Time distributed delay model - MRV

Plant protection service - Emilia-Romagna

Cydia molesta

The model parameters (Logan's curves of eggs, larvae and pupae; ageing rate of females; fecundity of females; H coefficient for the variability of each stage) were defined on literature data.

Field validation was conducted by comparing the flight curves forecasted by the model with the observed flight curves (sex traps) determined in 1992- 1995 in several peach orchards (a total of 45 cases)

Results showed 1 week delay both for 1st and 2nd adult flights. Since it was a sistematic error, model calibration was performed modifying some parameters related to the insect's development curves. After the modification results showed a reduced delay.

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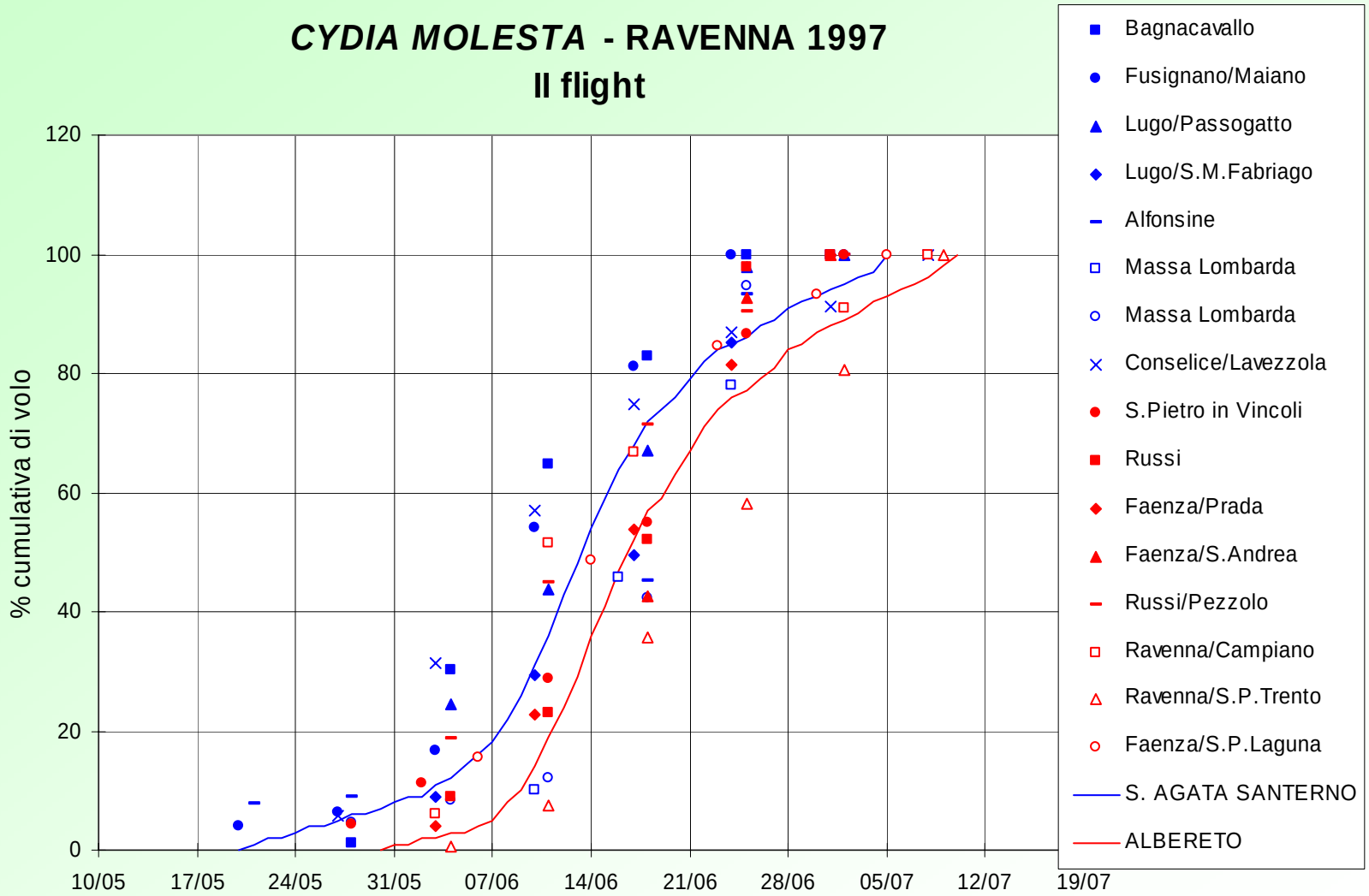
Cydia molesta- MRV

Plant protection service - Emilia-Romagna

Average duration of development (days)

Temperatures	EGGS	LARVAE	PUPAE	ADULTS (FEMALES)
12 °C	-	50	-	-
15 °C	-	-	-	27,49
15,5 °C	7,5	-	-	-
17 °C	-	-	23	-
17,5 °C	-	-	-	18
18,3 °C	5,75	-	-	-
19 °C	-	25,97	-	-
20 °C	-	-	12,5	-
21 °C	-	17,98	-	-
23 °C	-	-	-	7
23,8 °C	3,9	-	-	-
24 °C	-	16	8,2	4,8
26 °C	-	14,51	6,69	-
28 °C	-	-	5,19	-
29 °C	-	13	-	-
29,4 °C	3,27	-	-	-
31 °C	-	11	-	-
34,4 °C	2,75	-	-	-
35 °C	3,3	-	-	-

TD-model application on oriental fruit moth expected flight vs. observed flight



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CYDIA MOLESTA

1st & 2nd generation	Model information
TRAP PLACEMENT	Almost all the pupae formed
MATING DISRUPTION DISPENSER PLACEMENT	Almost all the pupae formed before the beginning of adult flight
1st OVICIDAl OR LARVICIDAL SPRAY	At the beginning of egg-laying and larval birth

Time distributed delay model - MRV

Plant protection service - Emilia-Romagna

Cydia pomonella

•**The model parameters** (Logan's curves of eggs, larvae and pupae; ageing rate of females; fecundity of females; H coefficient for the variability of each stage) were determined by rearing the different stages at four, five or six different constant temperatures, ranging from 12,6 °C to 34 °C, at 70% relative humidity and with a photoperiod L:D 17:7 h.

