Biogeography of cereal stemborers and their natural enemies: forecasting pest management efficacy under changing climate

Reyard Mutamiswa, Gerald Chikowore, Casper Nyamukondiwa, Bester Tawona Mudereri, Zeyaur Rahman Khan and Frank Chidawanyika,

Abstract

Background: Climate warming presents physiological challenges to insects, manifesting as loss of key life-historyfitness traitsand survival. For interacting host–parasitoid species, physiological responses to heat stress may vary, thereby potentially uncoupling trophic ecological relationships. Here, we assessed heat tolerance traits and sensitivity to prevailing and futuremaximum temperatures for the cereal stemborer pests,Chilo partellus,Busseola fuscaandSesamia calamistisand their endo-parasitoids,Cotesia sesamiaeandCotesiaflavipes. We further used the machine learning algorithm, Maximum Entropy(MaxEnt), to model current and potential distribution of these species.Results: The mean critical thermal maxima (CTmax) ranged from 39.5±0.9°C to 44.6±0.6°C and from 46.8±0.7°C to 48.5±0.9°C for parasitoids and stemborers, withC. sesamiaeandCh. partellusexhibiting the lowest and highestCTmaxrespectively.From the current climate to the 2050s scenario, parasitoids recorded a significant reduction in warming tolerance comparedwith their hosts. Habitat suitability for all stemborer–parasitoid species was spatially heterogeneous under current and future climatic scenarios. Cotesia sesamiae C.flavipesandB. fuscaexhibited significant habitat loss, whereasCh. partellusandS. calamistisshowed a significant habitat gain under future 2050s predictions. Model metrics based on mean area under thecurve ranged from 0.72 to 0.84 for all species, indicating a good predictive performance of the models.Conclusion: These results suggest C. sesamiaeandC.flavipesmay face survival constraints or extirpation compared with their pest hosts when environmental temperature reaches their upper thermal limits earlier, likely reducing pest regulation through density-mediated effects. The results demonstrate potential destabilization of stemborer–parasitoid trophic systems poten-tially compromising biocontrol efficacy under climate warming.

© 2022 The Authors.Pest Management Science published by John Wiley & Sons Ltd on behalf of Society of Chemical Industry.