

Climate Change Impacts on Outbreak of Brown Plant Hopper and Options for Prevention

1. Executive summary

In South East Asia, brown plant hopper (BPH) is one of the most destructive pests on rice. The change of climate will change the conditions for rice cultivation in Vietnam, potentially eliciting outbreaks of pests such as BPH. We investigated the direct effects of climate change on BPH in controlled climate chambers. In the field, we investigated the occurrence of insecticide resistance in BPH to understand better the current constraints on BPH control. To establish an early warning system for BPH outbreaks, we implemented a BPH trapping network across Vietnam. To integrate our results, we built a BPH simulation model to be verified against historical data on BPH population dynamics in Vietnam.

In conclusion, climate change will alter the conditions for rice production in Vietnam but BPH does not stand out as a particular problem under climate change. We conclude that insecticide resistance is not yet a dominant problem in Vietnam. We were able to establish a BPH trapping network in Vietnam; however, the quality of the data was not high enough that this trapping network alone can serve as an early warning system for BPH. We developed a BPH simulation model; however, available data turned out inadequate for model validation.

Intelligent use of insecticides within an integrated pest management framework will remain the most powerful tool to secure rice production in Vietnam against insect pests also under climate change.

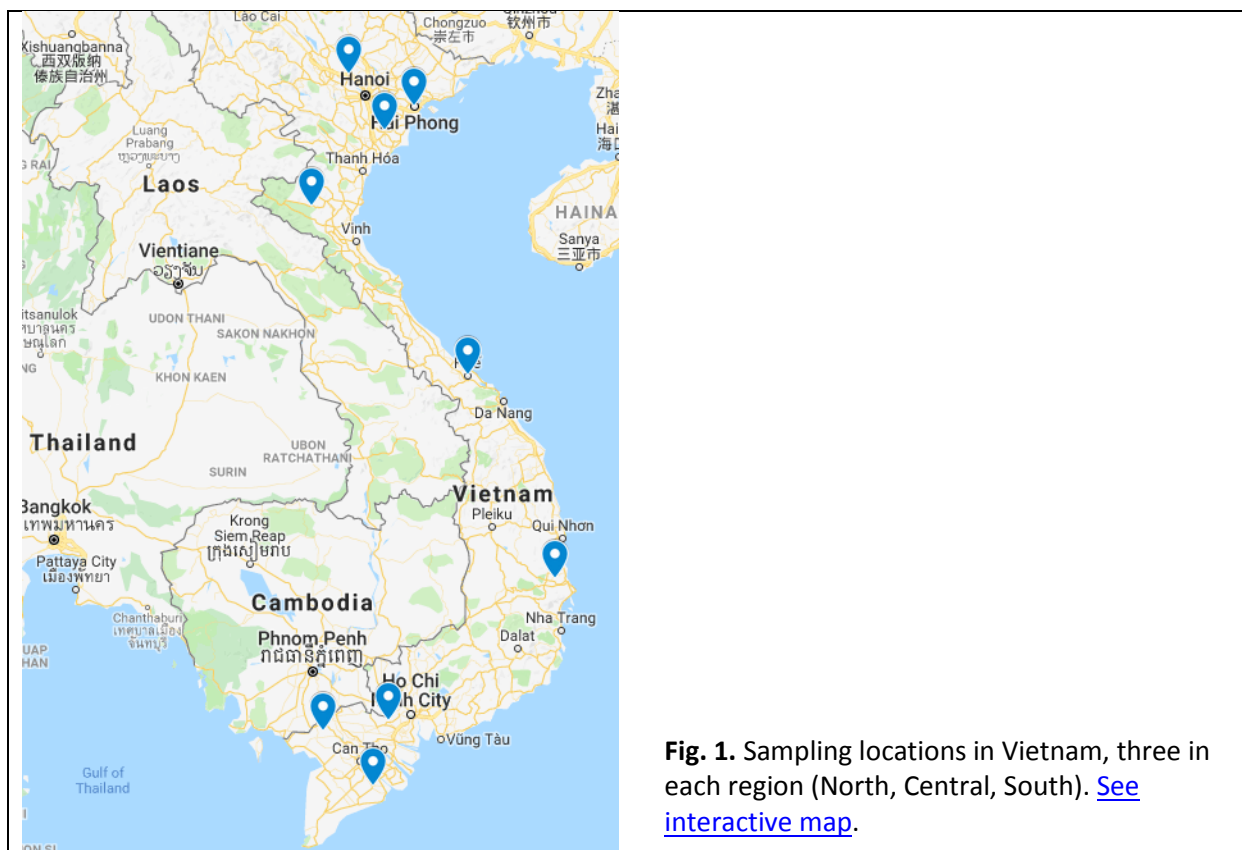


Fig. 1. Sampling locations in Vietnam, three in each region (North, Central, South). [See interactive map.](#)

