Effect of Climate Change on the Management of *Phytophtora* Pod rot of Cacao in Nigeria

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INTRODUCTION

Climate is a very important factor in agriculture. it sets the limit for the agricultural activity in many agroecology.

Temperature, rainfall, humidity, photo-period and altitude are major components of climate which interact to produce the local weather.

Adverse effects of climate change continue to be a major threat to rural livelihoods.

Global warming, food poisoning and environmental pollution are current challenges as a result of excessive exposure to and combustion of chemical substances.

The management of BPD is a major challenge to cocoa farmers in Nigeria as they frequently apply fungicide to safeguard their crops without consideration for the safety of life and the environment.

The sensitivity of cocoa production to change from length and intensity of sunshine, rainfall and water application, soil condition and temperature due to evapo-transpiration effects is very high.

Climate change also plays a major role in altering the development of cocoa pests and pathogens and shifting their interactions, which implies reduction in crop yields and out-turns and negative impact on income and livelihood of farmers.

Climate change imposes constraints to development especially among smallholder farmers whose livelihoods mostly depend on rain-fed agriculture.

Cocoa black pod disease is one of the major diseases affecting the cocoa production in Nigeria and other producing countries.

Black pod diseases account for quite a lot of cocoa production losses by attacking the ripened or young pods and the diseases are closely related to rainfall distribution pattern.

It is more prevalent in damp situations with utmost pod infection in years when the short dry period from July to August is very wet.

The climate variables influenced the cocoa black pod disease incidence and it is important to quantify the black pod disease variation due to the effect of climate variables.

Changing climate can also alter the development of pests and diseases and modify the host's resistance and more importantly, the black pod disease is a major threat to cocoa production when the relative humidity is very high.

OBJECTIVE

This paper presents preliminary investigation of effect of climate variables on the cocoa black pod disease incidence in selected growing ecologies of Nigeria.

MATERIALS AND METHODS

Mature and optimally bearing cocoa plots were selected at Onigambari on Lat. 7.216°N, Long. 3.852°E), Oyo State, Nigeria for the field trials.

Copper-1-oxide 60% + metalaxyl 12% WP – based fungicide

Spray pumps

Evaluation of the effect of climate change on *Phytophthora* pod rot incidence on cacao during the fruiting season of 2014, 2015 and 2016 was done.

The copper-1-oxide 60% + metalaxyl 12% WP – based fungicide was applied to control *Phytophthora* pod rot disease on cacao between May and October each year.

The selected cacao plots were subjected to three spray application strategies: Alternate monthly-spray, monthly-spray and no spray application.

Record of observation of the black pod incidence on cacao trees were taken and information on incidence of *Phytophthora* pod rot, weather parameters in the study location were subjected to correlation and regression analysis to determine effect of weather condition on black pod disease and management technique.

RESULTS

Table 1: Regression and ANOVA summary output (2014)

Regression Statistics	
Multiple R	0.978491043
R Square	0.957444722
Adjusted R Square	0.893611805
Standard Error	6.965128624
Observations	6

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2182.973966	727.657989	14.99923	0.063148915
Residual	2	97.02603351	48.5130168		
Total	5	2280			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-524.2533949	118.7990586	-4.4129423	0.047706	-1035.404489	-13.10230099	-1035.4	-13.1023
Relative humidity	6.096633819	1.467714595	4.15382789	0.05336	-0.218432389	12.41170003	-0.21843	12.4117
Temperature	-0.059691184	0.404287887	-0.1476452	0.896163	-1.799201563	1.679819194	-1.7992	1.679819
Rainfall	0.215775057	0.03427323	6.29573157	0.024313	0.06830925	0.363240864	0.068309	0.363241

Y = -524.25+6.09X1-0.06X2+0.22X3+e, Where Y is the estimated black pod incidence, X1 is relative humidity, X2 is temperature, X3 is rainfall and e is the error terms

Regressing the parameters (Relative humidity, temperature and rainfall) on incidence of black pod disease, the result shows a significant effect on pod rot incidence at α = 0.05 (Table 1).

The regression statistics of the weather parameters on black pod disease incidence show 0.9785 as strength of relationship and R2 as 95.7%.

These weather parameters significantly affect black pod incidences in 2014 crop season.