•All insects used were collected from the field to avoid changes in biology (prolonged laboratory rearing)

•The larvae were fed on apple, adults were given water and honey

•The age-related fecundity was fitted to a modified Bieri's function on literature data

•All stages were individually reared, with data recorded daily, to assess variability

Cydia pomonella - MRV

Plant protection service - Emilia-Romagna

Average duration of development (days)

	Temperatures					
	12.6° C	**18.2° C**	**23.2° C**	**26° C**	**29.8° C**	**34° C**
EGGS	29.56	10.88	6.34	5.17	4.71	4.26
LARVAE	-	41.65	30.26	20.69	16.69	25
PUPAE	-	20.36	12.44	9.63	8.38	9.2
ADULTS	62.5	33.25	21.82	18.94	-	-

Time distributed delay model - MRV

Plant protection service - Emilia-Romagna

Cydia pomonella

FIELD VALIDATION

1) **Comparison of forecast flights (I and II) and pheromone trap catches:** data was collected from 1992 to 1998 in several apple and pear orchards in Emilia Romagna region (a total of 56 cases)

2) **Comparison of forecast and actual oviposition pattern**:
Data was collected from 1998 to 2005 in .

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EGG SURVEY

- 200 fruit-leaf clusters colletion
- Lab check of the samples collected in the orchards
- Egg classification as:
  - 1) "white"
  - 2) "red ring"
  - 3) "black head"
- Determination of the oviposition date by Degree Day (DD) calculation

Hatched egg of Codling moth

Eggs incubation duration

85.5 DD; threshold 10°C
(Wyniger)

Egg of Codling moth

<u>Stage</u>: “white” (newly laid eggs)

<u>DD</u> : 10

Egg of Codling moth

Stage: “Red ring”

