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Evaluation of Sugarcane Varieties against Pokkah Boeng Disease, Role of Meteorological Factors and its Management

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ABSTRACT

Sugarcane (*Saccharum officinarum* L.) is widely grown as cash crop in India and provides employment to over a million of people directly or indirectly. Recently, increasing trends of Pokkah boeng disease caused by (*Fusarium proliferatum*) incidence were noticed in most of the sugarcane varieties grown in Bihar which ranged between 5-15%. A field trial was conducted during 2016-2018 at sugarcane research Institute farm, RPCAU, Pusa. In this study, thirty one sugarcane varieties were evaluated against Pokkah boeng disease, out of thirty one sugarcane varieties evaluated against Pokkah boeng disease, sixteen varieties showed resistant, ten varieties showed moderately susceptible while, four varieties were graded as susceptible to Pokkah boeng disease. The correlation analysis between meteorological factors and disease incidence signify that minimum tempra-ture showed significant positive correlation where-as, relative humidity of 07 hrs, 14 hrs. and rainfall showed highly positive correlation while, sunshine displayed significant but statistically was negative relationship with Pokkah boeng disease incidence. Sett treatment with fungicide Carbendazim @ 0.1% and three foliar sprays with Carbendazim @ 0.1% at 15 days intervals revealed that highest germination and maximum control of disease incidence in all the tested varieties.

Keywords Sugarcane, Evaluation, Varieties, Pokkah boeng, Management.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) of family poaceae traditionally cultivated over centuries in many Asian countries for the preparation of several sweeteners and for direct consumption. It is an im-portant agro-industrial crop of the world which is vagitatively propagated in tropical and sub-tropical zones of the country. It provides raw materials for the production of white sugar, Jaggery, Khnadsari and other bi-products. In India, it is occupied in an area of 50.98 lakh hectare with production of 430.50 million tonnes and productivity of 84.44 tonnes/ha. In

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Bihar, it is occupied an area of 2.11 lakh hectare with production of 13.97 million tonnes and productivity of 66.25 tonnes/ha (Anonymous 2022).

Pokkah boeng disease was first time reported in India from Maharashtra state during 1983-84 and this disease was observed on the varieties Co 7219 and Co 671. It was observed mostly in all cane producing areas of the world and causes yield losses varying from 40-60% in the susceptible varieties (Goswami *et al.* 2013). Recently, increasing trends of Pokkah boeng disease incidence were noticed in most of the sugarcane varieties grown in Bihar which ranged between 5-15% (Minnatullah *et al.* 2022). The disease spread through infected cane, rain splashes, Pupae and adults of sugarcane stem borers (Viswakarma *et al.* 2013). The disease is favoured by warm, moist condition during early monsoon followed by summer showers with cloudy weather. The incidence of Pokkah boeng disease was observed more during rainy season from July to first fortnight of September. It is recorded that minimum temperature, relative humidity and rainfall were the favourable weather condition for the growth of disease in Bihar (Ranjan *et al*. 2018). Generally the disease takes place through the spindle along with the margin of a partially unfolded leaves which are carried by water to the base of spindle where they grow into the inner tissues of the spindle leaves. The earliest symptom of Pokkah boeng disease is a chlorosis on the base of the young leaves, yellowing, twisting, and shortening of the leaves irregular redish stripes and minute spots are observed in the chlorosis part forming a hole. The young spindles are killed and the base of the spindles become rotten and dries up and producing a top rot symptoms of the upper most part of the cane.

MATERIALS AND METHODS

For evaluation of sugarcane entries, to know the effect of weather factors on the growth of the Pokkah boeng disease and its management, an experiment was carried out for three years at Sugarcane Research Institute, RPCAU, Pusa during the planting season (2016-2018).

To know the varietal resistance against Pokkah boeng disease 31 sugarcane entries including one check were artificially tested. *Fusarium proliferatum* inoculum for application in soil, 250g maize seed (half broken) and 750g sand in 1:3 ratio and 50-100 ml of distilled water (depending upon the soil moisture) in the container was mixed.After that100g of maize-sand mixture in 250ml conical flasks were mixed and sterilized at 15lb psi for 2 hr. After 2 days, each flask was inoculated with 4-5 mycelia discs of *Fusarium proliferatum* grown on oat meal agar medium in a petri plates and incubated at 22+1oc for 15 days. On 16th day, whole inoculum was collected in one tray and then mixed thoroughly. Finally the inoculum mixture(@100g/meter row) were applied over the setts uniformly in the furrows at the time of planting. After that the setts were covered with soil.

