

CLIMATE REANALYSIS TO SUPPORT SUSTAINABLE AGRICULTURE: BIOSUCCESS

The key objective for **BioSuccess** is to assist the agriculture industry in moving away from the use of synthetic chemical pest control to the use of more sustainable biopesticide products.

Research has shown that, **pest and diseases are responsible for up to 40% of small-holder crop losses worldwide**. To date, synthetic chemical pesticides are the primary means of pest / disease control, but concern regarding over-reliance on these products is increasing due to issues such as environment toxicity, worker and consumer exposure, and insect resistance.

Biopesticides are emerging as safer, effective alternatives to chemical pesticides. As a living organism, the efficacy of a biopesticide is controlled in part by environmental conditions such as temperature. In addition, biopesticides require time to take effect and hence users need guidance on when to expect results from their spraying campaign. BioSuccess assists users make better use of their biopesticide by addressing;

- When should I spray to achieve maximum effectiveness?
- If I spray on this day, when will the pest population be controlled/killed?
- When should I spray to achieve control aims by a certain date?
- Where in the country/world will a biopesticide effective?

BioSuccess allows users, manufacturers and governments to estimate the time it would take for a biopesticide to control insect populations in specific scenarios, and the latest date that a biopesticide could be applied whilst still being effective.

The algorithm uses global reanalysis data to estimate the temperature of the habitat favoured by the locusts. This is important in calculating the hourly rate of development of the biopesticide working within the pest, where parameters used here were derived from a combination of biopesticide efficacy data and fieldwork investigating local environmental temperature trends. The final output given to the user is the number of days calculated to reach 90% mortality within the pest population after the given spray date. To date, the focus of **BioSuccess** has been on locust management and control. Future development will broaden the range of pest targets and applicability to a range of biopesticide products.

About Biosuccess
BioSuccess has been developed by Assimila as part of a project funded by the Copernicus Climate Change Service (C3S). The C3S programme Copernicus, implemented by the European Centre for Medium-Range Weather Forecast (ECMWF) on behalf of the European Commission, provides the user with the information you need to manage crop pest populations in a more eco-friendly way. BioSuccess traditional chemical pesticides, but they do require prior knowledge to ensure they are used as effectively as possible. The Biosuccess graphics you need to control Chinese migratory locust populations with the fungus *Metarhizium anisopliae*.

Biosuccess Current analysis
Steps:
1. Select the locust hatching date from the '1. Hatch date' dropdown.
2. Select the date of biopesticide application from the '2. Spray date' dropdown.
3. Enter a latitude and longitude into the '3. Location' value boxes and a complete the '4. Calculate' button to display results.
4. Click the '5. Calculate' button to display results.

Locust will reach 4th instar and be in 1st generation on 90% population death.
When spraying on 2019-04-18 at Lat=37.0 and Lon=118.75 it will take 14 days until death of 90% of locusts.

Last Chance Tool
1. Hatch date: Thu Apr 18 2019
2. Stage: adult
3. Latitude: 37
4. Longitude: 118
5. Calculate

Steps:
1. Select the locust hatching date from the '1. Hatch date' dropdown.
2. Select the locust development stage you want to prevent from the '2. Stage' dropdown.
3. Enter a latitude into the '3. Latitude' value box and a longitude into the '3. Longitude' value box to specify your location of interest.
4. Click the '4. Calculate' button to display results.

The last chance to prevent locusts reaching stage: **adult (hatch date = 2019-04-18)** is to spray on: **2019-5-20**

The tool combines temperature data from Copernicus Climate Change Service (ERA5), delivered via the Copernicus Climate Data Store, with biological models of insect development (initially locusts) and biopesticide efficacy.

BioSuccess predicts the 'time-to-kill' based upon location and time of application, using reanalysis derived climatologies and data from individual years to show where applications will be most reliable.

Biosuccess Historical Analysis
1. Province: Shandong
2. Kill Level: 90%
3. Spray date: Wed Apr 18 2018
4. Latitude: 37.0
5. Longitude: 118.75
6. Calculate
7. Hide stats

Days to 90% death of locust

Steps
1. (Optional) Select a province in the '1. Province' dropdown.
2. Select the required population kill level from the '2. Kill Level' dropdown.
3. Select the date of biopesticide application from the '3. Spray Date' dropdown.
4. Click on the map to specify the latitude and longitude of your location of interest OR manually enter a latitude in the '4. Latitude' value box and a longitude to the '4. Longitude' value box.
5. Click the '5. Calculate' button to display results.
6. (Optional) Click the '6. Show Stats' button to display additional analytics on historical results.

Average time to 90% mortality: **22 days**
Uncertainty range is **16 to 29 days** until death of 90% of locust at **Lat=37.0 Lon=118.75 on Apr-18**

Number of days to 90% mortality
Number of years vs Days to 90% mortality

Time to 90% mortality on Apr-18
Days to 90% mortality vs Year

The **BioSuccess** tool is an interactive web-based application providing:

1. Historical Analysis: a map where the user can access required products for the whole area of study or a specific province and based on 20 years of data, storing all the datasets needed to derive the climatology
2. Current Analysis: a display depicting results of biopesticide efficacy in combination with locust development over time for a single location. Thus allowing users to plan best utilization of their biopesticide product
3. Last chance to kill' mode offers the user the ability to determine the latest date by which to apply the biopesticide to prevent the insect reaching a selected locust development stage
4. User feedback utility enables biopesticide suppliers to gain a measure of the efficacy of their products in the field.