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CORRELATION AND REGRESSION OF METROLOGICAL FACTORS WITH SUGARCANE SMUT DISEASE CAUSED BY *SPORISORIUM SCITAMINEA* (SYN. *USTILAGO SCITAMINEA)*

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ABSTRACT
Smut caused by *Sporisorium scitamineum* (Syn: *Ustilago scitaminea)* is an important fungal disease widely prevalent in tropical India causing huge monetory losses. Sugarcane crop requires a hot and humid climate for its development which is also conducive for the development of various diseases. The disease incidence was studied for both the infection cycles for primary infection cycle the maximum temperature showed positive significant correlation (0.074) while, in case of secondary infection cycle average relative humidity showed negatively significant correlation (-0.683) and there was non significant correlation obtained in case of rainfall, wind velocity and sunshine. Though disease development was observed at 22.3°C maximum temperature, it was rapid at above 34.8ºC and slow between 11.5ºC - 22.2ºC which was favoured by average relative humidity 65% - 76.5%.

INTRODUCTION

Sugarcane is not only cash crop for the growers, but it is the main source of white crystal sugar and also a very good substitute of sugar in the form of 'gur' and 'khandsari' (brown sugar). India ranks second among the sugarcane growing countries of the world on terms of both area and production. Smut disease of sugarcane caused by *Sporisorium scitamineum* (Syn: *Ustilago scitaminea)* was first noted in Natal (South Africa) in 1877 as reported by (Martin *et al*., 1961). In the 1930's *S. scitamineum* caused severe problems in India and since than it became widespread in most of the sugarcane growing states in the country (Viswanathan *et al*., 2009).

The disease is sometimes referred to as "culmicolous" smut of sugarcane because it affects the stalk of the cane. Infection ranges from 30-40% in plant crops and even up to 70% in ratoons. It can cause signifi-cant tonnage losses as well as juice quality losses.Sucrose content of infected cane is reduced to 3-7% (Sandhu et *al*., 1975). Disease development is dependent on the environmental conditions and the resistance of the sugarcane varieties grown. The most recognizable diagnostic feature of a smut infected plant is the emergence of a "smut whip" (Comstock, 2000). A "smut whip" is a curved, pencil-thick growth, gray to black in colour that emerges from the top of the affected sugarcane plant.

Bock, 1964 had reported the optimum temperature for the production of infection hyphae, promycelium and sporidia was 31ºC which is favourable for development of disease. According to Sreeramulu (1973), the day time dispersal of spores is maximum. The maximum dispersal of spores takes place at 24 to 27ºC and 50 to 60% R.H. The inoculum trapped below the height of the canopy serves as a source for secondary infection. Infection of the buds may take place, on standing cane, by the wind borne spores. Spore germination was reported to be favorable at high temperatures and low relative humidity conditions, which appears, to be ideal for maximum infections in the field (Gul, 1989). Disease severity is associated with hot dry climate where crop may experience water stress. Crop age and cycle at the time of infection appear to be important (Ferreira and Comstock, 1989). Therefore, a field trial were thus, conducted with the objective to determine the effect of weather parameters on development of smut on sugarcane.

MATERIALS AND METHODS

Field experiments were conducted at Norman E. Borloug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (29.5º North latitude, 79.3º East longitude at an altitude of 243.84 m above the sea

level) during the crop season 2011-12 to assess the impact of different climatic factors *viz.,* temperature (p C), relative humidity (%), rainfall (mm), wind speed (km/hr) and sunshine (hrs) on smut disease development and disease incidence in sugarcane crop. Observations of smut incidence were recorded weekly during primary and secondary infection. Smut infection was recorded by using following formula

Percent smut infection = (Number of infected clumps / Total number of clumps) / 100

Data of weather parameters were obtained from Agromet. Cell of GBPUA&T, Pantnagar and were averaged for the period between two smut disease incidence (primary and secondary infection), which was subjected to correlation and regression analyses with weather parameters to determine the relationship between weather parameters and disease development. The prediction equation used was

