中国農業大學
China Agricultural University

Corridors in chinese northern single-cropping potato region exhibit high dispersal potential of invasive Colorado potato beetle considering climate change

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CONTENTS

The increase in the frequency of intrusions leads to higher management costs

Source: CABI(https://www.cabi.org/)

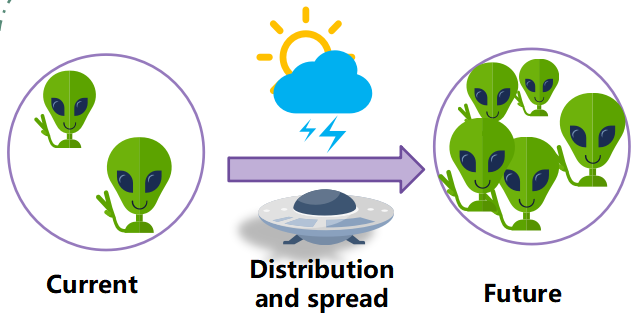
Reduce

Biodiversity & Ecosystem stability

Economic development

Managing invasive species is a global challenge!

(Dakhil et al., 2019; Li et al., 2016; Seebens et al., 2017; Strayer, 2012; Turbelin et al., 2024)



Climate change affect the distribution and spread of invasive species！！

Scientific management of the spread of invasive species is importance！！

(CBD, 2022 ;Di Febbraro et al., 2023;Faulkner et al., 2024)

Solanum rostratum

Source: CABI(https://www.cabi.org/)

Origin Host

Colorado potato beetle

Leptinotarsa decemlineata

Source: CABI(https://www.cabi.org/)

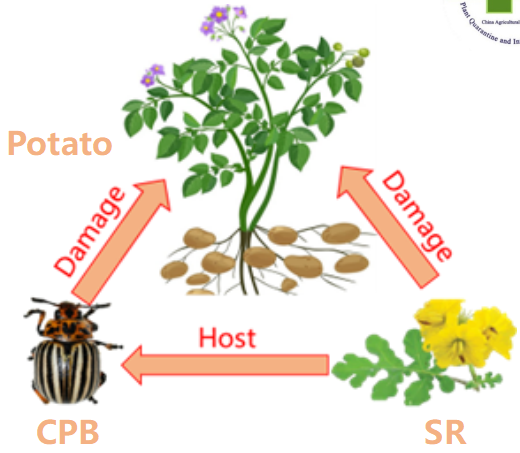
- **Annual invasive weed;**
- **Plant is toxic, has high seed yields,;**
- **Harm economic crops such as cotton, corn, and potatoes in farmland;**

- **Native to the Rocky Mountains, USA;**
- **Now distributed in multiple countries;**
- **Feeds on plants in the *Solanaceae* family;**
- **Strong adaptability and mobility;**

Both CPB and SR can cause great harm to potatoes! !

(Izzo et al., 2018; CABI, 2021; Alyokhin et al., 2022;Chen et al., 2023; Cingel et al., 2016; Cohen et al., 2022; Abu-Nassar and Matzrafi, 2021; Mukherji, 2023;Gu, 2017; Sofaer et al., 2019)

(Yingxuan Li Drawing)

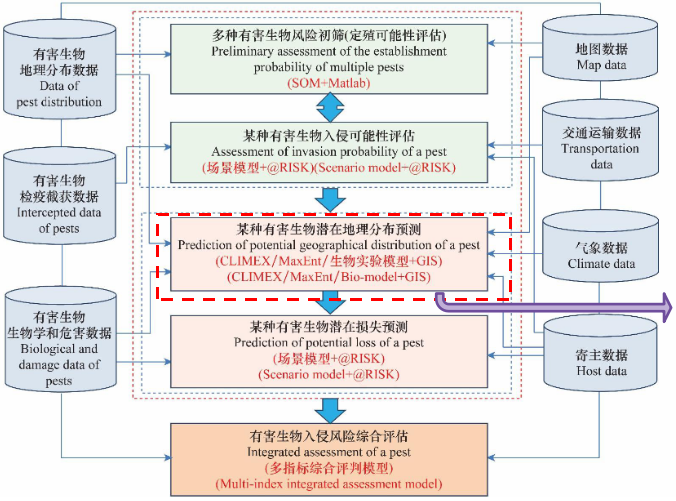


- **China is the world’s largest producer of potatoes, with four growing areas covering the entire country**
- **CPB and SR directly promote invasion and jointly threaten the growth and yield of potatoes.**

