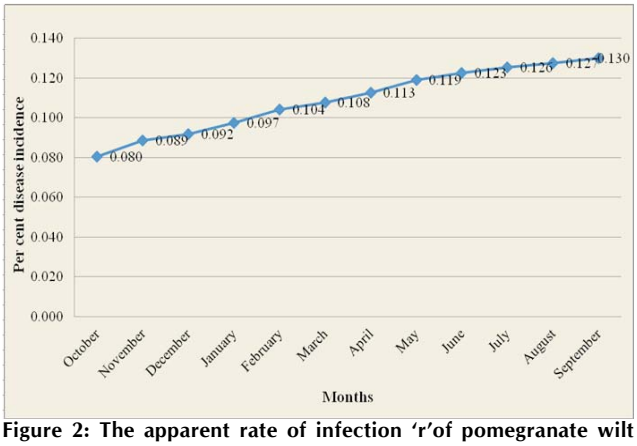

Figure 2: The apparent rate of infection 'r'of pomegranate wilt caused by *C. fimbriata* at different time intervals

disease, based on proportional measures of extent of infection at different times. The apparent rate of infection 'r' at different intervals ranged between 0.080 to 0.130. The area under disease progress curve (AUDPC) is a useful quantitative summary of disease incidence over time, for comparison across different time intervals. The AUDPC value ranged between 37.50-187.50 across different months. On the basis of the study undertaken at wilt sick plot, it was observed that there was significant differences in per cent wilt incidence. The wilt incidence and apparent rate of infection 'r' increased from the initial to final assessment month. The curve showed an increasing trend of disease development across the different months. The AUDPC values obtained from the result showed that disease spread was maximum over the period of time. This is in agreement with the findings of Bhardwaj and Gupta (2005) reported that the area under disease progress curve (AUDPC) was highest during the rainy season. The correlation between mean temperature, average relative humidity mean soil moisture and mean soil temperature with web blight (*Rhizoctonia solani*) severity was positive and significant. Merkuz and Getachew (2012) reported that the AUDPC percentage value per day was higher in early (12th Sep) and late (12th Oct) sowing dates than the farmers' sowing date (27th Sep) in *Fusarium* wilt of chickpea. Ashish and Anita Arora (2015) reported that AUDPC of *Xanthomonas axonopodis*pv. *punicae* was maximum in the month of July than in the months of June and August. AUDPC was maximum (495.25) on fruits when inoculated on fruit surface followed by leaves (427.00), when inoculated with clip method in the month of July. It was observed that value of AUDPC increased with increase in degrees of susceptibility

Influence of abiotic factors on disease development of *C. fimbriata* with multiple and step wise regression models

Multiple regression equation was developed to establish relationship between weather parameter and per cent disease incidence of wilt during the period of October 2015 to September 2016 and presented in Table 2. The result revealed that all the weather parameters contributed to significant variation in per cent disease incidence. The equation developed is Y= 117.784 + 0.452RF – 6.162Tmax + 6.914Tmin – 0.605RH with co-efficient of determination (R^2) of 44 per cent.

Further, step wise multiple regression analysis was applied to know the influence of individual weather parameters on per cent disease incidence of wilt. The result obtained is presented in Table 3. The analysis indicated that the weather parameters explained 44.94 per cent variation in per cent disease incidence. The rainfall explained 30.66 per cent of total variation in disease incidence, whereas maximum temperature explained 3.64 per cent, minimum temperature explained 8.24 per cent and relative humidity explained 2.40 per cent. The maximum variation was explained by rainfall and other three parameters explained less per cent variation in per cent disease incidence.

The multiple regression analysis between weather parameters and per cent disease revealed that all the weather variables tested *viz.*, rainfall, maximum temperature, minimum temperature and relative humidity together attributed 44 per cent towards the per cent disease incidence of wilt during the study. The equation derived was Y= 117.784 + 0.452RF – 6.162Tmax + 6.914Tmin – 0.605RH with co-efficient of determination (R^2) of 44 per cent.

Step wise multiple regression analysis indicated that the maximum variation was explained by rainfall (30.66 %) and

other three parameters explained less per cent variation in per cent disease incidence.*C. fimbriata* being soil borne fungi it is highly influence by soil moisture and soil temperature rather than spatial weather variable. The results also showed that among different weather variable only rainfall was positively correlated to per cent disease incidence. The results are also in conformity with the findings of Bhardwaj and Gupta (2005) who reported that under field conditions, high rainfall coupled with high soil moisture, high relative humidity and soil temperature ranging between 23 to 25°C prevailing during July-August were found conducive for the development and spread of web blight of strawberry caused by *Rhizoctonia solani*.

REFERENCES

Anonymous 2015. Horticultural statistics at a glance. Ministry of Agrico. *and Farmer welfare Government of India,* p. 43.

Ashish and Anita Arora 2015. Standardization of field inoculation techniques for progression of bacterial blight of pomegranate in Punjab.*The Bioscan*. **10(4):** 1475-1481.

Bhardwaj, L. N. and Gupta, B. R. B. 2005. Effect of epidemiological parameters on the development of web blight of strawberry. Paper Presented In: VII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics - Part Two, Nauni, Solan, India, 25 November, p. 696.

Dutta Ray, S. K., Takawale, P. V., Chatterjee, R. and Hnamte, V. 2014. Yield and quality of pomegranate as influenced by organic and inorganic nutrients. *The Bioscan*. **9:** 617-620.

Merkuz, A and Getachew, A. 2012. Epidemic of Fusarium wilt (*Fusariumoxysporum*f.sp. *ciceris*) of chickpea at wilt sick plot in adet-ethiopia. *Int. J. Curr. Res.* **40(5):** 135-144.

Pearson, K. 1896. Regression, heredity, and panmixia. *Philosophical Transactions of the Royal Society of London*, Ser. A, **187:** 253-318.

Shanner, G. R. and Finney, R. E. 1977. The effect of nitrogen fertilization on the expression of slow-mildewing resistance in wheat. *Phtopathol.* **67:** 1051-1056.

Somasekhara, Y. M. and Wali 1999. New record of *Ceratocystis fimbriata* causing wilt of pomegranate. *Pl. Dis*. **83(4):** 400.

Van der Plank, J. E. 1963. Disease resistance in plants. Academic Press, New York, p. 206.