Response of the Xylella fastidiosarelated plant diseases to future climate conditions

Martin Godefroid, Astrid Cruaud, Jean-Claude Streito, Jean-Yves Rasplus, Jean-Pierre Rossi

3rd European Conference on
Xylella fastidiosa and XF-ACTORS final meeting

Response of the *Xylella fastidiosa*-related plant diseases to future climate conditions

M. Godefroid, A. Cruaud, JC. Streito, JY. Rasplus, JP. Rossi

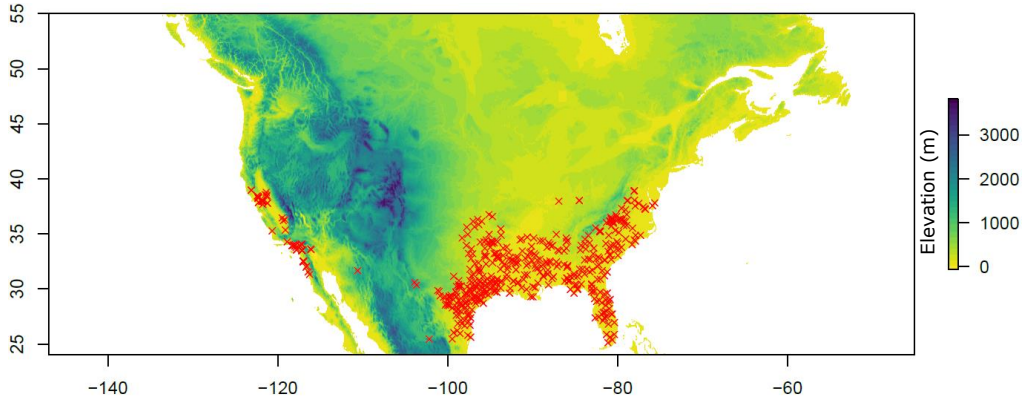
INRAE- Centre de Biologie pour la Gestion des Populations, Campus International de Baillarguet, Montferrier-sur-Lez, France

CONTEXT, OBJECTIVE AND METHODS

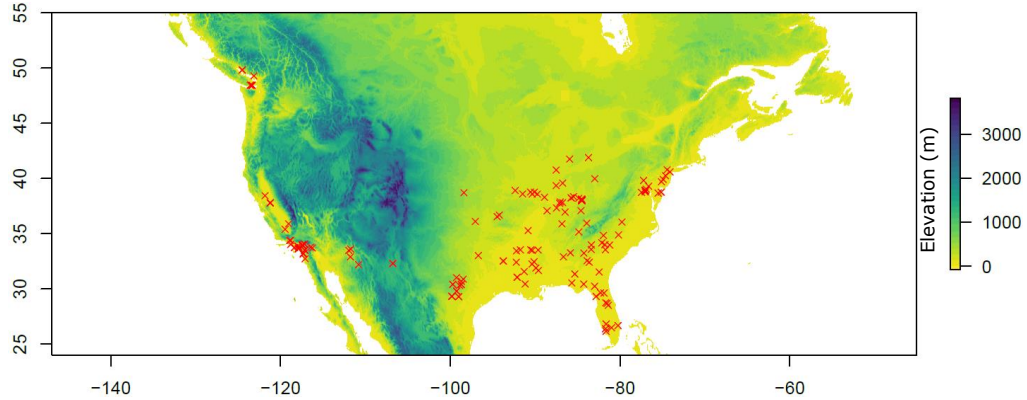
- **Context** The design of monitoring and pest management strategies relies on an accurate forecast of *Xylella fastidiosa* (*Xf*) response to ongoing climate change.
- **Objective** In the present study, we aim at forecasting the change in potential climatic suitability of Europe induced by ongoing climate change for two important *Xf*-related plant diseases namely the Pierce's disease of grapevine (PD) and the bacterial leaf scorch of tree (BLS). PD is a grapevine disease caused by the subspecies *Xf fastidiosa*, while the BLS is a disease attacking a diversified range of host plants (e.g. oak, elm, maple, sycamore, etc.) caused by the subspecies *Xf multiplex.*
- **Methods** We used correlative species distribution models (SDMs – Peterson et al. 2011) to establish a statistical relationship between subspecies' presence/absence and climatic conditions in order to predict potential change in climatic suitability of Europe under future climate conditions. We collected presence records of both subspecies in their native range (Americas), and fitted 2 different models - i.e. generalized linear models (GLMs) and Maxent (Phillips et al. 2006) - using two climatic descriptors namely the mean temperature of the coldest quarter of the year and the average temperature of the warmest 8-month period of the year. Bioclimatic data were extracted from the CHELSA database, which reflects average climate conditions for the 1979-2013 period (Karger et al. 2017). For the PD, we also generated "artificial" presences in south-eastern states of North America (Texas, Florida, Alabama, Georgia, etc.), which are considered as the traditional range of the PD. Models were fitted using presences and 10,000 pseudo-absences (i.e. localities where the presence/absence status of the disease is unknown) randomly generated in North America (between latitudes of 25 and 65 degrees North). We split the data into calibration/evaluation datasets (80-20% of data) and evaluated the predictive accuracy of models using the area under the curve of the receiving operator curve (AUC – Fielding and Bell, 1997). We predicted the potential future climatic suitability of Europe for both diseases using simulations of future climate conditions (period 2040-2060) available in the fifth Assessment Report of the Intergovernmental Panel on Climate Change. We averaged the predictions of models projected on three simulations of future climate conditions (MIROC5, CanESM2 and HadGEM2-CC global circulation models). We adopted a conservative approach by considering the most pessimistic future greenhouse gas emission scenario (rcp85 ; Van Vuuren et al. 2011).