How will CPB follow a dynamic spread path by consuming SR?

quantitative assessment of pest risk analysis

(FAO,2024)



Integrated technology system for quantitative assessment of pest risk Analysis

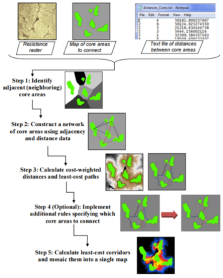
- **There is a quantitative assessment framework for pests, which is applied to multiple species.**
- **Now, we have also combine the research on species spread into this framework.**

Spread: Linkage mapper

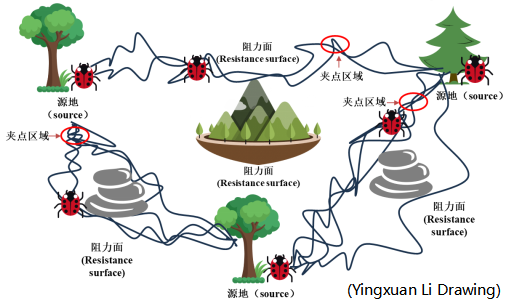
(Li and Qin, 2018)

Ensemble model：Biomod2

- **Integrating the results of multiple models;**
- **Balancing the deviation of a single model;**
- **Reducing the risk of overfitting.**



Linkage Mapper workflow
(https://linkagemapper.org/)



Linkage Mapper identifies habitat corridor concept maps

Linkage Mapper

- **Identifies potential ecological corridors;**
- **Locates key pinch points.**

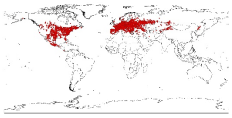
(Thuiller et al., 2009; McRae&Kavanagh,2011; McRae et al., 2008)

How will CPB follow a dynamic spread path by consuming SR?

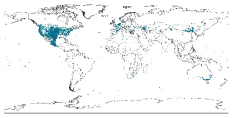
- 1. What are the key environmental variables that affect the changes in CPB and SR adaptation zones?
- 2. What are the potential distributions of CPB in China under climate change?
- 3. What are the potential corridors of CPB in potato producing areas in China through feeding on SR ?
- 4. What are the Pinchpoints in the corridors of CPB that require focused management ?

Biomod2

- **Distribution data processing of CPB and SR**



Distribution data of CPB



Distribution data of SR

- **Significant environmental variable**

  Current； 2050SSP1-2.6； 2050SSP5-8.5.

- **Ensemble models setup and evaluation**

  Seven single models：RF ,XGBoost, MaxEnt, GLM, GBM, GAM, CTA;

  Distribution points were divided into a 75% training set and a 25% testing set .

Linkage Mapper

- **Identify source areas**

  Select high and medium suitability areas with potential distribution area of CPB than 2500 km^2

- **Build resistance surface**

  Potential distribution of SR + Elevation

- **Build corridor and Identify Pinchpoint**

  Using the Linkage Mapper to identify the lowest-cost pathway corridors and key points.