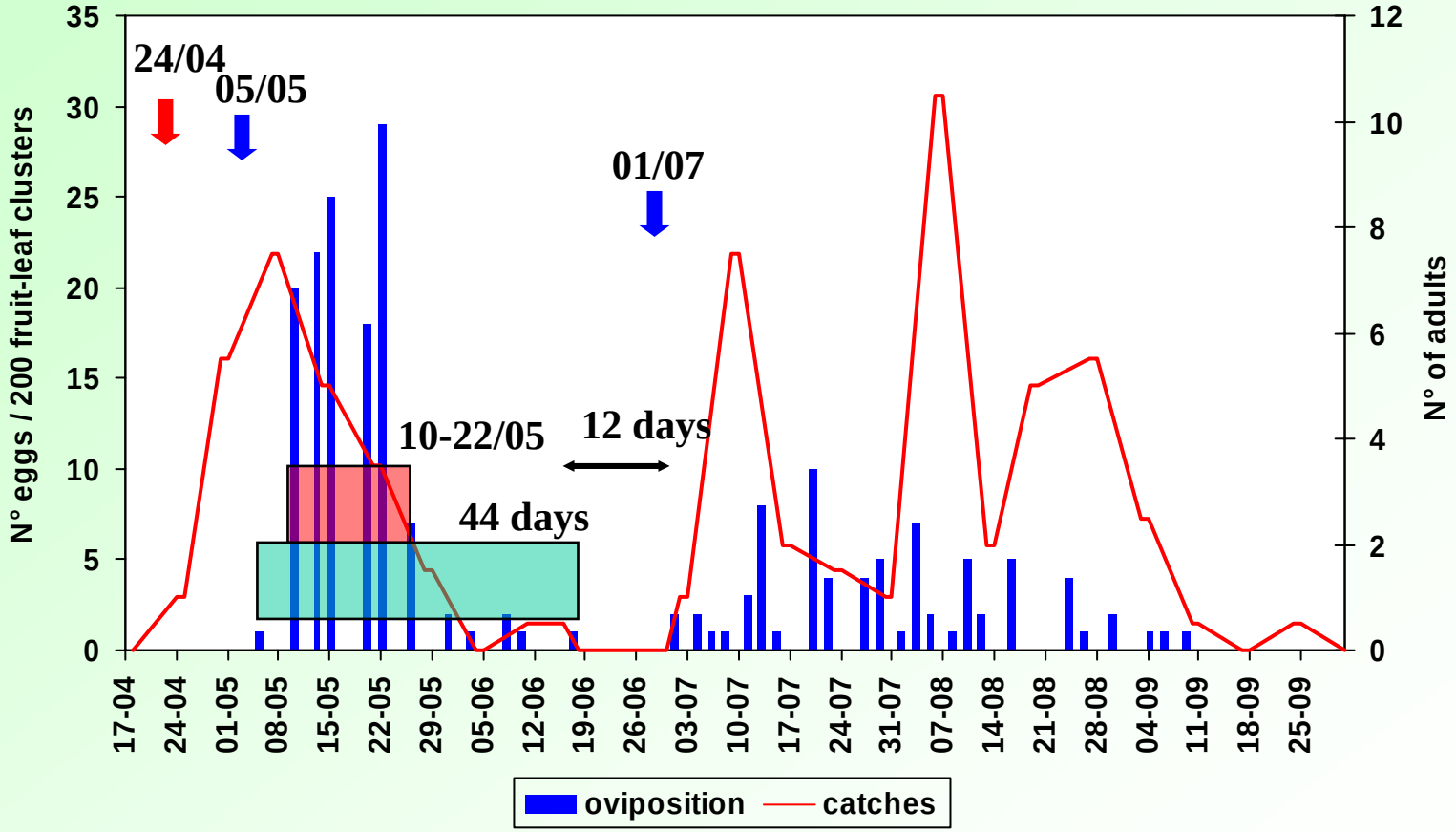
DD: 41.3

Egg of Codling moth

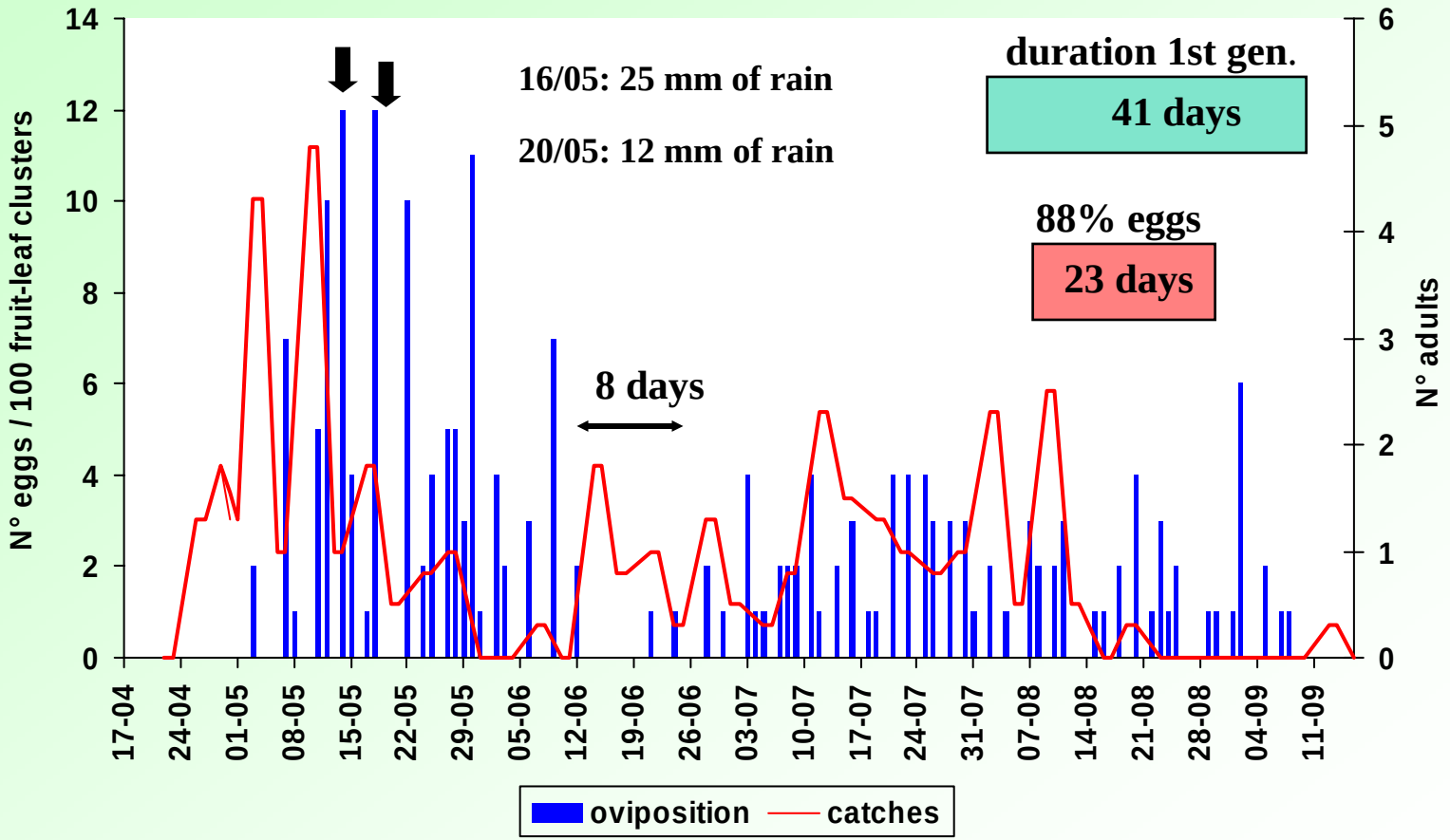
Stage: “Black-head”

DD: 74.1

Oviposition monitored in the orchard and pheromone trap catches - S. Giovanni in Persiceto - 1998



Oviposition monitored in the orchard and pheromone trap catches - S. Giovanni in Persiceto - 1999



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CONCLUSIONS

- The duration of the 1st generation is fairly prolonged ; in the first week the percentage of eggs laid is low; most of the eggs are laid during the following two weeks

- During the oviposition a clear separation exists between the 1st and the 2nd generation while the 2nd and the 3rd usually overlap.

- At the end of oviposition, male are still likely to be caught.