2. Introduction

Vietnam, with its long coastline (3,260 km) and tropical monsoon climate, is considered one of the most vulnerable countries under climate change. Rice plays an important role in the national economy of Vietnam. Rice accounts for 92% of the total food grain production and provides 68% of the calories consumed by the population. Among the many pests attacking rice in South East Asia, brown plant hopper (BPH) is a recurring, serious problem. Thus, a BPH outbreak in Vietnam in 2010 caused a 30% loss in rice yield. The question is whether the anticipated change of climate in Vietnam will provoke BPH outbreaks in the future.

To answer that question, the rice cropping system must be studied as a whole, taking into account the growing practices that influence both rice and BPH. Our working hypothesis was that an intelligent orchestration of these practices (foremost, choice of rice cultivars and insecticides) could be key to prevent BPH outbreaks, both in the current and future climate.

Our main project outcomes:

- The direct effect of climate change on BPH was assessed in climate chamber studies (to be concluded ultimo 2018).
- An early warning system on BPH outbreaks was established in the form of six light traps with trap catches recorded in an online database; however, this trapping network cannot stand alone but must be complemented by the existing field observation network on rice pests and diseases.
- A simulation model of BPH dynamics was created but could not be scientifically published because the historical records of BPH, meant for validation, were missing essential information (no data on rice cultivars grown or insecticides used).
- In contrast to other regions in South East Asia, we found that Vietnamese BPH has not acquired resistance at a significant level against any insecticide.
- We were partly successful in educating young Vietnamese scientists in the disciplines of molecular biology and ecological modelling.

We conclude that the BPH outbreaks observed in Vietnam so far has not been due to insecticide resistance, nor has the climate been exceptional in the outbreak years. The likely causes for BPH outbreaks until now and in the future are

- an overreliance on insecticides, causing a breakdown of the natural pest control by natural enemies.
- choosing rice cultivars susceptible to BPH, rather than BPH-resistant cultivars