3.1 Ensemble Model Performance and variables importance

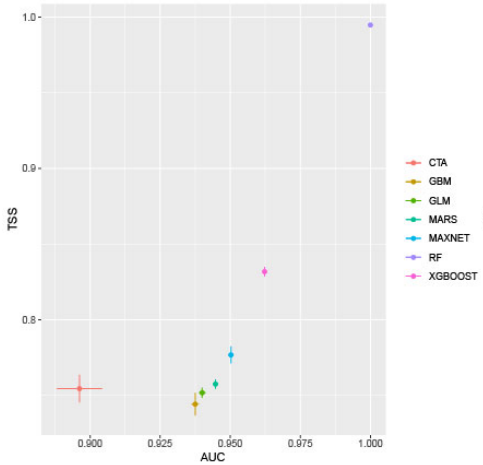


Fig 1.The performance of CPB seven single models for ROC and AUC

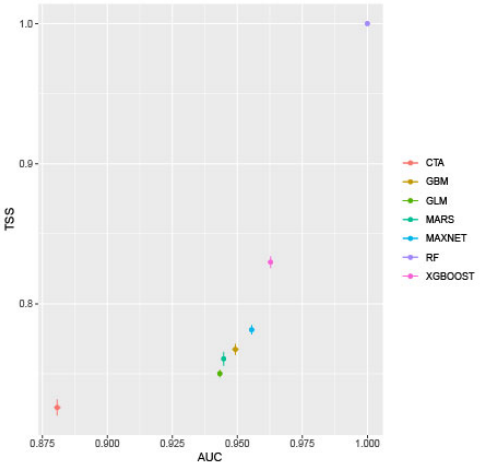


Fig 2.The performance of SR seven single models for ROC and AUC

- The seven single models for CPB and SR performed well (mean TSS > 0.783, AUC > 0.943)

Indicators to evaluate the performance

- True skill statistics (TSS)
- Under the receiver-operating characteristic curve (AUC）

(Yingxuan Li et al；Unpublished)

3.1 Ensemble Model Performance and variables importance

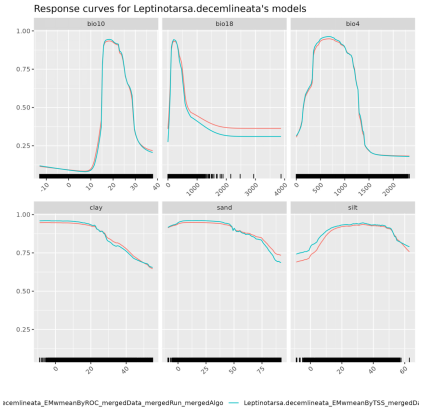


Fig 3.Response curve of CPB to variables

Note: Bio 10: Mean Temperature of Warmest Quarter;
Bio 18: Precipitation of Warmest Quarter
Bio 4: Temperature Seasonality

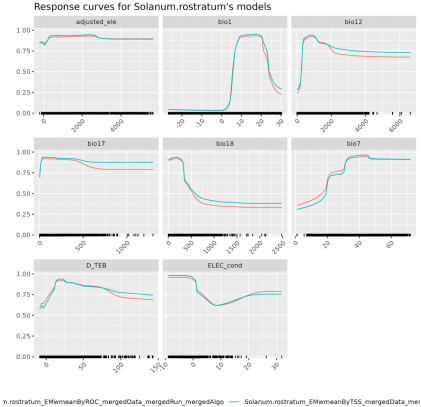


Fig 4.Response curve of SR to variables

Note: Bio 1: Annual Mean Temperature Bio 12: Annual Precipitation
Bio 17:Precipitation of Driest Quarter Bio 18:Precipitation of Warmest Quarter
Bio 7: Temperature Annual Range

- **The factors influencing CPB include: temperature, precipitation and soil.**
- **The factors influencing SR include temperature, precipitation, soil and elevation.**

(Yingxuan Li et al; Unpublished)