$Y = a + b_1x_1 + b_2x_2 + ... + b_6x_6$

Where, Y = Predicted disease incidence; a = Intercept; $b_1 - b_6$ = Regression coefficients; X_1 = Average maximum temperature (°C), X_2 = Average minimum temperature (°C), X_3 = Average relative humidity, X_4 = Rainfall (mm), X_5 = Wind velocity (km/hr), X_6 = Sunshine (hrs)

R^2 = coefficient of determination

RESULTS

Progress of sugarcane smut was affected by variations in weather variables as well as their interactions from tillering to harvesting stage of the crop. Results (Table 1-2) revealed that the correlation of primary infection cycle with maximum temperature and average relative humidity showed significant correlation while minimum temperature showed negatively significant correlation, while in case of rainfall, wind velocity and sunshine there was a non significant correlation obtained. Similar results were observed in case of secondary infection cycle, maximum temperature showed significant correlation, while minimum temperature and average relative humidity showed negatively significant correlation while other factors showed a non significant correlation.

Based on the results of multiple regression analysis prediction, equations were developed for both the infection cycles which revealed that maximum temperature, minimum temperature and average relative humidity are the key factors which affect the disease development. For primary infection, where a = 0.075, R^2 = 0.836

$Y = a + (0.015) X_1 + (-0.227) X_2 + (-0.028) X_3 + (0.337) X_4 + (-0.089) X_5 + (-0.023) X_6$

For secondary infection, where a = -31.01, R^2 = 0.765

$Y = a + (0.625) X_1 + (-0.156) X_2 + (0.0) X_3 + (0.222) X_4 + (0.141) X_5 + (0.339) X_6$

As evident from the weather data and incidence of the disease in it, it was found that for primary infection the temperature requirement is a little higher (maximum temperature 31.6 to 37.6ºC and minimum temperature 20.8ºC to 23.8ºC and average relative humidity 60.58%). The maximum incidence *i.e.* 2.56% was recorded when the max and min temp was 34.3ºC and 20.8ºC respectively and average humidity 78.0%. Whereas minimum incidence *i.e.* 1.35 % was recorded when the max and min temp was 31.8ºC and 23.3ºC respectively and average relative humidity 65.0% (Fig. 1).

In case of secondary infection temperature requirement is less (maximum temperature 22.2 to 27.2ºC and minimum temperature 7.8 to 13.8ºC and average relative humidity 74.25%). The maximum incidence *i.e.* 2.32% was recorded when the max and min temp was 26.0ºC and 7.8ºC respectively. Whereas minimum incidence *i.e.*1.11 % was

Table 1: Impact of environmental conditions prevailing for primary infection of smut incidence

Date of observation	Temperature (ºC) Max. Temp (ºC)	Min. Temp (ºC)	Relative Humidity Avg R.H.(%)	Rain fall (mm)	Wind velocity (km/hr)	Sunshine (hrs)	Per cent smut Infection# (primary infection)
7 May' 10	37.6	23.8	44.5	0.0	8.6	8.7	1.56 (7.04)
14 May' 10	37.2	21.3	53.5	0.0	5.3	10.7	2.12 (8.33)
21 May' 10	34.3	20.8	78.0	4.6	11.7	7.3	2.56 (9.10)
28 May' 10	31.6	22.9	62.5	1.4	5.6	4.5	2.01 (8.13)
4 June'10	35.6	21.9	60.0	0.0	5.2	12.2	1.75 (7.49)
11 June'10	31.8	22.3	65.0	0.0	6.7	2.5	1.35 (6.29)
Correlation	0.074*	-0.836*	0.544*	0.809	0.653	-0.460	-

*significant correlation; # calculated on the basis of infected tillers; £ value in paranthesis are angular transform values

Table 2: Impact of environmental conditions prevailing for secondary infection of smut incidence

