Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(5): 2278-2280
Received: 10-07-2018
Accepted: 11-08-2018

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Impact of weather factors on Pokkah boeng disease of sugarcane

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Abstract
To know the impact of weather factors on Pokkah boeng disease on Sugarcane in Bihar situation, an experiment was carried out at Pusa farm, Sugarcane Research Institute, RPCAU, Pusa during the crop season of 2017-18 and the observations were recorded at fortnight interval starting from May to November. The maximum (15.9%) incidence was recorded during first fortnight of July whereas, minimum (0.85%) was observed at second fortnight of November. However, its peak was observed during first fortnight of July to first fortnight of September. The minimum temperature (0.57*), relative humidity at 07 hrs. (0.62*) showed statistically significant, whereas, relative humidity at 14 hrs. (0.86**) and rainfall (0.74**) showed statistically significant and highly positive correlation with disease incidence. While, sunshine showed significant (-0.73**) but had negative correlation. Multiple regression equation in between per cent disease incidence and weather parameters showed all the weather parameters together governed 89.04 per cent towards disease incidence. It may be concluded that minimum temperature, relative humidity and rainfall were the congenial weather factors for the development of disease.

Keywords: Sugarcane, weather, factors, Pokkah boeng and disease

Introduction
Sugarcane is the most important industrial and emerging multiproduct crop in the country occupying about 52.84 lakh hectare of land with an annual production of 3369.00 lakh tones and productivity of 63.70 tones/ha. In Bihar, it has occupied an area of 2.44 lakh hectare with a production of 126.49 lakh tones with an average productivity of 51.83 tones/ha during 2016-17 [1].

Among the various factors lowering down the production and productivity of sugarcane the prevalence and abundance of diseases are one of them. Of which Pokkah boeng is one of the major disease caused sugarcane production and productivity. Pokkah boeng is an air-borne fungal disease caused by *Fusarium* that can lead to serious yield losses in varieties of sugarcane. It is present in most sugarcane producing areas of the world and symptoms of the disease tend to develop during periods of rapid crop growth when rainfall is high [2] which results in malformed top and stalk. Malformation of the young leaves is usually accompanied by wrinkling, twisting and shortening of the leaves. The most serious and advanced stage of pokkah boeng is top rot, where the growing point is killed and the entire top of the plant dies. Although the disease is caused by *Fusarium*, there is some debate regarding the species involved [3]. In Malaysia, the causal organism for pokkah boeng was known as *Fusarium moniliforme* var. *subglutinans* [4]. Patil *et al*. [5] studied the morphological and pathogenicity of different isolates of *F. moniliforme* associated with Pokkah boeng disease collected from various places in Maharashtra.

Approximately 40.8–64.5% sugars can be reduced from sugarcanes infected by *F. moniliforme* var. *subglutinans*, depending upon the cultivars. About 10 to 15 per cent of the nation's sugar yield is lost due to diseases [6] Earlier, Pokkah boeng disease was considered to be of minor importance but during recent past this disease is posing major threat to the sugarcane cultivation in all cane growing areas of Bihar and it was observed in almost all of the growing varieties, which reduces the quality and quantity of sugarcane.

Materials and method
To assess the impact of weather factors on Pokkah boeng disease of sugarcane an experiment was laid out at Pusa farm, Sugarcane Research Institute, RPCAU, Pusa during the cropping season (2017-18). The observations were recorded from the months of May to November, 2017 at weekly interval and correlate with the weather factors *viz*., maximum and minimum temperature (°C), relative humidity (%) at 07 hrs. and 14 hrs., rainfall (mm) and sunshine (hrs.) corresponding to crop duration on development of Pokkah boeng disease.

The meteorological data related to the weather conditions prevailing during crop season were obtained from Agro-meteorological advisory services, RPCAU, Pusa. The data so obtained was finally merged together to obtained the fortnightly average of weather parameters for the period under investigation. The plant disease incidence percentage was carried out by using the following formula.

$$\text{Percent Pokkah boeng incidence} = \frac{\text{No of affected canes}}{\text{Total no of cane assessed}} \times 100$$

The following statistical model was used to assess the impact of weather factors on disease incidence.

