A process–based guide to data collection in plant health

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A process–based approach is key to managing pests effectively.

Cost of management (millions of US dollars)

Biological information available

The biology matters

\[
y = -85.672x + 1045.3
\]

\[R^2 = 0.8277\]
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Why the biology matters
North American examples

A process–based approach
Physiological analogies

Work in progress
*Tuta absoluta*
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*Tuta absoluta*
Pink bollworm cost 300 million $, yet in the Central Valley of California weather is the limiting factor.

Introduced to California in the late 60s.
Mediterranean fruit fly cost >450 million $ as threat to California agriculture was overestimated

First detected in California in 1975
Large-scale monitoring and eradication since 1975 with no knowledge of the potential distribution

Medfly pupae

\((10^3)\)
Planned eradication (worth 100 million $) for light brown apple moth was abandoned.

First detected in California in 2007

USDA: risk of establishment (Fowler et al. 2009)
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The regional pest status of species is affected by many factors difficult to separate and quantify.
Physiological analogy among trophic levels is a powerful conceptual tool

Processes like predation play by similar rules in all ecosystems

Purves et al. 2013
All organisms are consumers with common pattern of resource acquisition and allocation.
Same model can be used in all trophic levels, each level supplies resource to the next
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Same model describes species biology across trophic levels including the economy of **humans**.
Sub-models of biological process are the same for all trophic levels

Physiologically based modeling
PBDM
Sub-models of biological process are the same for all trophic levels

- Physiologically based modeling (PBDM)
  - Based on physiological analogies
Sub-models of biological process are the same for all trophic levels

Physiologically based modeling
PBDM

Based on physiological analogies

Same process sub-models
Rate of development

1 / days

Temperature
Temperature

Rate of development

1 / days

Scalar for developmental time

Effect of nutrition

Nutrition
Temperature

Rate of development

Scalar for developmental time

Nutrition

Effect of nutrition

Age

Age-specific fecundity

Eggs per female per day

1 / days
Temperature

Scalar for developmental time

Nutrition

Eggs per female per day

Age-specific fecundity

Age

Rate of development

Effect of nutrition

Scalar for eggs per female

T effect on fecundity

Temperature

1 / days
Population dynamics adds more realism (and **density**) via age structure, distributed delay, and attrition.

[Diagram of population dynamics with birth and death processes, age structure, distributed delay, and attrition.]
GIS integration occurs at the population level, factors are modeled on a per-capita basis.
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PBDM clearly identifies data gaps in the biology of *T. absoluta* and guides data collection.
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