Also effect of weather parameters on black pod disease incidence shows a correlation coefficient of 0.8766 and R2 of 76.84% showing significant effect of the weather on black pod incidence in 2015 crop season.

In 2016 crop season, effect of weather parameters was also significant on the incidence of black pod disease also at α = 0.05.

The regression statistics of the three weather parameters on black pod disease incidence show 0.6648 as strength of relationship and R2 as 44.20%.

The weather parameter significantly affects black pod incidence, however the level of significant was low compare to the effect recorded in 2014 and 2015 crop seasons.

The year 2014 evaluation shows a linear relationship exists between black pod incidence and relative humidity, there is a weak positive correlation (r= 0.19) between black pod incidence and relative humidity, thus high relative humidity could bring about increase in black pod disease.

Moderate negative correlation (r= -0.54) was recorded between black pod incidence and temperature and increase in temperature will result in reduction of black pod disease. Also, a moderate negative correlation (r= -0.43) was recorded between black pod incidence and amount of rainfall.

The second-year trial showed that a moderate positive correlation (r=0.53) was recorded in black pod disease and relative humidity.

Correlation between black pod incidence and relative humidity was stronger than what obtained in year 2014.

Increase in relative humidity result into a much more significant increase in black pod disease than recorded in year 2014

A trend of moderate negative correlation (r= -0.54) was recorded in the relationship between black pod incidence and temperature of the environment, and similar to the year 2014 which shows a correlation r= -0.54.

The linear relationship between black pod disease and rainfall in year 2015 shows a strong negative correlation (r= -0.64) and this is stronger than the relationship recorded for these two variables in year 2014.

The result of the third-year trial depicts the effect of climate change on black pod incidence and showed a different dimension in year 2016 as a negative linear correlation (r= -0.19) was recorded between black pod disease and relative humidity.

Though the relationship was a very weak correlation, it however differs significantly from positive very weak and moderate positive correlation recorded in year 2014 and 2015 respectively.

Another variation in effect of climate on black pod disease was also observed in the relationship between black pod incidence and temperature of environment.

A moderate positive correlation (r=0.53) was recorded in year 2016 while moderate negative correlation were recorded in both year 2014 and 2015 with correlation value of -0.54.

The relationship between black pod disease and rainfall show moderate negative correlation (r= -0.43) in year 2016, this is similar to trend of high rainfall resulting into reduction of black pod incidence recorded in both year 2014 and 2016.

Effect of weather vis-à-vis relative humidity, temperature and rainfall was established both in temporal and spatial distribution of pod rot incidence in cocoa production,

The regression statistics of the three weather parameters and black pod disease incidence indicates strong relationship and high R2 values, weather parameters significantly affect the black pod incidence in cocoa season in the trial location.

DISCUSSION

The weather pattern for Oyo among other Southwest states showed that height of rainfall was between the months of March and October from 1991 to 1995.

This suggests the possibility of black pod infection within these periods and that *Phytophthora* megakarya thrives better between 20°C and 30°C, therefore the specific periods of the year that favoured such temperature values in Oyo state inclusive were June, July, August, and September.

The effect of weather condition on black pod disease infestation was carried out in this study between May and October in adoption of the recommendation on period of black pod infection.

Significant effect and differences were recorded in the weather variable and the incidence of black pod disease in study location.

The effects of climatic parameters on the expression of black pod disease on cacao were evaluated and the parameters evaluated varied significantly from the first to the third year of assessment.

The findings in this study revert the initial believe by farmers that rainfall bring about increase in black pod disease.

The temperature increase is not the cause of high black pod disease incidence but the high humidity usually in the morning among other contributing factors.

CONCLUSION

Positive correlation was recorded between black pod incidence and relative humidity with exception of 2016.

Negative correlation in black pod incidence and temperature also except in 2016 season and negative relationship between black pod disease and rainfall in the selected years.

The effect of weather was established both in temporal and spatial distribution of pod rot incidence in cocoa production, the weather parameters and black pod disease incidence indicates strong relationship and high R-square value and significantly affect the black pod incidence in cocoa season in the trial location.

A model is required to be developed in Nigeria, which could be used to forecast black pod incidence to assist farmers determine timely application of fungicide and cultural practices to control black pod disease in cocoa growing ecologies.

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