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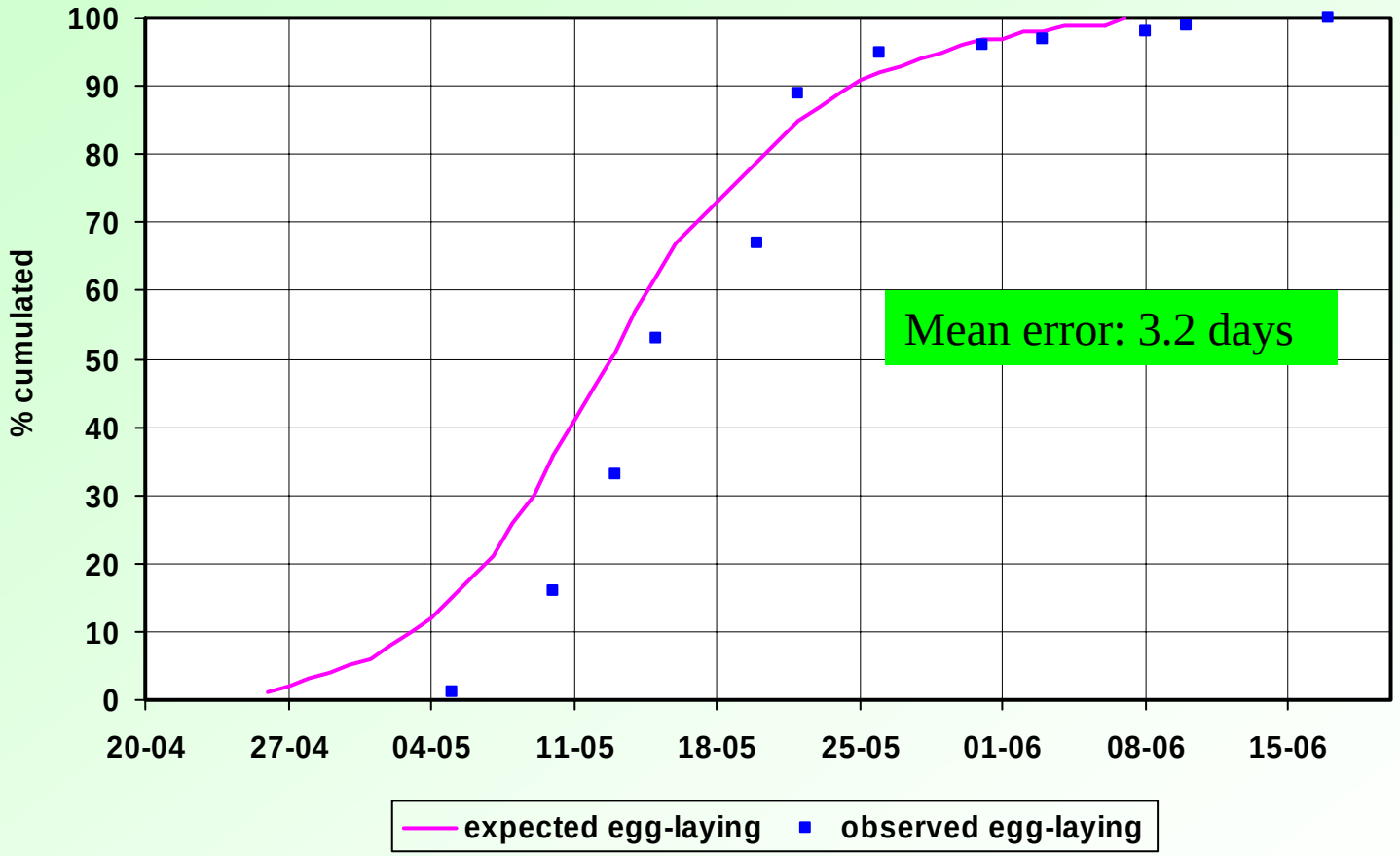
Codling moth – 1st generation
Comparison of forecasted and actual oviposition pattern
S. Giovanni in Persiceto - 1998



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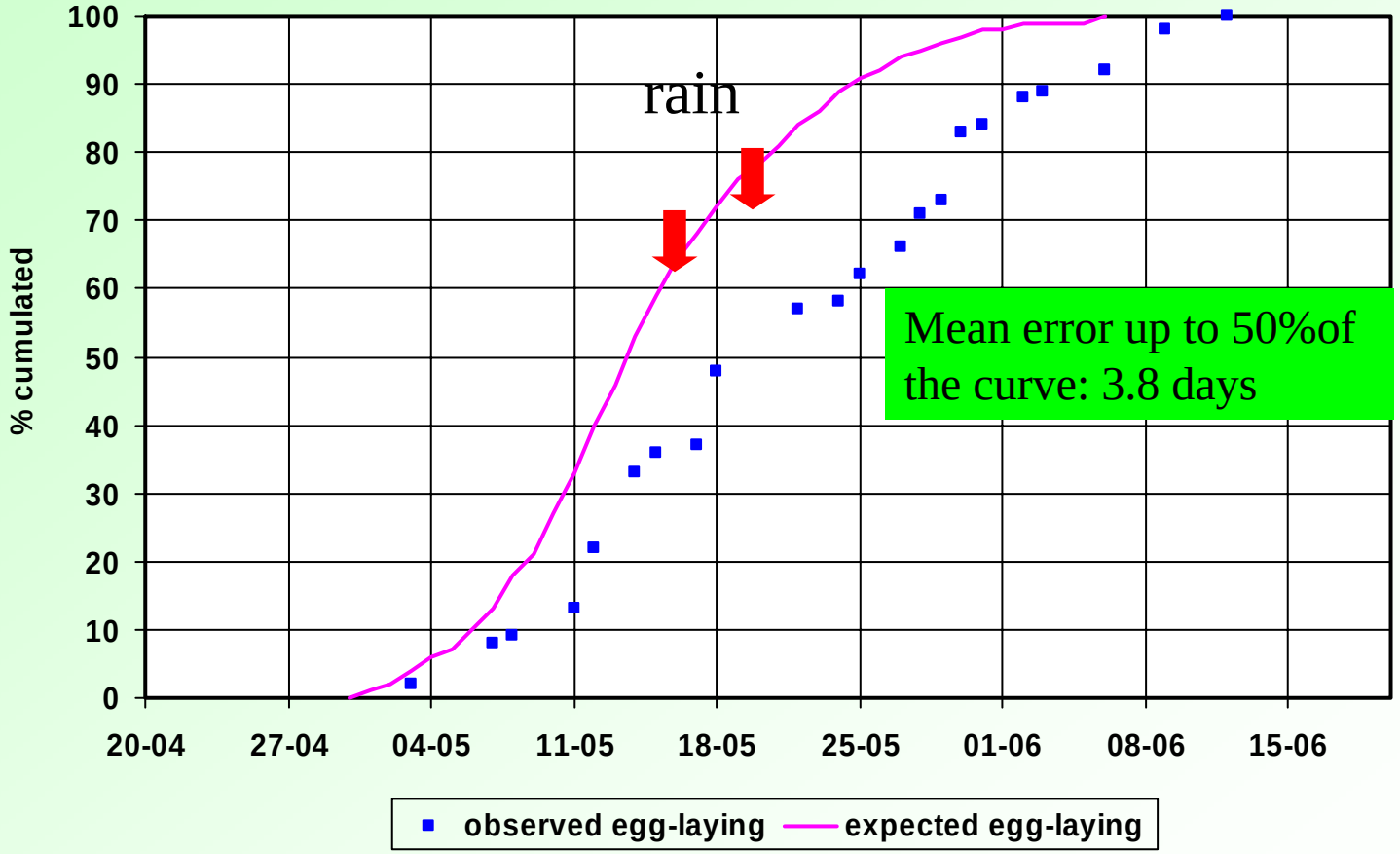
Codling moth – 1st generation
Comparison of forecasted and actual oviposition pattern
S. Giovanni in Persiceto - 1999



