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**Modeling the life cycle and aeroecology of wind-borne crop pests in temporally-variable spatially-heterogeneous environments**

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Hsiao-Hsuan Wang, William E. Grant, John K. Westbrook, Michael J. Brewer, Tomasz E. Koralewski, Tavvs M. Alves, Gregory A. Sword, and Norman C. Elliott
Modeling the Life Cycle and Aeroecology of Wind-borne Crop Pests in Temporally-variable Spatially-heterogeneous Environments

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Abstract: Wind-borne crop pest insects affect the sustainability of agricultural systems throughout the world. Their long-distance, wind-aided dispersal together with their ability to survive on alternative host plants in temporally-variable, spatially-heterogeneous environments pose critical management challenges. We developed an integrated modeling framework that couples local life cycle and regional aeroecology of wind-borne crop pests to simulate their dynamics in complex environmental systems. The integrated framework facilitates assessment of sensitivity of model predictions of local intensities and regional patterns of infestations to uncertainties embodied in assumptions regarding life cycle and aeroecology of specific crop pests. As a proof of concept, we simulated infestation dynamics of the sugarcane aphid (Melanaphis sacchari) on sorghum (Sorghum spp.) in the Great Plains of the United States. More specifically, we assessed efficacy of planting aphid-resistant sorghum hybrids in different portions of landscape to decrease local aphid densities and to slow regional spread of infestations. We first parameterized the model based on different assumptions regarding aphids’ life cycle and aeroecology. We next evaluated the model’s ability to reproduce regional patterns of sugarcane aphid infestations observed in 2014. We then used the model to simulate regional infestation patterns under a variety of scenarios in which aphid-resistant sorghum had been planted in different portions of landscape. The exercise yielded valuable information regarding our current ability to assess model predictions of local aphid intensities and regional patterns of infestations as affected by weather and manipulation of planting aphid-resistant sorghum. Our results should contribute to managing sugarcane aphid infestations at area-wide scale.

Keywords: HYSPLIT; Individual-based model, NetLogo; Spatially-explicit model; Stochastic model