Date of observation	Temperature (ºC) Max. Temp (ºC)	Min. Temp (ºC)	Relative Humidity Avg. R.H. (%)	Rain fall (mm)	Wind velocity (km/hr)	Sunshine (hrs)	Per cent smut Infection# (secondary infection)
7 Nov' 10	25.9	11.9	76.5	0.0	2.0	1.5	1.11 (6.02)
14 Nov' 10	27.2	13.8	77.5	0.0	2.3	0.0	1.38 (6.29)
21 Nov' 10	27.2	12.5	69.5	0.0	2.8	6.4	2.05 (8.13)
28 Nov' 10	26.0	7.8	71.5	0.0	1.9	6.3	2.32 (8.72)
4 Dec' 10	26.5	11.0	69.0	0.0	1.5	6.6	1.62 (7.27)
11 Dec' 10	22.2	12.4	81.5	0.0	4.5	4.9	1.34 (6.29)
Correlation	0.315*	-0.667*	-0.683*	0.0	0.699	-0.221	-

*significant correlation; # calculated on the basis of infected tillers; £ value in paranthesis are angular transform values

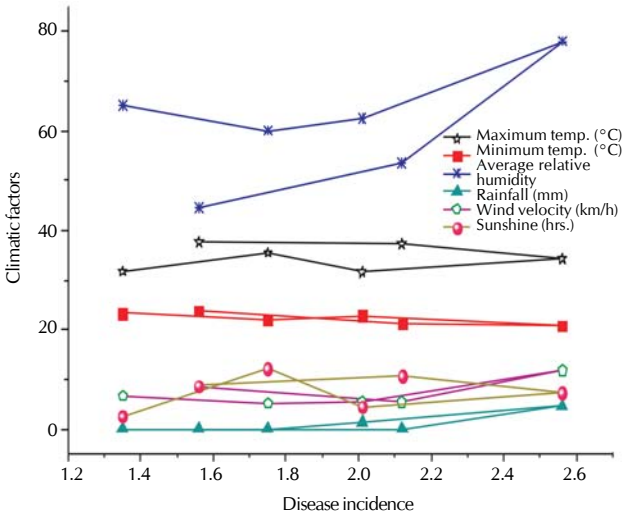

Figure 1: Impact of environmental conditions on primary infection of smut incidence

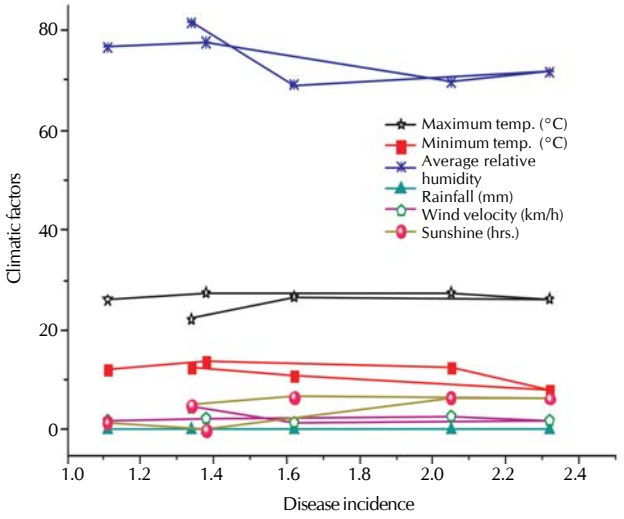

Figure 2: Impact of environmental conditions on secondary infection of smut incidence

recorded when the max and min temp was 25.9°C and 11.9°C respectively (Fig. 2).

DISCUSSION

Weather conditions are critically important in the development and spread of the pathogen causing smut of sugarcane. Some of these can be utilized to form the basis of disease prediction model. They may vary in their combinations in different agroclimatic zones and influence not only the pathogen but also the host. The present findings are in accordance with Sreeramulu (1973) reporting that there is definite diurnal (circadin) and seasonal rhythms in the spore incidence, the day time dispersal of spores is maximum. The maximum dispersal of spores takes place at 24 to 27°C and 50 to 60% R.H. The inoculum trapped below the height of the canopy serves as a source for secondary infection. Infection of the buds may take place, on standing cane, by the wind borne spores.