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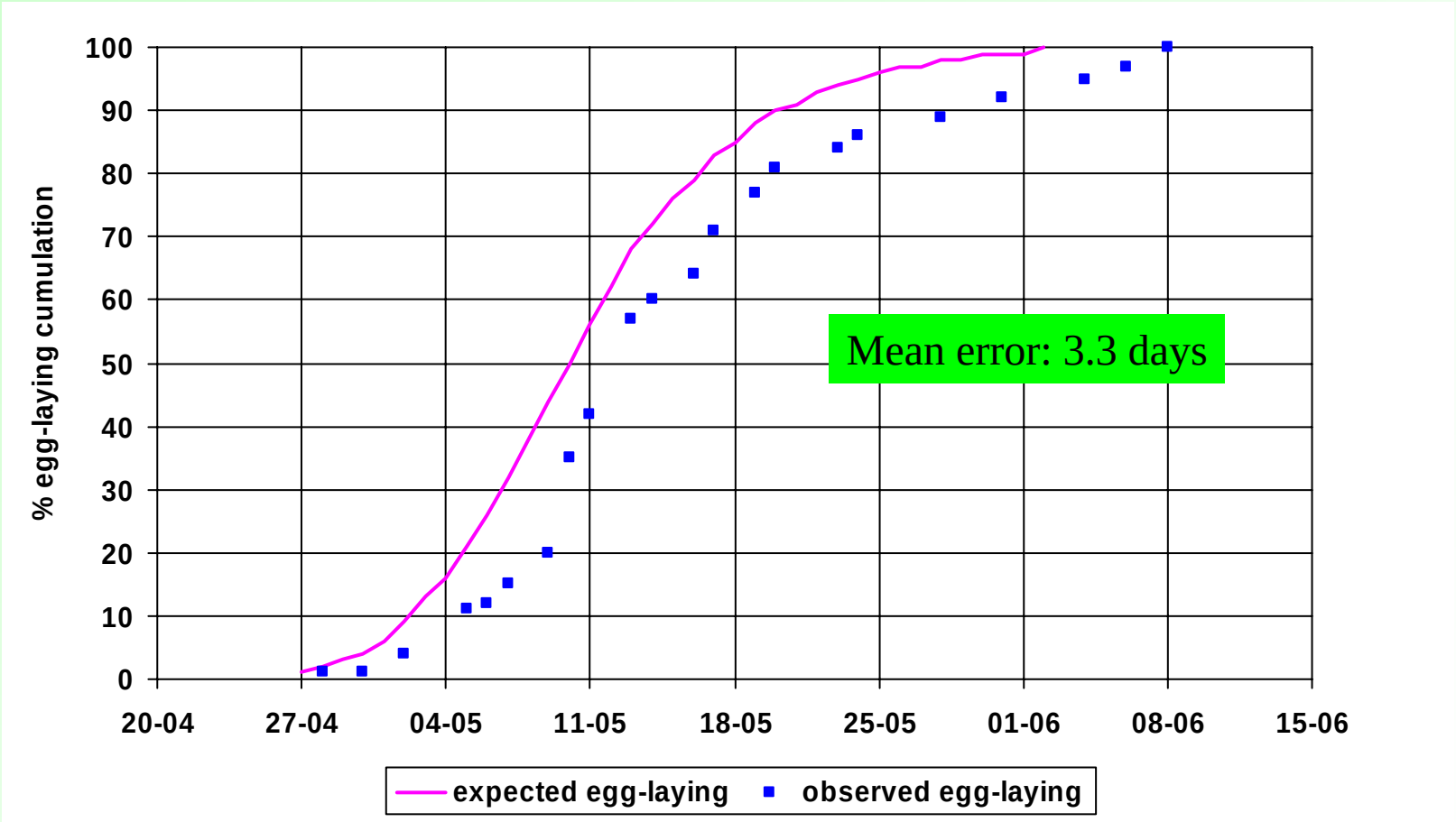
Codling moth – 1st generation
Comparison of forecasted and actual oviposition pattern
S. Giovanni in Persiceto - 2000