Symptoms observed

Mild	Green plants with Pokkah boeng (curling/ twisting of spindle leaves, tearing of leaves, and whitish / chlorotic streaks on the leaves) at varying intensities.
Moderate	Yellowing of 3rd/4th leaf followed by complete yellowing of foliage and expression of top rot symptom.
Severe	Yellowing of leaves + Discolouration (light coloured) of stalks + Wilting symptom in opened stalks.

Disease reaction.

Scale (%)	Rating
0-5	Resistant
>5-10	Moderately susceptible
>10-20	Susceptible
>20	Highly susceptible

For epidemiological study, the data related to disease incidence were recorded fortnightly intervals on clump basis. The meteorological data were obtained from Agro-meteorology division, RPCAU, Pusa, Samastipur, Bihar.The disease incidence percentage was drawn out by using the formula.

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

Table 1. Pooled data (2016 to 2018) of sugarcane Pokkah boeng disease incidence and weather parameters.

Months		Incidence of disease (%)	Weather parameters Temperature (^{0}C) Maximum	Minimum	Relative humidity (%) 07 hrs	14 hrs	Rainfall (mm)	Sunshine (hrs)
May	I	2.12 (8.37)	35.22	22.74	79.00	52.97	28.82	8.33
	II	2.52 (9.12)	34.35	24.07	83.42	60.83	63.80	8.23
June	I	3.87 (11.34)	35.47	25.98	82.54	61.10	18.40	8.00
	II	6.25 (14.48)	35.60	26.47	84.22	62.43	30.98	7.07
July	I	12.45 (20.65)	32.87	26.11	87.54	72.85	153.50	4.20
	II	12.97 (21.10)	33.04	26.31	87.57	74.04	52.15	5.27
August	I	14.17 (22.09)	32.46	26.05	89.64	75.24	128.93	4.53
	II	13.35 (21.41)	33.17	26.28	87.64	71.71	82.59	5.00
September	I	10.44 (18.84)	33.22	26.02	89.93	73.37	29.61	4.97
	II	7.57 (15.26)	33.13	25.32	88.54	70.19	35.37	4.63
October	I	5.60 (13.71)	32.47	23.88	87.54	68.07	45.92	5.60
	II	4.60 (12.36)	32.04	20.32	87.77	57.19	3.73	5.73
November	I	4.00 (11.54)	30.61	17.09	84.81	52.93	0	6.83
	II	2.62 (9.32)	28.04	13.32	84.01	52.09	0	6.8

Figure in parenthesis indicates inverse transformed value.

Fortnightly average of three years (2016-18) Pokkah boeng disease observations along with meteorological factors are mentioned in Table 1.

The following model was applied to observe the role of meteorological factors on disease progress.

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

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 relative humidity at 7 hrs (x_3)
b_4= regression coefficient for relative humidity at 14 hrs. (x_4)
b_5= regression coefficient for rainfall (x_5)
b_6= regression coefficient for sunshine (x_6)

To manage the Pokkah boeng disease, sett treatment with carbendazim @ 0.1%, three foliar sprays at 15 days interval with carbendazim @ 0.1%, sett treatment as well as three foliar sprays at 15 days interval with carbendazim @ 0.1% and a treatment as control were carried out and the data were recorded on germination(%) and disease incidence (%) on five varieties (CoS 8436, BO 154, BO 153, CoSe 95422 and CoBln 15501) at fortnightly intervals.

RESULTS AND DISCUSSION

The perusal of pool data of three years presented in Table 2 revealed that thirty one sugarcane variety along with check were evaluated against Pokkah boeng disease, out of which sixteen varieties (CoP 151, CoP 9301, CoP 153, BO 91, CoP 16437, CoP 13439, CoSe 13452, CoP 2061, CoP 11438, CoP 12438, CoP 12436, COP 14437, CoP 14436, CoP 14438, CoP 15436 and CoP 15438) showed resistant reaction, whereas, ten varieties (BO 154, CoP 16440, CoP 11437, CoBln 14502, CoP 13437, CoSe 13453, CoLk 12207, CoLk 14208, BO 130, CoSe 12451) showed moderately susceptible while, rest four varieties (BO 139, BO 156, CoSe 95422, CoSe 14453) graded as susceptible reaction against Pokkah boeng disease Ranjan *et al.* 2022 and Wang *et al.* 2017 also evaluated the sugarcane varieties and similar findings were reported.