$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6$

Where,

Y = Dependent variable (Disease incidence)

a= Pure constant

b_1= Regression coefficient for maximum temperature (X_1)

b_2= Regression coefficient for minimum temperature (X_2)

b_3=Regression coefficient for RH at 7 hrs. (X_3)

b_4= Regression coefficient for RH at 14 hrs. (X_4)

b_5= Regression coefficient for rainfall (X_5)

b_6=Regression coefficient for sunshine (X_6)

Results and discussion

It reveals from the data (Table 1 and illustrated in Fig. 1) that disease incidence percentage varied from 0.85 to 15.9 per cent during course of investigation. The maximum (15.9%) incidence of disease was observed during first fortnight of July followed by 12.2 and 11.6 per cent during second fortnight of July and first fortnight of August respectively. The maximum (15.9) percentage of incidence was recorded during the first fortnight of July, 2017 when corresponding weather parameters *viz.*, maximum and minimum temperature (°C), relative humidity (%) at 07 hrs. and 14 hrs., rainfall (mm) and sunshine (hrs.) were 31.78, 25.84, 92.13, 80.06, 398.0 and 2.50 respectively. The minimum (0.85) percentage of incidence was recorded during the second fortnight of November, 2017 when corresponding weather parameters *viz.*, maximum and minimum temperature (°C), relative humidity (%) at 07 hrs. and 14 hrs., rainfall (mm) and sunshine (hrs.) were 27.64, 12.95, 87.53, 61.26, 0.00, 7.10 respectively. However, the incidence of disease was more prevalent during rainy season (July to first fortnight of September month) after that recovered trend of the disease was observed [7] and [8] has also observed the similar results.

The correlation analysis between weather factors and disease incidence are summarised in Table 2. It is clearly indicated that minimum temperature and relative humidity at 07 hrs. have showed significant positive correlation with disease incidence (r = 0.57 and 0.62), while relative humidity at 14 hrs. and rainfall showed highly positive correlation (r = 0.86 and 0.74), whereas, sunshine showed significant but statistically was negative relation (r = -0.73). The multiple linear regression were worked out by taking disease incidence as dependent variable and climatic factors as in dependent variables (Table 2a). The data revealed that all the weather parameters together governed 89.04 per cent towards disease incidence (R^2 = 0.890). It is clearly indicated that minimum temperature, relative humidity and rainfall were the congenial weather elements for the development of Pokkah boeng disease.

Conclusion

The incidence of disease was more prevalent during rainy season from July to first fortnight of September month. After that recovered trend of the disease was observed. Minimum temperature and relative humidity at 07 hrs. showed significant positive correlation with disease incidence. While, relative humidity at 14 hrs. and rainfall showed highly positive correlation. Multiple regression equation in between per cent disease incidence and weather parameters showed all the weather parameters together governed 89.04 per cent towards disease incidence. It is observed that minimum temperature, relative humidity and rainfall were the congenial weather factors for the development of disease.

Table 1: Effect of weather factors on Pokkah boeng disease development (2017)

Months		Disease incidence (%)	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Sunshine (hrs.)
			Maximum	Minimum	07 hrs.	14 hrs.		
May	I	2.25	33.39	23.43	82.00	65.40	47.25	8.30
	II	2.56	34.96	24.31	84.25	64.50	72.00	8.60
June	I	3.9	35.00	26.43	86.13	67.26	19.60	6.40
	II	6.4	35.11	27.02	85.66	63.80	44.55	7.20
July	I	15.9	31.78	25.84	92.13	80.06	398.00	2.50
	II	12.2	33.23	26.63	85.37	71.12	44.16	5.90
August	I	11.6	32.27	26.06	92.93	79.73	301.50	3.60
	II	10.85	32.81	26.65	88.62	73.62.	85.76	5.80
September	I	9.12	33.66	26.46	89.80	69.60	13.95	4.70
	II	4.7	33.99	26.06	88.13	66.06	30.00	5.40
October	I	4.6	33.20	24.75	88.13	68.20	3.45	5.70
	II	3.8	31.94	21.36	89.00	64.87	0.00	6.30
November	I	3.5	29.83	17.58	85.93	56.80	0.00	4.60
	II	0.85	27.64	12.95	87.53	61.26	0.00	7.10