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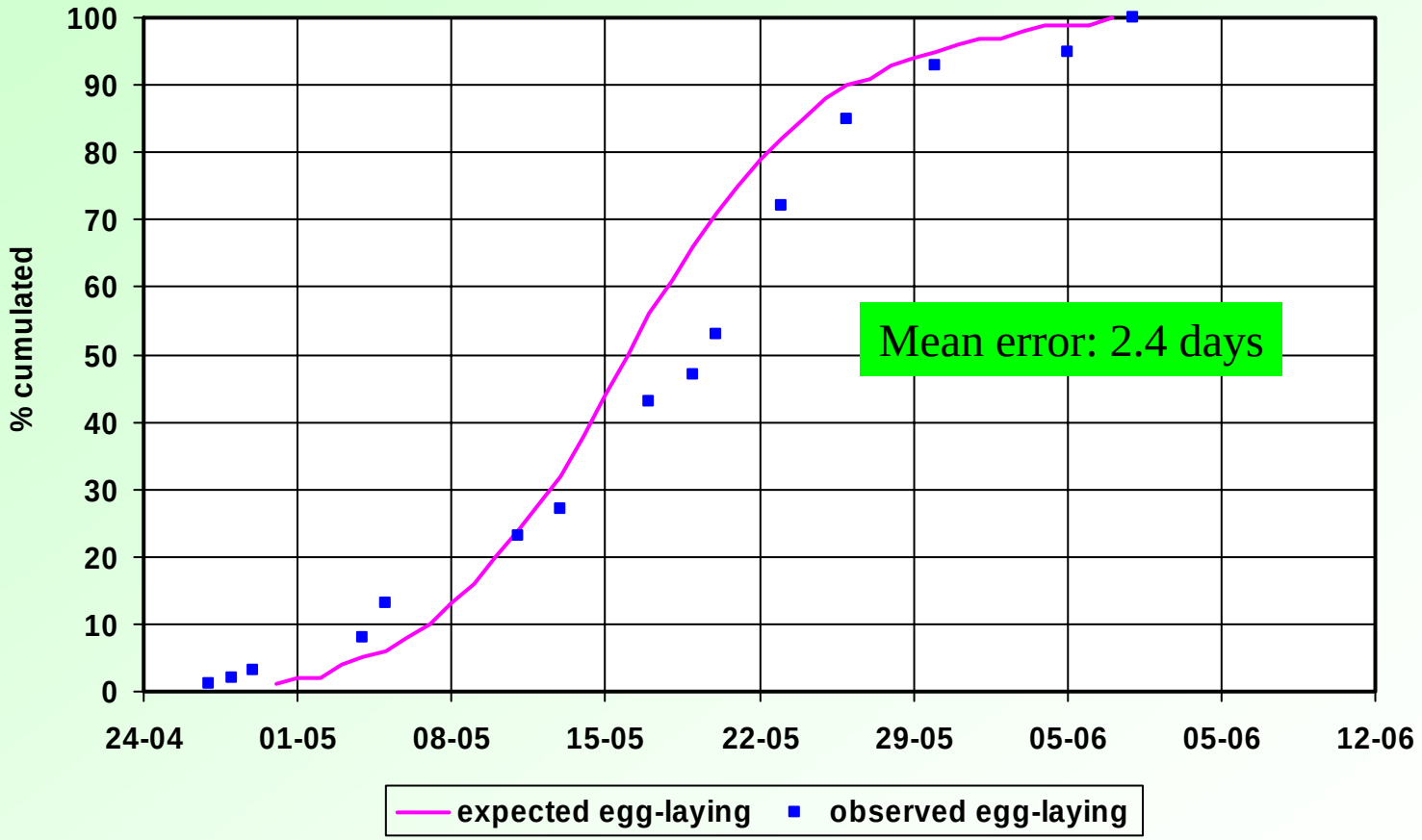
Codling moth – 1st generation
Comparison of forecasted and actual oviposition pattern
S. Giovanni in Persiceto - 2002



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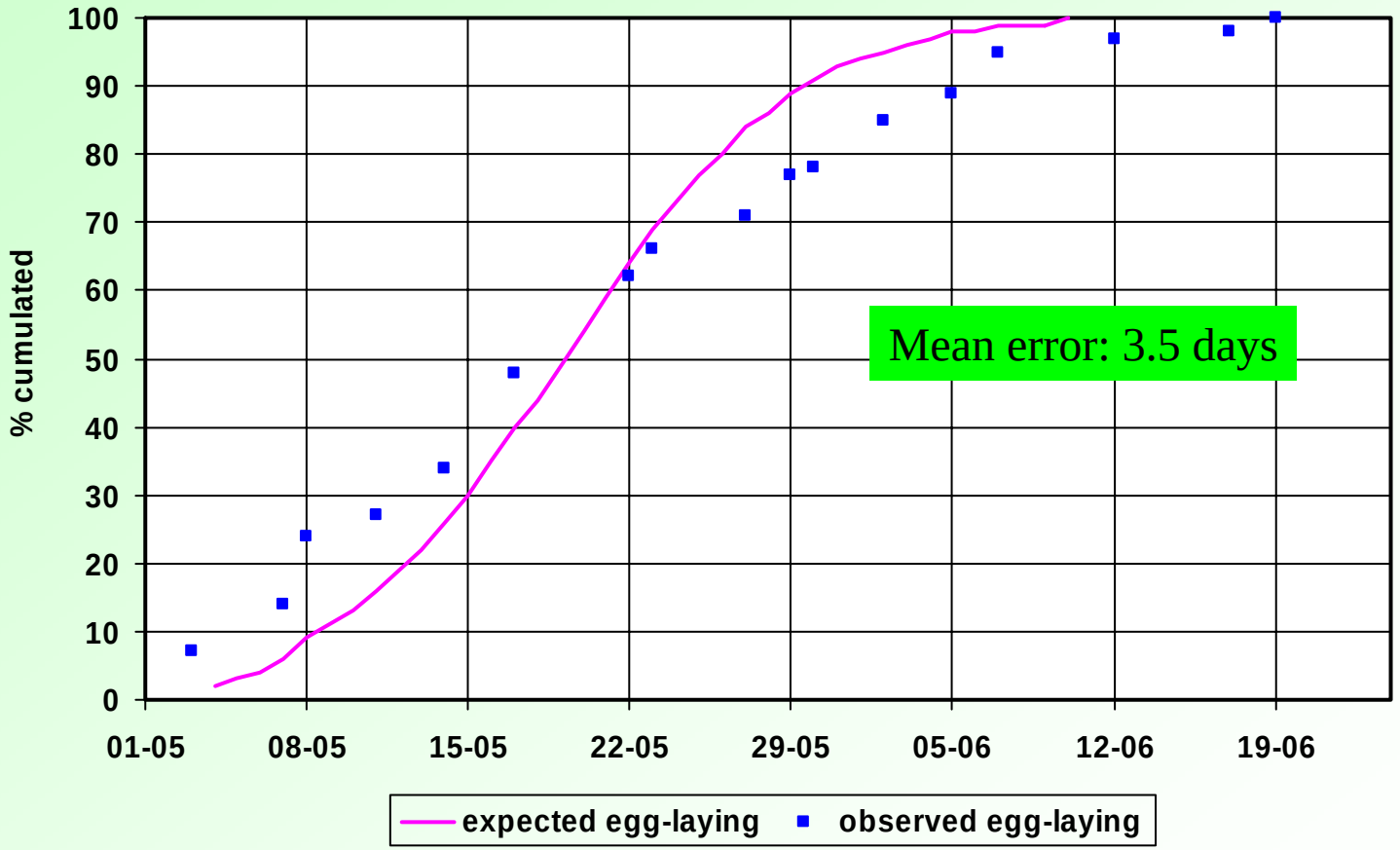
Codling moth – 1st generation
Comparison of forecasted and actual oviposition pattern
S. Giovanni in Persiceto - 2005



