Using the relationship between foliar emission rate and disease progress over time as a tool for managing black sigatoka in plantain

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Introduction

Bananas and plantains (*Musa* spp.) are important crops that contribute to the food security and income of small-scale farmers in tropical countries. Black sigatoka or black leaf streak disease (BLSD) is the most important leaf disease attacking these crops, and is caused by the pathogenic fungus *Mycosphaerella fijiensis* (anamorph: *Pseudocercospora fijiensis*). BLSD significantly affects the plant's photosynthetic area (Fig. 1), reducing fruit weight[1]. Although BLSD is managed mainly by periodic applications of fungicides, this control method is often too costly for small-scale farmers in developing countries.

To adopt effective control strategies that reduce costs, the factors behind disease progress in a host plant must be understood. To design an eco-efficient approach to managing BLSD, we evaluated the relationship between the disease's temporal dynamics and foliar emission rate (FER) in plantain.

Figure 1. *Plantain plants affected by BLSD in a study trial (photo: Neil Palmer / CIAT)*

Materials and methods

An on-farm trial was carried out in the Colombian Department of Quindío (1080 m altitude; mean temperature 26°C). The farm was chosen for its high *M. fijiensis* inoculum pressure and favorable environmental conditions for disease development. A 1.5-ha plot was planted with suckers of the widely cultivated plantain, 'Dominico hartón' (*Musa* AAB), growing at a density of 1600 plants/ha. Data were collected weekly from 10 plants in each of three distantly located subplots. No disease management practices were performed during the cropping cycle.

Host-plant response to black sigatoka was assessed in terms of disease severity, as measured by the Stover scale, modified by Gauhl[2] on a scale of 0 to 6, where 0 = no symptoms and 6 = >50% of leaf affected. A disease severity index was then calculated, using the formula $DSI = [(\Sigma nb) / (N-1)T] * 100$, where n = the number of leaves at each scale level, b = the scale score, N = the number of scores used in the scale, and T = the total number of leaves evaluated.

Host-plant response was also determined by examining (i) the youngest leaf with symptoms (YLSt), that is, the youngest leaf from the top of the plant bearing symptoms of the disease; and (ii) the youngest leaf spotted (YLS), that is, the youngest leaf bearing at least 10 BLSD necrotic lesions.

The daily FER was calculated by the formula $FER_d = \{(NLN) + [0.1 * (NCS)]\} - \{(OLN) + [0.1 * (OCS)]\}/N_d$, where *NLN* = new leaf number, *NCS* = new cigar stage, *OLN* = old leaf number, *OCS* = old cigar stage, and N_d = number of days between the old and new observations[3].

Data on total daily precipitation and relative humidity were collected from the nearby weather station 'Paraguaicito' by the National Coffee Research Center.

All data collected were exported to SAS v. 9.2 (SAS Institute, Inc., Cary, NC, U.S.A.) for analysis. The CORR procedure was then used to estimate the Pearson correlation coefficients and significance levels.

Results

Symptoms were first observed 10 to 20 days after the first leaf had fully opened. Weather conditions throughout the study were highly favorable for disease development, with well distributed total precipitation at 3098 mm, and average relative humidity of >70% (Fig. 2).

