Harnessing data science to improve integrated management of invasive pest species across Africa: An application to Fall armyworm (Spodoptera frugiperda) (J.E. Smith) (Lepidoptera Noctuidae)

Ritter A. Guimapi, Saliou Niassy, Bester Mudereri, Elfatih Abdel-Rahman, Ghislain T. Tepa-Yotto, Sevgan Subramanian, Samira Abuelgasim, Mohamed Karl Thunes, Emily Kimath, Komi Mensah Agboka, Manuele Tamo, Jean Claude Rwaburindi, Buyung Hadi, Maged Elkahky, May-Guri Saethre, Yeneneh Belayneh, Sunday Ekesi, Segenet Kelemu, and Henri E.Z. Tonnang

Abstract

After five years of its first report on the African continent, Fall armyworm (FAW), Spodoptera frugiperda (J.E. Smith) is considered a major threat to maize, sorghum, and millet production in sub-Saharan Africa. Despite the rigorous work already conducted to reduce FAW prevalence, the dynamics and invasion mechanisms of FAW in Africa are still poorly understood. This study applied interdisciplinary tools, analytics, and algorithms on a FAW dataset with a spatial lens to provide insights and project the intensity of FAW infestation across Africa. The data collected between January 2018 and December 2020 in selected locations were matched with the monthly average data of the climatic and environmental variables. The multilevel analytics aimed to identify the key factors that influence the dynamics of spatial and temporal pest density and occurrence at a 2 km x 2 km grid resolution. The seasonal variations of the identified factors and dynamics were used to calibrate rule-based analytics employed to simulate the monthly densities and occurrence of the FAW for the years 2018, 2019, and 2020. Three FAW density level classes were inferred, i.e., low (0–10 FAW moth per trap), moderate (11–30 FAW moth per trap), and high (>30 FAW moth per trap). Results show that monthly density projections were sensitive to the type of FAW host vegetation and the seasonal variability of climatic factors. Moreover, the diversity in the climate patterns and cropping systems across the African sub-regions are considered the main drivers of FAW abundance and variation. An optimum overall accuracy of 53% was obtained across the three years and at a continental scale, however, a gradual increase

in prediction accuracy was observed among the years, with 2020 predictions providing accuracies greater than 70%. Apart from the low amount of data in 2018 and 2019, the average level of accuracy obtained could also be explained by the non-inclusion of data related to certain key factors such as the influence of natural enemies (predators, parasitoids, and pathogens) into the analysis. Further detailed data on the occurrence and efficiency of FAW natural enemies in the region may help to complete the tri-trophic interactions between the host plants, pests, and beneficial organisms. Nevertheless, the tool developed in this study provides a framework for field monitoring of FAW in Africa that may be a basis for a future decision support system (DSS).