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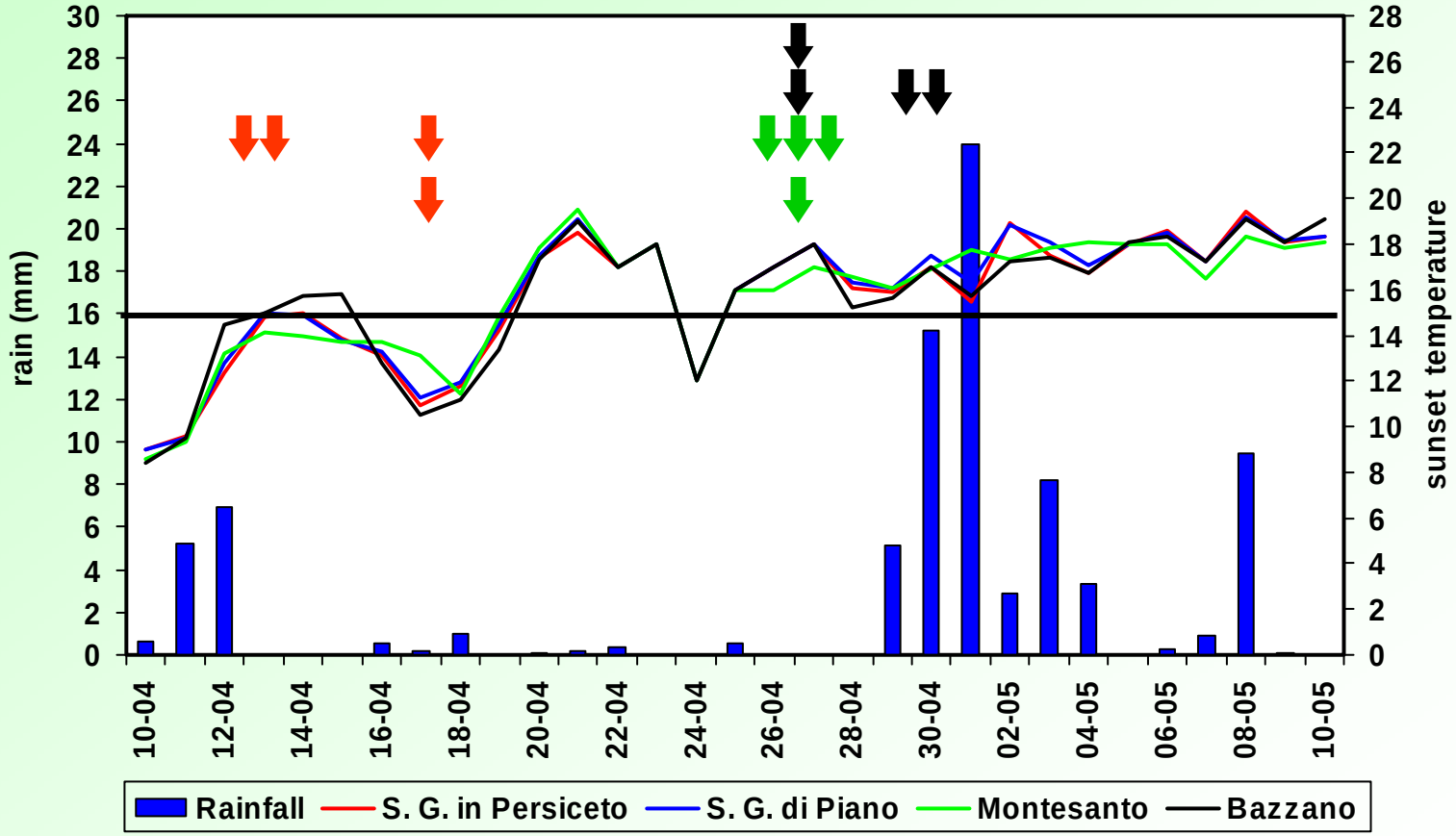
MONITORING THE FIRST OVIPOSITION - 2000

- An effective control of the 1st generation is essential to contain the damages due to the following generations.
- In Emilia-Romagna the first spray is performed with IGR. It has the maximum efficacy if applyed before the egg-laying
- Very few is known about the period between the beginning of flight and the beginning of oviposition.

