MIGRATION ANALYSIS AND FORECASTING OF MIGRATORY INSECT PESTS

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ABSTRACT

Japan is located at mid-latitudes on the globe where westerly winds constantly prevail. The Asian Continent where many insect pests occur is also situated west of Japan. Some of these insect pests can fly a long distance, sometimes for over 1,000 km crossing the East China Sea. A variety of migratory insect pests, therefore, arrive in Japan. These environmental conditions basically explain why we have many migratory insects. So far, we have studied the migration of seven species including rice planthoppers, a fruit fly and nocturnal moths. The fall armyworm, Spodoptera frugiperda, originally native to the Americas, is a very recent one having arrived in Japan in summer 2019. The moth was rapidly expanding this spring in China, thus we evaluated the risk of possible immigration with forward trajectory analysis using meteorological data from the past five years. We also quickly developed a preliminary migration prediction system and monitored favorable winds from southern China on a daily basis. This prediction was shared with colleagues in Taiwan. The result showed that Japan would be invaded from Fujian and Zhejiang Provinces in 1 June–15 July, and Kyushu, Shikoku and southwestern Honshu could face the highest risk of S. frugiperda invasion. The migration prediction system predicted a possible migration from Guangdong Province emigrating on 20 and 23 May, and late instar larvae were found in Taiwan on 8 June. These timings quite matched the developmental time from oviposition to 6th instar of 14 to 17.7 days, based on reference estimates. In Japan, the first two larvae were found in Minami-Kyushu City, Kagoshima Prefecture, southwestern Japan, on 27 June 2019. A total of 78 larvae were found in six prefectures of Kyushu-Okinawa region by 16 July. A predicted possible migration from southern China on 6 June suggested the first immigration timing for Japan. Topological analysis of larvae collection sites suggested for the first time that S. frugiperda’s flight height during overseas migration reaches an altitude of up to over 800 m. We are also studying the migration and dispersal of the oriental armyworm, Mythimna separata, and the common cutworm, Spodoptera litura. The cutworm is a highly dispersible insect pest and attacks soybean leaves in summer in western Japan. Its dispersal was monitored with searchlight traps and an entomological radar. The armyworm usually arrives in northern Japan and its migration source is being estimated with trajectory analysis and stable isotope analysis of wing samples. Technologies related to insect migration studies are also introduced in this presentation.
Migration analysis and forecasting of migratory insect pests

Arrival of the fall armyworm and expansion of its distribution in East Asia

Fall armyworm, Spodoptera frugiperda
- Migratory insect (Westbrook, 2015)

Arrival in southwestern China in Jan 2019

Late April to late May

Overseas migration: Taiwan

Overseas migration: Korea
Session 1

**Summary: FAW overseas migrations**

<table>
<thead>
<tr>
<th>Case</th>
<th>Arrival date</th>
<th>Meteorol. condition</th>
<th>Estimated source</th>
<th>Flight duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taiwan</td>
<td>17-23 May</td>
<td>rainy front</td>
<td>Fujian, Guangdong</td>
<td>17-21 h</td>
</tr>
<tr>
<td>Korea</td>
<td>6 June</td>
<td>low-pressure system</td>
<td>Fujian, Guangdong</td>
<td>24 h</td>
</tr>
<tr>
<td>Japan</td>
<td>7 June</td>
<td>low-pressure system</td>
<td>Zhejiang, Fujian, Guangdong</td>
<td>14.9-38 h</td>
</tr>
</tbody>
</table>

*First estimation of parameters of FAW’s overseas migrations*

**What would happen in 2020?**

- Autumn populations in China and Japan exist
  - They migrate to the south and overwinter there.
  - Guangdong, Henan, Guangxi, Yunnan provinces as well as probably Vietnam would be overwintering areas (>10 deg.C in winter).
  - Spring population could become larger than that in 2019.
  - Spring-summer migration could get intense.

**International cooperation on migration studies**

- JIRCAS
- P.R. China
  - Peking Academy of Agricultural Sciences
  - Nanjing Agricultural University
  - Jiangsu Academy of Agricultural Sciences
  - Guangdong Academy of Agricultural Sciences
- Korea
  - National Institute of Agricultural Science, RDA
- Vietnam
  - Plant Protection Research Institute
  - Southern Region Plant Protection Center
- Taiwan Agricultural Research Institute

**Insects caught in pheromone traps in 2009**

- Suggestion: possible overseas migration in East Asia could occur from spring, early summer to the Baiu rainy season.
- This is the same as Ma et al. 2019 J Appl Entomol
- Monitoring of the overwintering population in southern China is key.