PRESENCE RECORDS IN NORTH AMERICA

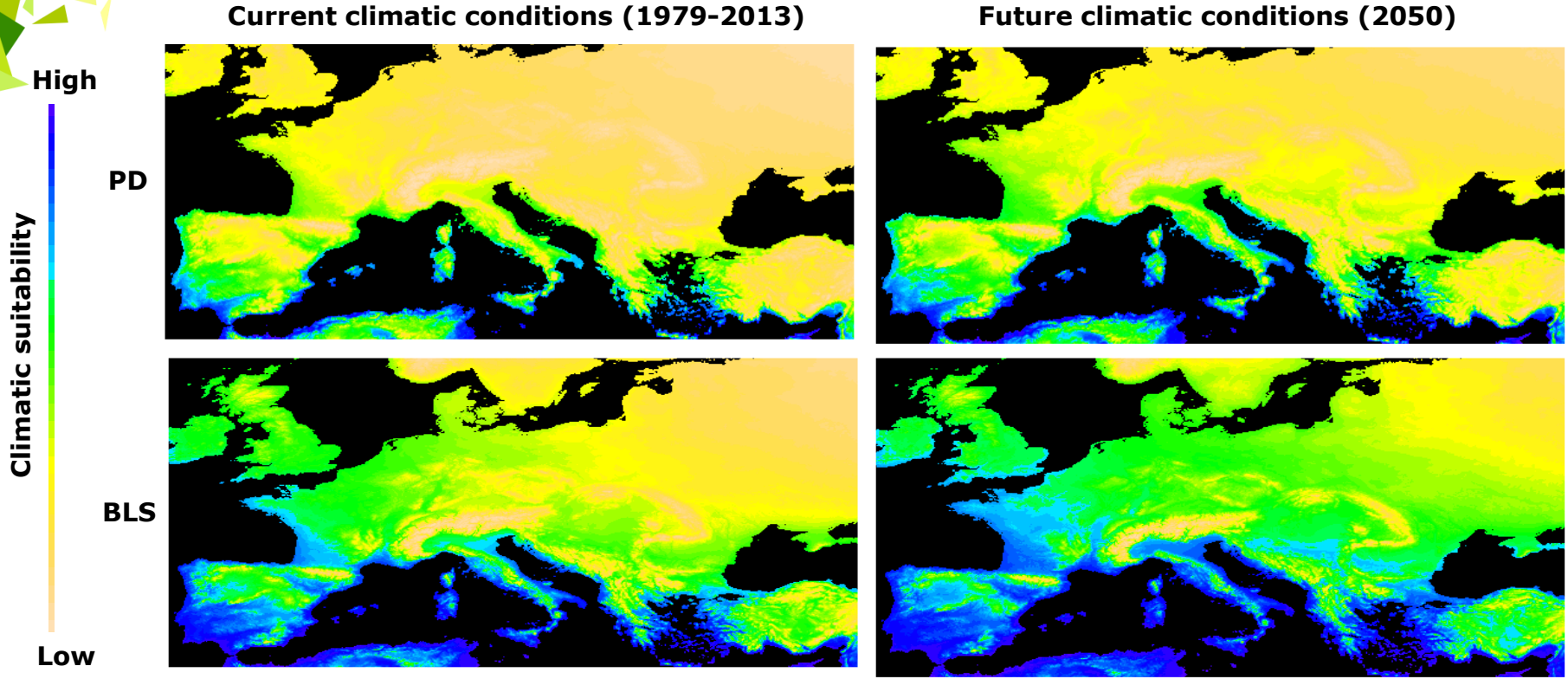
PD



BLS



PREDICTIONS



RESULTS AND CONCLUSIONS

- Models yielded excellent evaluation metrics (AUC > 0.9).
- For PD, the most ecologically realistic predictions were provided by the Maxent approach.
- For BLS, the most ecologically realistic predictions were provided by the GLM approach.
- Winter temperatures yielded the highest relative contribution to models for both diseases.
- Temperatures of the warmest 8-month period yielded extremely low relative contribution to models.
- Models predicted that the climatic suitability for PD will increase during the next decades in most of Europe. Economically important wine-growing regions of southern France, lowlands of Italy and Greece, southern and central Spain, southern and western Portugal and coastal Balkans could become severely threatened by PD.
- Climatic suitability is predicted to increase for BLS in Europe. Most of lowlands in the Mediterranean area as well as southern United Kingdom and most of western France could become severely threatened by BLS.
- Weaknesses: There is high correlation between both bioclimatic variables. The maps presented here only consider climate suitability for multiplication of the bacterium (no data on vectors, host plants, landscape or human activities were accounted for in these predictions).
- These maps constitute promising proxies to design control strategies and monitoring plans at European scale.

References

- Fielding AH, Bell JF (1997) A review of methods for the assessment of prediction errors in conservation presence/absence models. Environ Conserv 24:38–49
- Karger DN, Conrad O, Böhner J, et al (2017) Climatologies at high resolution for the earth's land surface areas. Sci data 4:1–20
- Peterson AT, Soberón J, Pearson RG, et al (2011) Ecological niches and geographic distributions (MPB-49). Princeton University Press
- Phillips SJ, Anderson RP, Schapire RE (2006) Maximum entropy modeling of species geographic distributions. Ecol Modell 190:231–259
- Van Vuuren DP, Edmonds J, Kainuma M, et al (2011) The representative concentration pathways: an overview. Clim Change 109:5–31