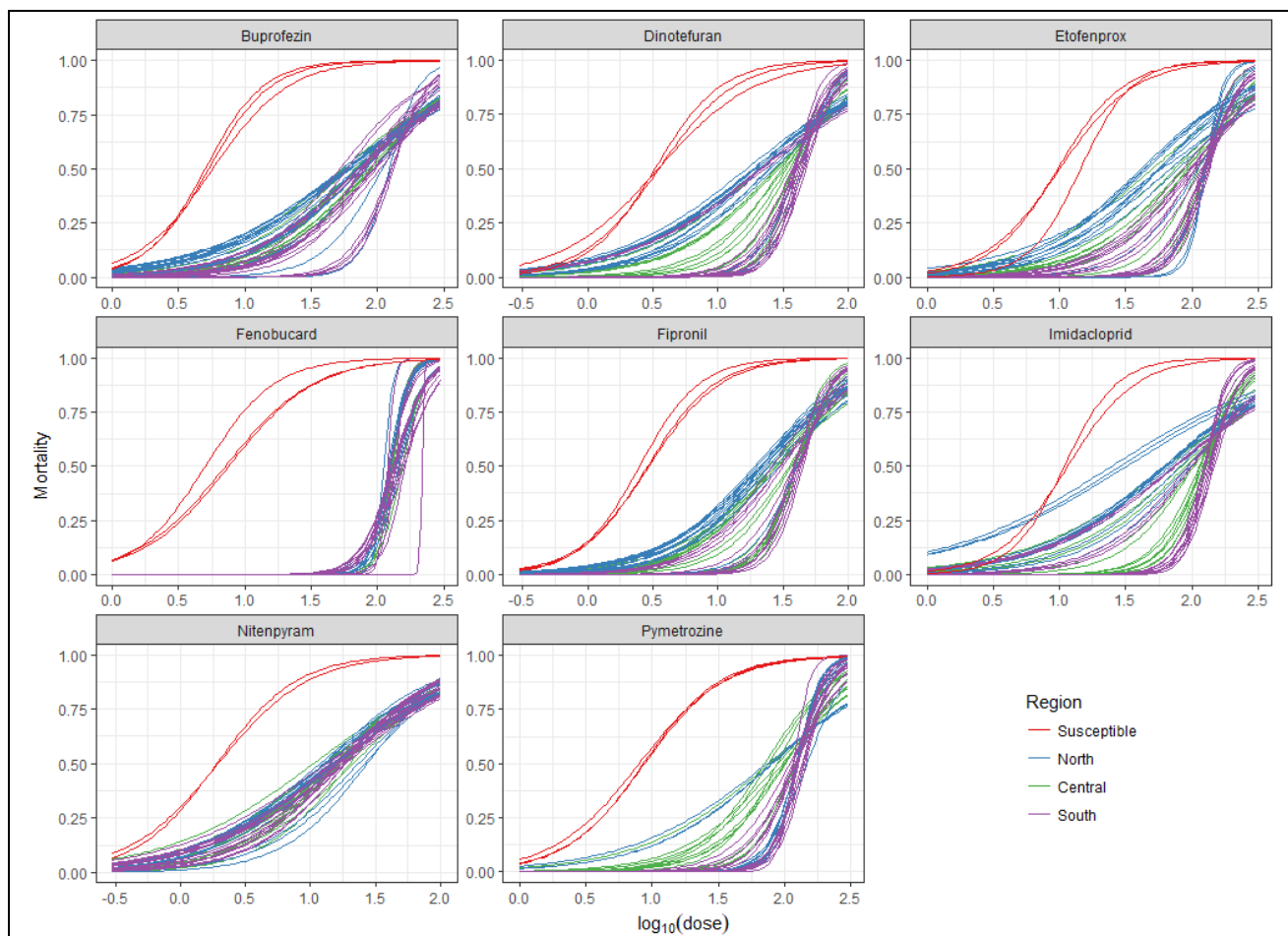


Fig. 2. The mortality of BPH exposed to increasing doses of eight different insecticides. BPH caught in the different regions of Vietnam (blue, green and violet curves) were only slightly resistant compared to the susceptible laboratory strain of BPH (red curves). In conclusion, insecticides will still work effectively in Vietnam. From Khoa, Thang, Liem, Holst & Kristensen (PLOS ONE, *in press*).

3. Results

Q: Will climate change cause an increased incidence of brown plant hopper (BPH) outbreaks?

A: Not by itself. Anthropogenic factors (primarily insecticide use and choice of rice cultivar) will continue to be the dominant causes eliciting BPH outbreaks.

Q: How can we manage the rice crop to prevent BPH outbreaks?

A: Regionally: By using insecticides with different modes of action alternatingly and by choosing BPH-resistant rice cultivars. Locally: By applying insecticides only when needed in the field.

Q: Can we predict BPH outbreaks?

A: Trap catches in South Vietnam might give an early warning of a BPH built-up before BPH migrates north, but only if the trapping network is extended and is properly serviced.

Specifically, the results were

- There is no evidence that climate change by itself will cause a rise in BPH outbreaks in Vietnam.

- Improper use of insecticides is the most likely cause of BPH outbreaks in Vietnam, curtailing natural control of BPH.
- BPH has not developed insecticide resistance at a significant level in Vietnam.
- Expertise on biological experiments, biomolecular analysis and underlying laboratory facilities was established at the Vietnamese partner institute.
- The capacity building in terms of young scientists was unsatisfactory.

4. Conclusions

BPH outbreaks can be prevented by

- a need-based use of insecticides.
- a proper rotation of different types of insecticides to prevent the build-up of insecticide resistance.
- an intelligent choice of rice cultivars based on already known types of rice resistance against BPH.

5. Implications

The future implications of the project are

- Farmers must be enabled/nudged/enforced to take the correct integrated pest management (IPM) actions against BPH, including choice of rice cultivar, choice of insecticide and need-based insecticide applications (timing, dosage).
- Advisory services in Vietnam must be properly linked with research institutes to secure evidence-based decision making all the way to farmer level.
- Academic education in Vietnam can be improved to align with international standards.
- A synergetic teamwork was established between Vietnamese and Danish scientists; the collaboration will continue regarding BPH and other IPM problems in Vietnam.

6. Recommendations

The policy recommendations arising from the project are

- Policies must be developed to enhance the correct use of insecticides in Vietnam.
- Information: Specific and detailed strategies should be described, based on current knowledge, how to rotate between different types of insecticides and between different types of BPH-resistant rice cultivars.
- Early BPH warning system: The current field observation network on rice pests and diseases must be improved to include essential agronomic records (on rice cultivars, pesticides, fertilisers).
- Teaching of farmers: Farmers and agricultural consultants must learn to spray insecticides only when needed.
- Teaching of teachers: Teachers and lecturers at all academic levels would benefit from international collaboration on the development of curricula and teaching methodologies.
- Research collaboration between Vietnamese and Danish scientists should be promoted continuously.