

A long-distance migration analysis of rice planthoppers using computer simulations

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Summary

Since long-distance migration of rice planthoppers immigrating into Japan in the *Bai-u* rainy season had been analyzed by using 2-dimensional methods, there were limitations of precision in both estimating migration sources and predicting migrations. In order to improve analytical precision, this study has developed two kinds of 3-dimensional methods. One is a backward trajectory analysis method that estimates migration sources. The other is a migration simulation method that conducts a forward migration analysis.

The backward trajectory analysis method consists of a numerical weather prediction model to simulate 3-dimensional atmosphere, and a backward trajectory analysis model to calculate planthoppers' trajectories backwardly using simulated atmospheric data. A migration event observed at Chikugo in western Japan was analyzed, and a paddy field area along the coastal region of Fujian province in China was estimated to be a possible migration source. Moreover, various migration parameters such as takeoff time, migration course, flight height and so on could be estimated.

The migration simulation method consists of the weather prediction model and a migration simulation model to calculate relative aerial density of migrating planthoppers. A field survey to catch white-backed planthoppers hourly was conducted at two sites in Kyushu in June 2003, and several migration events captured in the survey were analyzed with the simulation method. The results indicated that the coastal region in Taiwan as well as in Fujian province were estimated to be possible migration sources, showing a good agreement with the result of the backward trajectory analysis.

Furthermore, a number of trajectories were calculated to find major migration sources for 15-year catch data of white-backed planthoppers caught in Kyushu. The result showed that the major source region was estimated to be located in the coastal region of Fujian province and Taiwan.

A new finding on migration between the populations in East Asia was presented as well. It had been believed that there was no migration across the border between the populations. However, migrations of brown planthoppers that might have occurred on the border of the East Asian and South East Asian populations was suggested by the trajectory analysis.

The migration simulation model was also applied to migration prediction, and could predict migrations over the next two days. An evaluation indicated that the hitting ratio of the prediction was as good as that of rainfall forecast by Japan Meteorological Agency.

As described so far, this study provided new advanced analytical methods and knowledge, and, therefore, greatly contributed to science and pest management. The new methods are expected to be applied to migrations of other migratory insects.