3.2 Potential geographic distribution of CPB in China

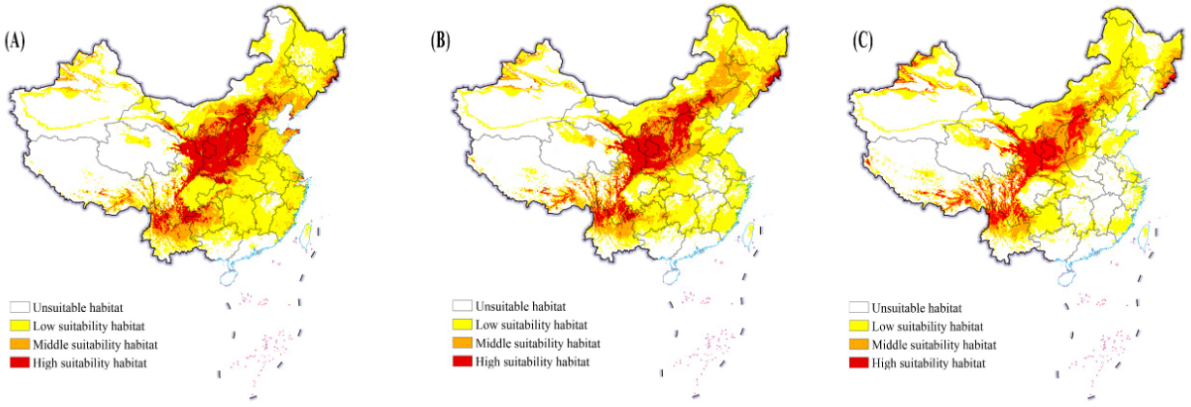


Fig 5. Potential distribution of CPB in China under three climate scenarios: (A) Current; (B) 2050 SSP1-2.6 (a low-emission, sustainable development pathway); (C) 2050 SSP5-8.5 (a high-emission, rapidly changing pathway)

- **CPB exhibited broad suitable areas across China, with a projected westward and northward shift under future climates.**

(Yingxuan Li et al; Unpublished)

3.3 Construction of the Resistance Surface Under Different Climate Scenarios

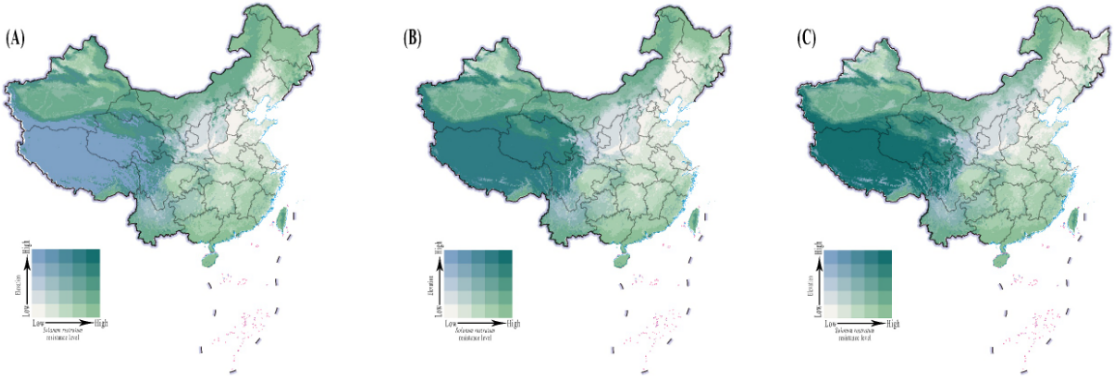


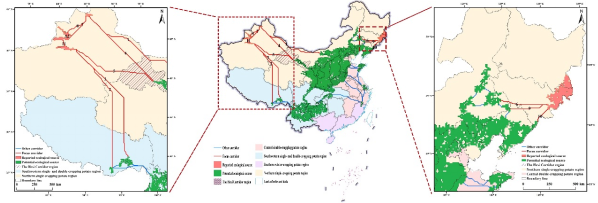
Fig 6. Bivariate maps of SR occurrence probability and elevation used to construct the CPB dispersal resistance surface under three climate scenarios: (A) Current, (B) 2050 SSP1-2.6, and (C) 2050 SSP5-8.5

Note :(1) SR occurrence probability is divided into five levels, represented by a color gradient from white (low suitable probability) to dark blue (high suitable probability). (2) Elevation is divided into five levels, represented by a gradient from white (low altitude) to dark green (high altitude). (3) Climate scenarios: SSP1-2.6: low-emission, sustainable development pathway; SSP5-8.5: high-emission, rapidly changing pathway.

- **Low resistance surface :east region and northeast region**
- **High resistance surface: the Qinghai-Tibet Plateau and in parts of Xinjiang**

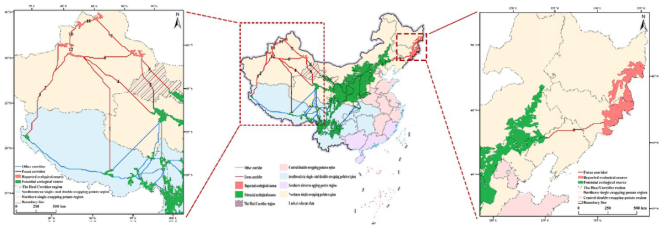
(Yingxuan Li et al; Unpublished)

3.4 Habitat corridors



A：Current

B：2050SSP1-2.6



C：2050SSP5-8.5

Figure 7. Habitat corridors for CPB dispersal under different climatic scenarios (A：Current；B：2050SSP1-2.6；C：2050SSP5-8.5) The left picture shows the potential focus corridors for CPB diffusion in the western region of China. The picture in the middle part shows the potential diffusion corridor of CPB in China. The picture on the right shows the potential focus corridors for CPB diffusion in eastern China.