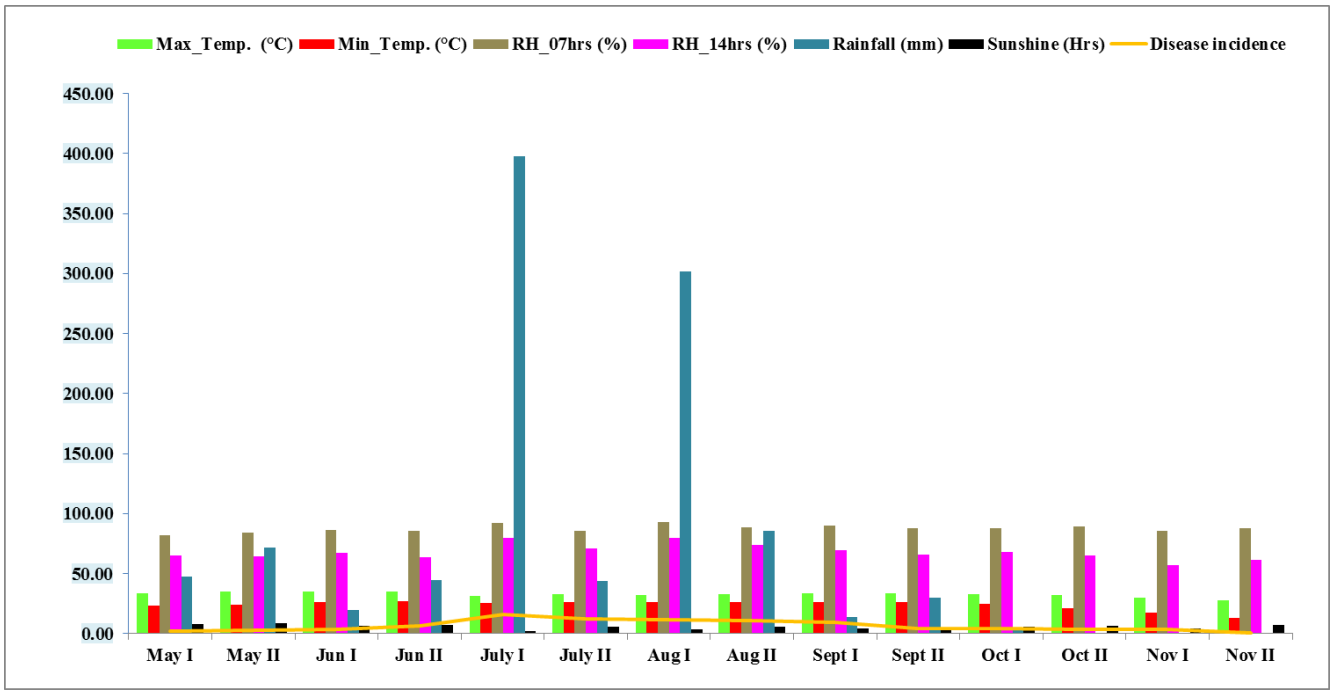

Fig 1: Impact of weather factors on disease development

Table 2: Correlation between environmental factors and Pokkah boeng disease development

Parameter	No. of observation	Temperature (°C)		Relative humidity (%)		Rainfall (mm) (X_5)	Sunshine (hrs.) (X_6)
		Maximum (X_1)	Minimum (X_2)	07 hrs. (X_3)	14 hrs. (X_4)		
Incidence (%)	14	0.12	0.57*	0.62*	0.86**	0.74**	-0.73**

*Significant at 5% probability level.
** Significant at 1% probability level

Table 2a: Multiple linear regression model for environmental factor and Pokkah boeng disease

Parameter	No. of observation	Pure constant	Temperature (°C)		Relative humidity (%)		Rainfall (mm) (X_5)	Sunshine (hrs.) (X_6)	R^2
			Maximum (X_1)	Minimum (X_2)	07 hrs. (X_3)	14 hrs. (X_4)			
Incidence (%)	14	64.9872	-2.1843 (-1.524)	1.3874 (1.6114)	-0.2947 (-0.664)	0.1152 (0.3393)	0.007 (0.6583)	-0.4650 (-0.4771)	0.8904

Figure in Parenthesis indicated 't' value

Multiple linear regression equation

$Y = 64.9872 - 2.1843X_1 + 1.3874X_2 - 0.2974X_3 + 0.1152X_4 + 0.007X_5 - 0.4650X_6$

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