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CHARACTERISATION OF MICROCLIMATIC INDICATORS IN COFFEE PRODUCTION SYSTEMS UNDER VARYING BIOPHYSICAL CONTEXTS AND ITS RELATION TO FUNGAL COFFEE DISEASES

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The comparison of performance of coffee under shaded and sun-exposed conditions has been explored in numerous studies. The beneficial effects of shading on coffee sustainability through the mitigation of microclimatic extremes have been quantified and are generally well-established. It has also been acknowledged that the extent to which shaded systems are advantageous depends on the biophysical context. Particularly in studies on pest and disease dynamics, this variability of shade effects across sites has resulted in contradictory assumptions. In this study, we (i) quantified microclimatic differences between three coffee production systems (coffee shaded by trees, (CT), intercropped with banana (CB), or sun exposed (CO) as a function of different environmental sites. We then (ii) related microclimatic indicators to the intensity of two fungal diseases (Coffee Leaf Rust (CLR), and Coffee Berry Disease, (CBD) of Arabica coffee. Along an altitudinal gradient from 1000 to 2200 m.a.s.l.) and in diverse production systems on the slopes of Mount Elgon, Uganda, we collected hourly data on temperature and relative humidity during the 2015/2016 season in 27 plots. Microclimatic indicators to compare included diurnal temperature range (DTR), the accumulated hours of relative humidity above 95 % (RH>95) during night, and the accumulated hours of temperatures below the dew point (Temp<DP) during night. Disease incidence was assessed in four (CBD) and six (CLR) weekly time intervals. An indicator for the disease intensity was established as the maximum percentage of diseased leaves or berries by CLR or CBD, respectively. We used LMMs or GLMs with Gaussian or negative binominal-distributed errors to analyze the microclimatic indicators and CBD and CLR intensity. Measures for model selection and goodness of fit included AIC, R^2 (mixed models) and the likelihood ratio test. The microclimatic indicators were characterized as follows: the DTR was consistent across altitudes but was significantly higher in CO systems. The indicators RH>95 and Temp<DP showed significant response variability to altitude and system with highest values at high altitudes in CO systems, followed by mid altitudes in CB systems and low altitudes in CT systems. The intensity of CLR and CBD significantly varied as a function of altitude, coffee system, DTR and Temp<DP. The CLR intensity significantly increased, and CBD intensity decreased with declining DTR. Both, CLR and CBD intensity increased with rising RH>95. Our findings confirm the mitigation property of shading to microclimatic extremes. However, the widely accepted assumption of shade conserving moisture is not applicable considering the spatio-temporal context. (ii) The fact that unshaded systems at high altitudes expose better conditions for dew formation than compared to shaded systems could be a key mechanism explaining the high CBD intensity under

unshaded systems and the contradictory CLR responses along the gradient of altitude and shading intensities.