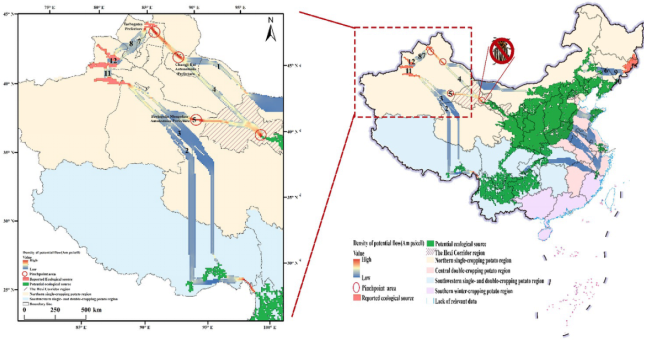
Under climate change the number of key corridors

West region ↑

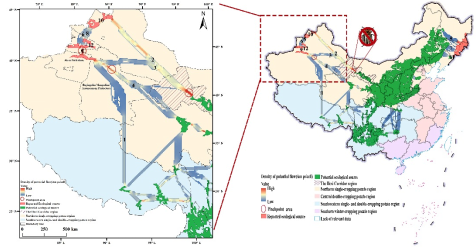
East region ↓

(Yingxuan Li et al; Unpublished)

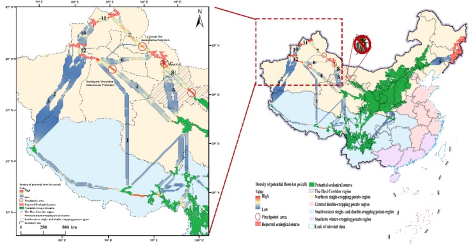
3.5 Pinch point identification



A: Current



B: 2050SSP1-2.6



C: 2050SSP5-8.5

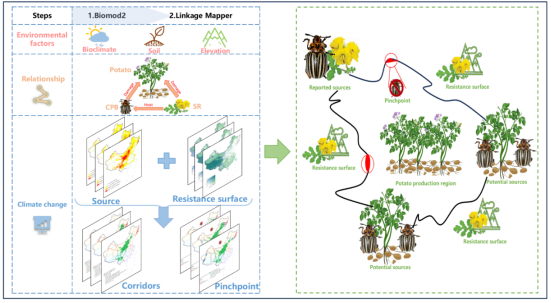
Figure 8. CPB dispersal corridor density currents under different climatic scenarios (A: Current; B: 2050SSP1-2.6; C: 2050SSP5-8.5). The left figure shows the current density of the potential corridor for CPB diffusion in the western region of China. The picture in the right part shows the potential corridor for CPB diffusion in China.

- **Consistently appeared in the Hexi Corridor and Bayingolin Mongol Autonomous Prefecture of Xinjiang across all scenarios.**

(Yingxuan Li et al; Unpublished)

(Yingxuan Li Drawing)

- **CPB corridors are mainly concentrated in western China, particularly in Xinjiang and the Hexi Corridor, which are rich in agricultural resources.**
- **Future climate scenarios suggest the emergence of new corridors in southwestern China, which is a potential hotspot for CPB spread.**
- **Considering environmental factors such as land use, distribution of various host plants, wind patterns and water flow, as well as human activity data, the spread corridor model is optimized.**



The framework of CPB for predicting spread corridors

- **CPB distribution is influenced by temperature, precipitation, and soil.**
- **CPB exhibited broad suitable areas across China, with a projected westward and northward shift under future climates.**
- **Under the current ,CPB corridors linked all the major potato-growing areas, among which the northern single-growing area contains the most corridors of focus.**
- **Corridor pinchpoints varied across climate scenarios, but they consistently appeared in the Hexi Corridor and Bayingolin Mongol Autonomous Prefecture of Xinjiang across all scenarios.**

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Thank you for your attention!