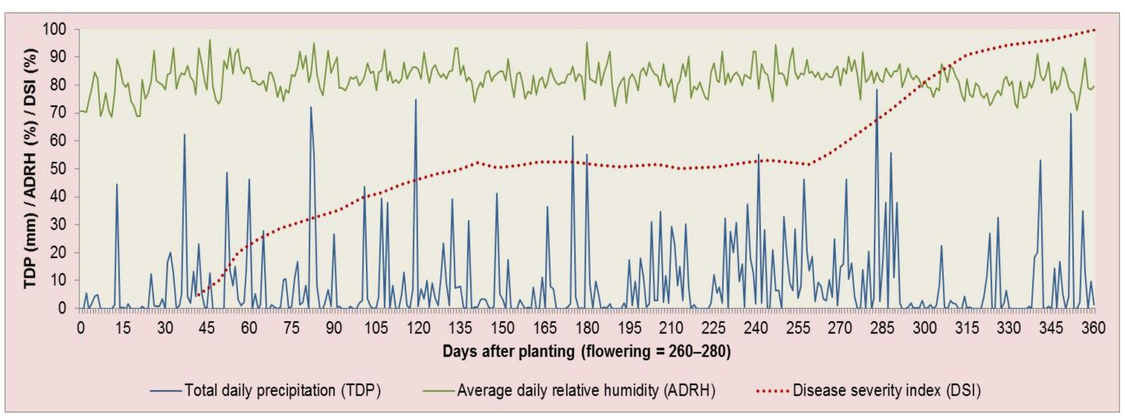

Figure 2. *Disease progress of black sigatoka over time, expressed by disease infection indices, together with weather conditions recorded throughout the study.*

According to the data analysis, FER values correlated positively and significantly with those for variables YLSt and YLS, and negatively and significantly for variable DSI. Inversely, values for the variable number of leaves emitted (NLE) correlated positively with those for DSI and negatively for YLSt and YLS (Fig. 3). Thus, increases in disease severity and presence of symptoms in younger leaves are associated with decreases in FER. This rate was faster during the plantain's vegetative stages (stages V1 to V3[4]), slower during its reproductive stages, and stopping as the total NLE reached 35 leaves (stage R5), just before emergence of the inflorescence. Under the conditions evaluated, completed NLE corresponded with 240 to 260 days after planting (Fig. 2).

The highest level of sigatoka infestation on banana plants at flowering corresponds with a reduced number of green-life days for fruits[5], meaning that banana growers must harvest younger fruits to reach the green-banana market. Bananas and plantains need a minimum of 6 to 8 functional leaves (i.e., leaves with a minimum of 50% photosynthetic area) at flowering to reach maximum fruit yield[6,7].

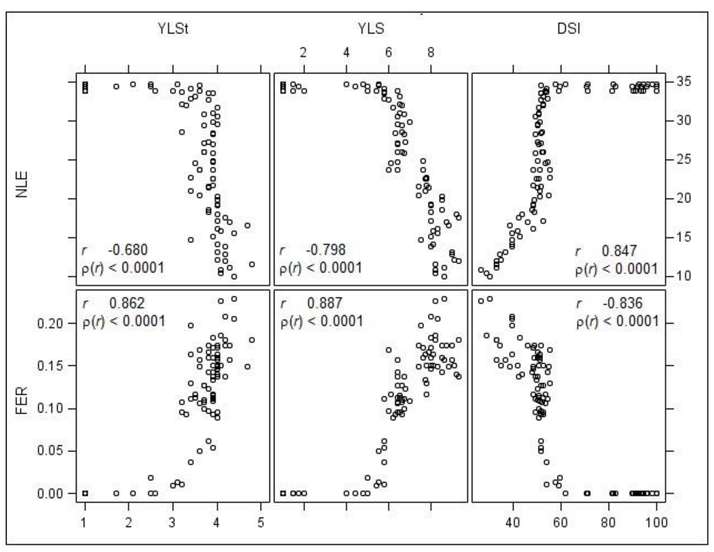

Figure 3. *Scatter plot matrix showing Pearson correlation coefficients (r) and their corresponding values [ρ(r)] between host-plant response to black sigatoka variables and plant growth characteristics, based on study data.*

Taking our results into account, FER and NLE can be monitored in plantain plantations during a cropping cycle. Thus, the critical time for applying fungicides before disease severity increases can be determined. Even as the number of applications drops, the number of functional leaves to flowering will still increase and the disease's impact will still decrease. Farmers can therefore save costs by waiting until they observe that foliar emission is about to cease before applying fungicides. The minimum number of fungicide applications according to the environmental conditions of different sites needs to be evaluated in further experiments.

References

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