Beginning of oviposition in the field (⬇) and forecasted by he model (⬇) in relation to the beginning of flight (⬇) - 2000



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Beginning of oviposition in relation to the beginning of flight expected vs. observed data **in 2000**

	Farm. MAIEUTICA S. Giovanni in Persiceto (BO)	**farm A S. Giorgio di Piano (BO)**	**farm B Bazzano (BO)**	**farm C Portomaggiore (FE)**
Start of catches	17 apr	17 apr	13 apr	14 apr
Start of actual oviposition	26 apr	27 apr	27 apr	28 apr
Predicted start of oviposition (1%)	27 apr	27 apr	30 apr	1 may

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CONCLUSIONS

- to better time the first ovicide spray, only rely exclusively on pheromone trap, can be misleading anticipating several days the spray.

- The forecasting model proved to simulate correctly the oviposition curve and therefore can be used as a usefull decision supporting tool.

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CONCLUSIONS

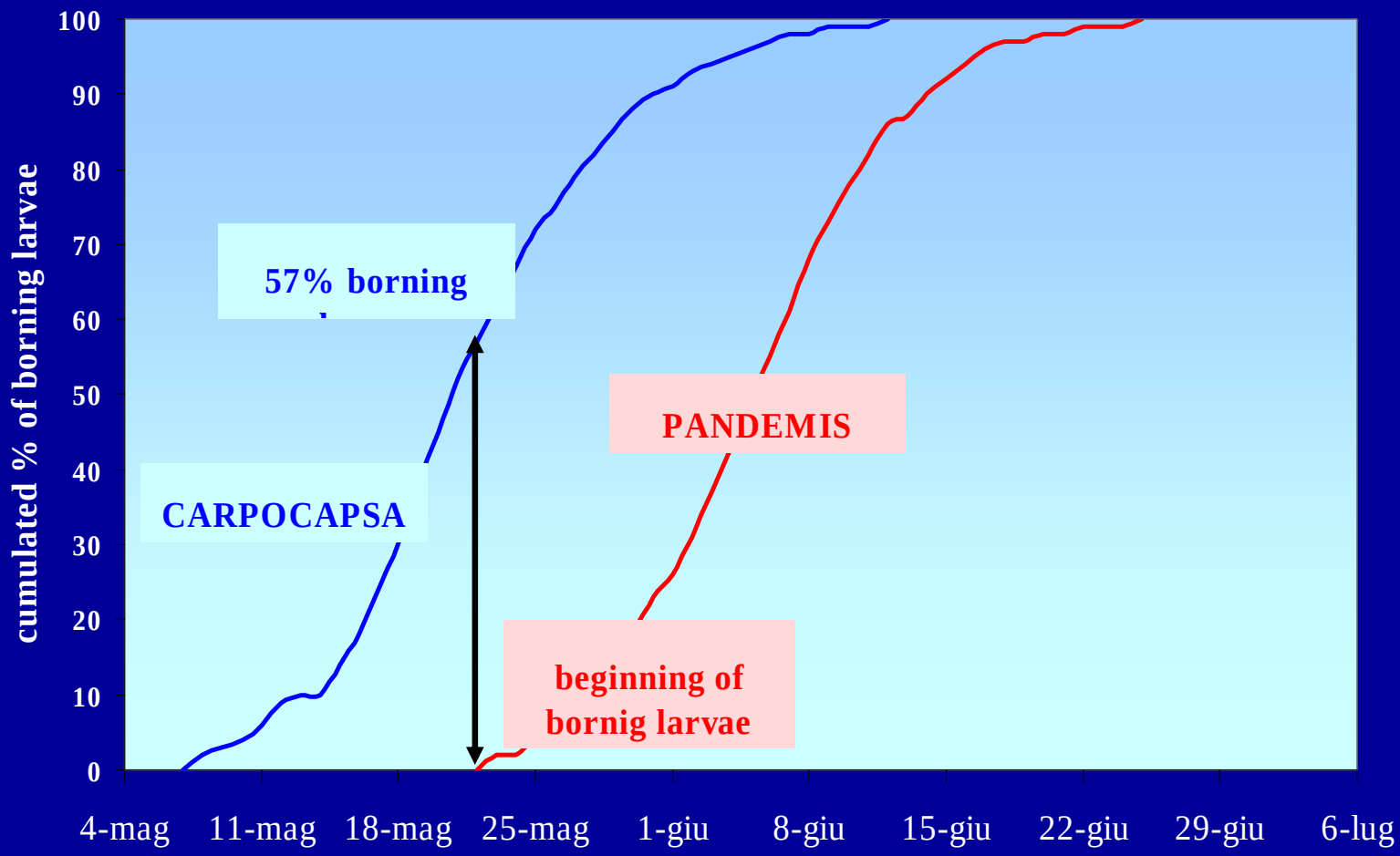
The combined use of the tools available (pheromone traps, forecasting model, weather data) and technician knowledge of their territory and farm specificity are essential for a rational pest control strategy

CODLING MOTH

1st & 2nd generation	Model information
1st OVICIDAL SPRAY AND WITH HIGH PEST PRESSURE	At the very first percentage of egg-laying
1st OVICIDAL SPRAY AND WITH LOW PEST PRESSURE	within 10% egg-laying and before larval birth
1st LARVICIDAL SPRAY	At the beginning of larval birth

Pandemis cerasana and *Cydia pomonella* - prediction of borning larvae (1st gen.)

S.Giovanni in Persiceto (BO) - year 2000



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Lobesia botrana – spray timing (2nd gen.)

Mandriole (Ra) - year 1998