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Correlation and regression studies on weather variables on sigatoka leaf spot in banana cv Grand Naine

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ABSTRACT

The present investigations were done to evaluate the weather parameters with correlation and regression analysis of the yellow sigatoka leaf spot in banana plantation at four locations viz Erasakkanayakkanur, Seepalakottai, TNAU orchard and Vellaiyankadu. In Erasakkanayakanur the relative humidity (0.611) and rainfall (0.622) were positively significantly correlated; maximum temperature (-0.608) was negatively correlated with respect to the sigatoka leaf spot in banana. All the three parameters were significantly correlated with the disease incidence. In Seepalakottai relative humidity (0.710) and rainfall (0.687) were significantly correlated with incidence of banana sigatoka leaf spot and at TNAU orchard the independent variables viz maximum temperature (-0.619) and minimum temperature (-0.573) were negatively correlated whereas relative humidity (0.862) had highly positive significant correlation with the disease. In velliangadu relative humidity (0.547) and rainfall (0.607) were positively correlated with the disease incidence although maximum and minimum temperatures had negative correlation and were statistically insignificant. At all locations relative humidity was positively correlated with disease incidence followed by rainfall. In regression, models to predict the rate of disease increase were developed in several stages. In the first stage each dependent variable was regressed on 4 environmental variables like maximum and minimum temperature, relative humidity and rainfall for one host variable. The R^2 values of the best equations were used as guide to indicate the levels of precision that could be attained for any given dependent variable. More appropriate statistics for that purpose were used at later stages of the analysis. The R^2 values ranged from 0.39, 0.51, 0.74 and 0.37 at four locations viz Erassakkanayakkanur, Seepalakottai, TNAU orchard and Vellaiyankadu respectively.

Keywords: Banana; sigatoka leaf spot; weather variable; correlation; regression

INTRODUCTION

Banana is the most widely consumed and exported fruit in the world. Though it is cultivated in tropics the demand exists all over the world for its unique flavour and taste. India has become the largest producer of bananas in the world by

producing 16.91 MT annually from an area of 4.97 lakh hectares (Anon 2007). In Tamil Nadu alone the crop is cultivated in 88000 hectares and the production is estimated around 4.4 MT. Among the various constrains in cultivation of banana sigatoka leaf spot is one. Weather variables like relative humidity, rainfall, maximum temperature and minimum temperature play an important role in agriculture and other economic activities in India. Hence their accurate prediction is essential to make strategic decisions. The threat of banana facing extinction within the next decade looms large due to the global epidemic of two fungal diseases namely yellow sigatoka and panama disease and the viral disease namely banana bunchy top that are rampaging through central America, Africa and Asia. Among the fungal diseases sigatoka leaf spot is the most important. Destruction of mature and functional leaves in large number leads to failure of bunches to fill out and ripen. Humid weather and high rainfall periods hasten the development and fasten the spread of the disease. Soils with poor drainage and low fertility are more conductive for disease build up. The disease may lead to a yield loss of 50 per cent, peel splitting and yellowing. The Cavendish bananas that dominate the export markets are highly susceptible to this disease. Present study was conducted to study the disease incidence relation to the micro-weather parameters. The cause of yellow Sigatoka is *Mycosphaerella musicola* (Leach) a polycyclic pathogen that continuously produces its reproductive structures. Because of this reproductive strategy the disease progression curve in a susceptible host may show exponential growth within a given time interval provided that the environmental conditions are favourable. These environmental variables also influence the aerobiology of the fungus and the epidemiology of the disease. Weather parameters analysis integrates the components of the patho system expressed as accumulated data on incidence and severity and is depicted by the disease progression curve (Van der Plank 1963). Thus the concentration or the amount of spores dispersed in the air can be important component of the progression of plant disease.