James (1969) found that spores can remain viable in dry soil for 16-32 days. In soil of plant crop, the spores were viable for at least 64 days. In wet soils (without crop), spores retained viability for 4-8 days only, whereas under similar moisture conditions in soil with plant crop, the viability is extended up to 16 days. The primary infection of sugarcane smut caused by *Ustilago scitaminea* Sydow showed significant positive correlation with minimum temperature (r = 0.937). Secondary infection of smut had significant negative correlation with soil temperature(r = -0.880). Among various abiotic factors, minimum temperature and soil temperature were most influencing with a contributing 87% and 77 % variation in primary and secondary infections respectively. (Neelam *et al.,* 2012).

Spore viability and longevity under the two soil conditions of wet and dry showed that smut teliospores maintained viability that was able to infect and incite the disease at an average of 64.3% and 50% infectivity at 64 days longevity under dry and wet soil conditions, respectively (Marchelo-d 'Ragga and Ahmed, 2015).

REFERENCES

Bock, K. R. 1964. Studies on Sugarcane Smut (*U. scitaminea*) in Kenya. *Trans. Br. Mycol. Soc.* **47:** 403-417.

Comstock, J. C. 2000. "Smut." In *A guide to sugarcane diseases (Ed. Philippe Rott, Roger A. Bailey, Jack C. Comstock, Barry J. Croft, and A. Salem Saumtally) Montpellier*, France. pp. 181-185.

Ferreira, S. A. and Comstock, J. C. 1989. "Smut." In *Diseases of sugarcane. Major diseases (Ed. C. Ricaud, B. T. Egan, A. G. Gillaspie Jr., and C. G. Hughes) Elsevier Science Publishers B.V.*, Amersterdam. pp. 211-229.

Gul, F. 1989. Analysis of viability of sugarcane smut (*Ustilago scitaminea* Syd.) spores in nature. *Pakistan Sugar J.* **3(3):** pp. 5-6

James, G. L. 1969. Viability of Sugarcane smut spores in the soil. *Sugarcane Pathol News1*. **3:** 10-12.

Marchelo-d'Ragga, P. W. and Ahmed, A. O. 2015. Epidemiology of *Ustilago scitaminea* (Syd.): II. Teliospore Viability and Longevity in Wet and Dry Soils. *International J. Agricultural Research and Review*. **3(7):** 350-352.

Martin, J. P., Abbot, E. V. and Hughes, C. G.1961. Sugarcane diseases of the world. *ElsevierPugl. Pub. Campany*, Amsterdam. p. 542.

Meena, R. S., Ameta,O. P. and Meena, B. L. 2013. Population dynamics of sucking pests and their correlation with weather parameters in chilli, *Capsicum annum* L. crop. *The Bioscan.* **8(1):** 177-180.

Neelam, R. K. Sahu and Srinivasaraghavan, A. 2012. Role of weather parameters on incidence and development of sugarcane Smut disease. *Bioinfolet.* **9(4):** 497-499.

Sandhu, S. S., Mehan, V. K., Ram, R. S., Shani, S. S. and Sharma, J. R. 1975. Screening of promising sugarcane varieties for resistance to smut by *Ustilago scitaminea* Syd. in the Punjab. *Indian Sugar*. **25:** 423 -426.

Sreeramulu, T. 1973. Aeromycological observations and their implications in the epidemiology of some diseases of Sugarcane. *Indian Natn. Sci. Acad. Bull.***46:** 506-510.

Viswanathan, R., Ramesh Sundar, A., Malathi, P. and Padmanabhan, P. 2009. Sugarcane Smut, *Extension Publication*. p.179.