The perusal of pool data of three years presented in Table 1 pertaining to the studies on role of meteorological factors, the disease incidence varied from 2.12 to 14.17% during the reported period 2016-18 (May to November). The maximum (14.17%) disease incidence was observed during 1st fortnight of August followed by (13.35% and 12.97%) during 2nd fortnight of August and 2nd fortnight of June, respectively. During maximum disease incidence

Table 2. Pooled data (2016-18) on evaluation of sugarcane varieties against Pokkah boeng disease.

Sl. No.	Varieties	Percent infected plants			Total incidence	Disease reaction
		Mild	Moderate	Severe		
1	CoP 151	2	1	-	3	R
2	CoP 9301	3	2	-	5	R
3	BO 153	2	2	-	4	R
4	BO 154	5	2	-	7	MS
5	BO 139	8	3	1	2	S
6	BO 91	3	2	-	5	R
7	BO 156	5	4	2	11	S
8	CoP 16437	2	2	-	4	R
9	CoP 16440	4	3	1	8	MS
10	CoP 11437	3	2	1	6	MS
11	CoBln 14502	4	4	1	9	MS
12	CoP 13437	5	1	-	6	MS
13	CoP 13439	2	2	-	4	R
14	CoSe 13452	2	2	1	5	R
15	CoSe 13453	3	2	1	6	MS
16	CoP 2061	2	1	-	3	R
17	CoP 11438	2	1	-	3	R
18	CoP 12438	2	2	-	4	R
19	CoLk 12207	4	2	1	7	MS
20	CoP 12436	2	1	1	4	R
21	CoSe 95422	8	5	3	16	S
22	CoP 14437	2	2	-	4	R
23	CoLk 14208	5	3	1	9	MS
24	CoP 14436	2	2	-	4	R
25	BO 130	4	3	1	8	MS
26	CoSe 14453	6	5	3	14	S
27	CoP 14438	1	2	-	3	R
28	CoP 15436	3	1	1	5	R
29	CoP 15438	2	2	-	4	R
30	CoSe 12451	3	2	1	6	MS
31	CoS 8436 (Check)	6	4	2	12	S

when corresponding weather factors were 32.46 and 26.05^{0}C maximum and minimum temperature, 89.64 and 75.24% relative humidity at 07 and 14 hrs. 128.93 mm rainfall and 4.53 hrs. Sunshine, respectively. It was observed that the incidence of Pokkah boeng disease was more prevalent during rainy months (June to 2nd fortnight September) after that recovered trend of Pokkah boeng disease was observed.

It is clearly indicated from Table 3, the correlation analysis between weather factors and disease incidence clearly indicate that minimum temperature

Table 3. Correlation between weather parameters and Pokkah boeng disease development of pooled data (2016 to 2018).

Parameter	No. of observation	Weather parameters Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	Sunshine (hrs)
		Maximum (X_1)	Minimum (X_2)	07 hrs (X_3)	14 hrs (X_4)	(X_5)	(X_6)
Incidence (%)	14	0.03	0.61*	0.78**	0.91**	0.68**	-0.85**

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

Table 4. Multiple linear regression model for weather parameters and Pokkah boeng disease of pooled data (2016 to 2018).

Parameter	No. of observation	Pure constant	Weather parameters						R^2
			Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	Sunshine (hrs)	
			Maximum (X_1)	Minimum (X_2)	07 hrs (X_3)	14 hrs (X_4)	(X_5)	(X_6)	
Incidence (%)	14	161.5505	-4.5333 (-1.1446)	3.3332 (1.1439)	-0.3758 (-0.6392)	-0.5305 (-0.6594)	-0.0024 (-0.1126)	-1.4546 (-1.1602)	0.9075

Figure in parenthesis indicated 't' value.

showed significant positive correlation with disease incidence (R=0.61), whereas, RH of 07 hrs and 14 hrs. and rainfall showed highly positive correlation (r=0.78, 0.91 and 0.68) respectively, while, Sunshine showed significant but statistically was negative relationship (r=-0.85).