MATERIAL and METHODS

The field trials were laid out at four locations viz Erasakkanayakanur and Seepalakottai villages of Theni district, Velliangadu village and fruit orchard of Tamil Nadu Agricultural Univeristy (TNAU), Coimbatore, Tamil Nadu during 2008-2009. The banana cv Grand Naine was raised in one hectare at four locations. Weather sensor model ET80 was fixed at four locations of experimentation. At Erasakkanayakanur and Seepalakottai planting was done in first week of July 2008 and weather sensors were installed during September 2008. At TNAU orchard planting was done in August 2008 and weather sensor was installed during October 2008. At Villaingadu village planting was done in September 2008 and

weather sensor was installed in November 2008. Sigatoka leaf spot incidence in banana was assessed at fortnightly interval up to harvesting in all the four fields. All the 25 selected plants were in the same vegetative developmental stage having an average height of 2.5 m containing seven to eight photosynthetic active leaves and three to five shoot apexes. All the evaluations were carried out in the same plants. Whenever one of the plants flowered the evaluations were carried out in another randomly selected plant similar in height, vegetative development and amount of leaves. Data on disease severity, weather conditions and aerial spore density were collected every 15 days. The infection rates for each plant were calculated according to the formula:

Infection index= S (n*b D (N)1)*T)* 100,

where n= the number of leaves at each scale level, b= the scale degree, N= the number of degrees used in the scale and T= the total number of leaves evaluated and development status according to the scale of Brun (1963) and the observations of ten or more necrotic mature lesions in this leaf (Foure 1982). For these determination plants with a leaf in stage B were labeled with a plastic ribbon noting the observation dates.

RESULTS

The results revealed that in Erasakkanayakanur relative humidity and rainfall were positively significantly correlated; maximum temperature was negatively correlated to the sigatoka leaf spot in banana. All the three parameters were significantly correlated to disease incidence. In Seepalakottai relative humidity and rainfall were significantly correlated to incidence of banana sigatoka leaf spot at TNAU orchard; the three independent variable viz maximum and minimum temperature was negatively correlated whereas relative humidity was highly positively significanlty correlated with the disease. In Velliangadu relative humidity and rainfall were positively correlated with the disease incidence although maximum and minimum temperature was negatively correlated and statistically insignificant. At all the places of trial relative humidity was positively correlated with disease incidence followed by rainfall. At TNAU orchard alone minimum and maximum temperature was negatively correlated along with above factors (Table 1). The multiple regression analysis was performed to find out the selective contribution of each meteorological variable towards the PDI of disease. Step up regression analysis was done to eliminate such independent variables whose contribution to the variable in the dependent variable was considered to be minimum.

The step-up regression analysis indicates that at Erasakkanayakanur minimum temperature, relative humidity and rainfall contributed to maximum disease incidence of 39 per cent of PDI of sigatoka

Table 1. Correlation co-efficient between weather variables and sigatoka leaf spot of banana at different locations

Variable	Location			
	Erasakkanayakanur	Seepalakottai	TNAU orchard	Velliangadu
Max temperature	-0.558	-0.593	-0.619*	-0.086
Min temperature	-0.608*	-0.149	-0.573*	-0.370
Relative humidity	0.611*	0.710*	0.862**	0.547*
Rainfall	0.622*	0.687*	0.277	0.607*

Table 2. Step-up regression analysis of weather variable with disease incidence

Location	Variable	SEd	B-value	t-value	R^2	F-value
Erasakkanayakanur	Min temp	2.340	-2.134	-2.61	0.390	10.236*
	RH	0.965	0.642	1.342		
	Rainfall	0.546	0.342	2.511		
Seepalakottai	RH	1.450	2.737	-2.67	0.516	11.464*
	Rainfall	0.856	0.564	2.34		
TNAU, orchard	Max temp	1.256	0.960	-2.175	0.743	22.360*
	Min temp	0.956	3.460	-0.2.00		
	RH	0.879	6.384	5.652		
Velliangadu	RH	1.260	0.856	4.625	0.370	10.645*
	Rainfall	0.456	0.336	2.649		

RH= Relative humidity

leaf spot. At Seepalakottai relative humidity and rainfall contributed to a maximum incidence of 51 per cent PDI of sigatoka leaf spot. In TNAU orchard maximum incidence of 74 per cent PDI was contributed by the independent variables of maximum and minimum temperature and relative humidity. At Velliangadu relative humidity and rainfall resulted in a maximum incidence of 37 per cent.

From the above regression equation it is observed that at Erasakkanayakkanur disease incidence was controlled by minimum temperature and relative humidity. At Seepalakottai rainfall and relative humidity played an important role while in TNAU orchard maximum and minimum temperature and relative humidity contributed to the disease incidence. At Velliangadu relative humidity and rainfall

played a major role with the disease incidence in banana. For both peaks of severity after the disease had reached its maximum index there was no lesion stabilization.

This finding can be explained by the fact that the infection index formula takes into consideration the evaluation of all the plant leaves including the newest ones (leaves 0, 1, 2 and 3) which rarely presents disease symptoms. In these cases the decrease in severity following the peaks occurred because the host developed faster than the pathogen ie leaf emission rates were more pronounced than disease progression. This inverse relationship was evidenced by the negative and statistically significant correlation (0.4225) between weather variables.

In July disease progression prevailed over the vegetative growth of the host resulting in peak with highest infection rate. It is also important to note that negative values for maximum temperature were caused by the lack of humidity during the dry period of the year which actually ceased leaf emission and caused total necrosis in the older leaves affected by the Sigatoka lesions. Under this situation the host plants were not able to overcome the damage caused by the disease launching new leaves as they did during the rainy period. *Mycosphaerella musicola* spores were sampled between March and October 2008. The lowest relative humidity rates of the whole year were observed between August and October leading to decrease in both spore concentration and infection index.

The R^2 values ranges were 0.39, 0.51, 0.74 and 0.37 at four locations viz Erassakkanayakkanur, Seepalakottai, TNAU orchard and Vellaiyankadu respectively (Table 3).

Table 3. Forewarning model for sigatoka leaf spot of banana

Location	Prediction equation	R^2-value
Erasakkanyakanur	Y= 13.04 – 0.835(Min temp) + 0.882 (RH)	0.39
Seepalakottai	Y= 205 + 0.488 (RF) +2.73 (RH)	0.51
TNAU, orchard	Y= 534 – 0.485 (Max temp) +0.597 (Min temp) + 0.862 (RH)	0.74
Velliangadu	Y= 10.612 + 0.542 (RH) +2.60 (RF)	0.37

RH= Relative humidity, RF= Rainfall

DISCUSSION

During the first period the infection of 53.66 per cent was owing to extremely favourable environmental conditions.

Significant positive correlations were found between the variables rainfall (RF), minimum temperature, relative humidity (RH) and soil moisture which were responsible for free water on the leaves and the infection rates were higher (Table 2). According to Simmonds (1966) conidia are produced continuously throughout the rainy season and disseminated through a film of free water resulting from either rainwater or dew dripping on the leaves. Thus it could be observed that the lesions were concentrated on old leaves and there was no new leaf emission during that season.

Furthermore among all the cultivars traditionally planted in Tamil Nadu conditions cv Grand Naine which belongs to the Cavendish sub-group (of AAA group) has a high degree of susceptibility to yellow Sigatoka (Gasparotto et al 2005).

According to Wardlaw (1961) the highest incidence of small striped lesions visible to the naked eye on the second, third or fourth leaf depends on the banana variety and the environmental conditions.

According to Meredith (1970) conidial germination is always associated with the presence of free water on leaves and occurs approximately 6 h after deposition as long as the temperature is favourable; the optimum temperature is around 27°C. After conidia deposition an epiphytic phase lasting four to six days may occur.

During this phase the growth of the germ tube is halted during the hottest and driest hours of the day and resumes under more favourable conditions which generally occurs at night (Meredith 1970, Stover 1972, Zadoks and Schein 1979) which was observed at the beginning of summer was predominantly a result of conidial infection at this time. Constant rainfall provided the maintenance of a film of free water for extended periods at an ideal temperature for infection by the pathogen. In contrast the second peak of greater intensity (53.66% average infection index) occurred during the first week of winter when the lowest rainfall levels were noted.

Yellow sigatoka was also reported to have two yearly peaks of maximum severity, the first peak in December to February and the second in June to July. According to Stahel (1937) these peaks should be attributed to the accumulation of infections in the previous four to five weeks.

Given the low rainfall recorded during the second peak of the disease it is possible to associate the elevation in the sexual spore concentration seen during the period of 15 April to 15 July 2007 with the

second peak of severity whose maximum concentration was observed 60 days before the maximum severity of the disease. Stahel (1937) stated that 28 days or more were needed after inoculation for formation of the first lesions to be visible to the naked eyes. In this study despite the reduced rainfall there was sufficient relative humidity to promote conidia production during the same period albeit at a much lower concentration. However the symptom patterns observed during the dry season were typical of ascospores (tip spotting) further supporting the proposed relationship. These results show the average duration of the disease cycle. They may assist in establishing a schedule for spraying and removal of inoculum sources in affected areas that have similar weather conditions as those in this study.

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