A perusal of the result from Table 4 indicated that the multiple linear regression were also worked out by taking disease incidence as dependent variable and weather factors as independent variables.

Multiple linear regression equation

$$Y = 161.5505-4.5333X_1+3.3332X_2-0.3758X_3-0.5305X_4-0.0024X_5-1.4546X_6$$

The data showed that all the weather factors together governed 90.75% towards disease incidence (R^2= 0.9075). Thus, it may be concluded that minimum temperature, relative humidity and rainfall were the congenial weather factors for Pokkah boeng disease incidence in Bihar climatic situation. Similar findings on meteorological factors were also observed earlier by Minnatullah *et al*. (2020) and Ranjan *et al,* (2022).

It is clearly indicated from Table 5 the efficacy of fungicide Carbendazim for the management of PBD was assessed with five sugarcane varieties and the study revealed that, the treatment T_3-T_1+T_2 (Sett treatment with Carbendazim @ 0.1%/lit + Foliar spray with Carbendazim @ 0.1% /lit, 3 sprays at 15 days interval). On the basis of three years observations, Carbendazim @ 0.1% was found effective in boosting the germination and reducing the incidence of PBD in comparison to check.

Treatment details

1 T_1- Sett treatment with Carbendazim @ 0.1% /lit
2 T_2 – Foliar spray with Carbendazim @ 0.1% /lit (3 sprays at 15 days interval)
3 T_3 – T_1+T_2 (Sett treatment with Carbendazim @ 0.1%/lit + Foliar spray with Carbendazim @ 0.1% /lit. (3 sprays at 15 days interval)
4 T_4– Control.

Table 5. Pooled data (2016-18) on management of sugarcane Pokkah boeng disease.

Treatment	CoS 8436		BO 154		BO 153		CoSe 95422		CoBln 15501	
	Germination (%)	Disease incidence (%)	Germination (%)	Disease incidence (%)	Germination (%)	Disease incidence (%)	Germination (%)	Disease incidence (%)	Germination (%)	Disease incidence (%)
T_1 sett Treatment	28.4	10.3	32.2	9.0	30.8	9.7	29.2	10.0	24.0	12.3
T_2 (foliar spray	26.2	10.5	31.0	9.6	30.0	9.8	28.0	10.4	22.3	13.2
T_3-T_1+T_2	31.4	9.2	36.4	7.2	32.0	8.8	30.6	9.6	27.3	11.0
Control	22.2	15.8	29.3	11.2	26.4	12.6	24.8	13.6	20.6	16.6
SEm	1.33	0.66	1.29	0.55	1.10	0.52	1.12	0.66	1.03	0.60
CD	4.70	2.33	4.47	1.93	3.95	1.85	3.88	2.31	3.57	2.08
CV	8.52	9.97	6.90	10.22	6.40	8.88	6.90	10.43	7.60	7.90

Sett treatment with Carbendazim @ 0.1% and three foliar sprays with carbendazim at 15 days intervals showed highest germination and maximum disease control in all the treated varieties. Highest germination 36.4% with low disease incidence (7.2%) were observed in BO 154 and lowest germination 23.3% and maximum (13.2%) disease incidence was recorded in variety CoBln 15501. Ranjan *et al.* (2018)also worked on Pokkah boeng disease management through fungicides and comparable findings were also reported.

CONCLUSION

Pokkah boeng disease is affecting several popular commercial varieties in cane growing regions of Bihar since last few years, due to which qualitative and quantitative losses were recorded. Disease scenario is also changing very fast due to frequent change in climatic condition. To achieve the disease free seed materials need to develop disease resistant varieties through evaluation of sugarcane varieties and to manage the crop through suitable management practices. Out of thirty one sugarcane varieties evaluated against Pokkah boeng disease, sixteen varieties showed resistant, ten varieties showed moderately susceptible while, four varieties were graded as susceptible to Pokkah boeng disease. The correlation analysis between meteorological factors and disease incidence signify that minimum showed significant positive correlation whereas, relative humidity of 07 hrs, 14 hrs. and rainfall showed highly positive correlation while, sunshine displayed significant but statistically was negative relationship with Pokkah boeng disease incidence. Sett treatment with fungicide Carbendazim @ 0.1% and three foliar sprays with Carbendazim @ 0.1% at 15 days intervals revealed that highest germination and maximum control of disease incidence in all the tested varieties.

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