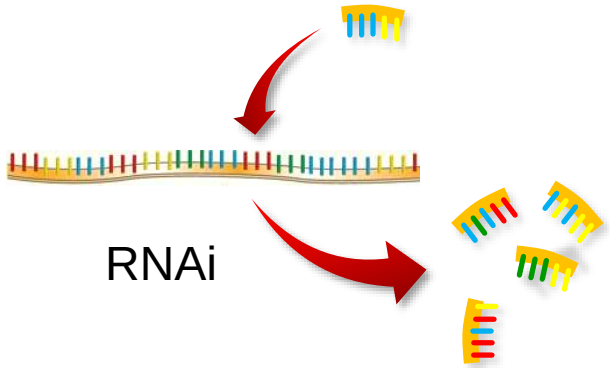
Lessons learned from developing an RNAi-based *Varroa* control product

Jim Masucci
Bayer Crop Sciences
12 September, 2019

Today's Topics

Description of our trials

Results related to mite management



Early results developing a new product

Data come from large field trials to develop new *Varroa* product

Year	Locations	Trt	Hive/trt	Total hives	Assessments	Question asked
2016	11	6	40	2640	8	Test many geographies
2017	8	6	40	1920	5	Fit into management system
2018	10	6	28	1680	5	How best to use it
2019	8	5	60	2304	5 x 2 years	What value does it bring

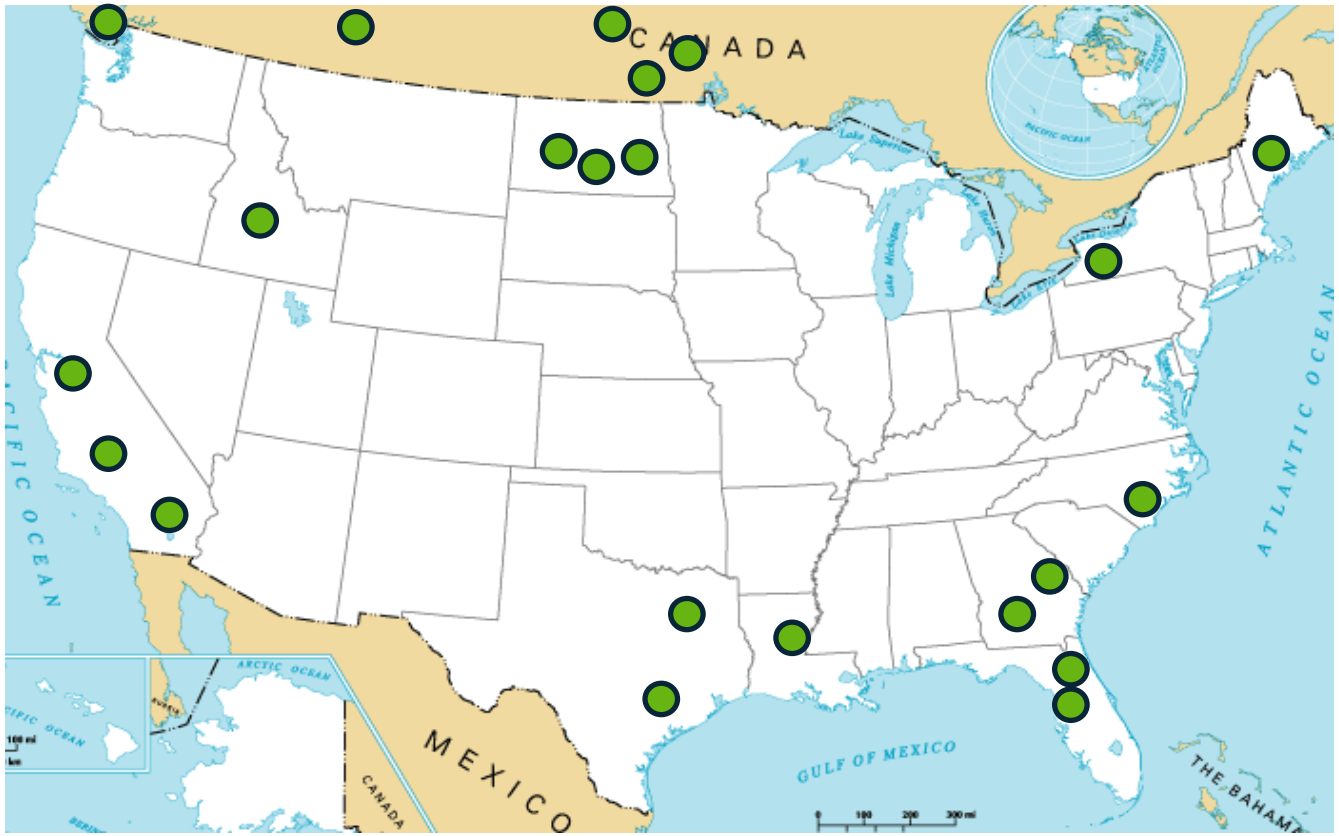
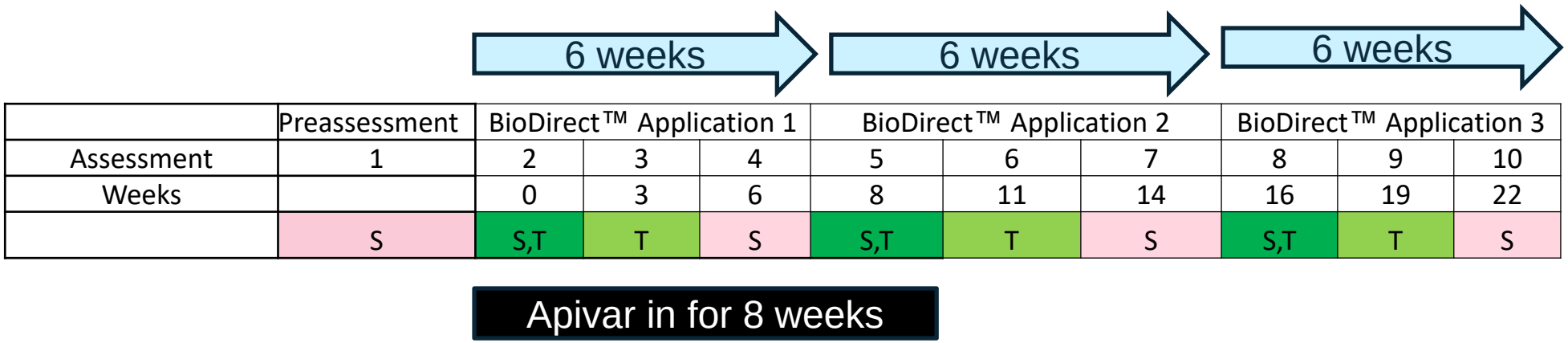


Figure 1



	Preassessment	BioDirect™ Application 1			BioDirect™ Application 2			BioDirect™ Application 3		
Assessment	1	2	3	4	5	6	7	8	9	10
Weeks		0	3	6	8	11	14	16	19	22
	S	S,T	T	S	S,T	T	S	S,T	T	S

Apivar in for 8 weeks

Treatments discussed:

1. Untreated control
2. Apivar
3. Low-dose BioDirect™
4. High-dose BioDirect™

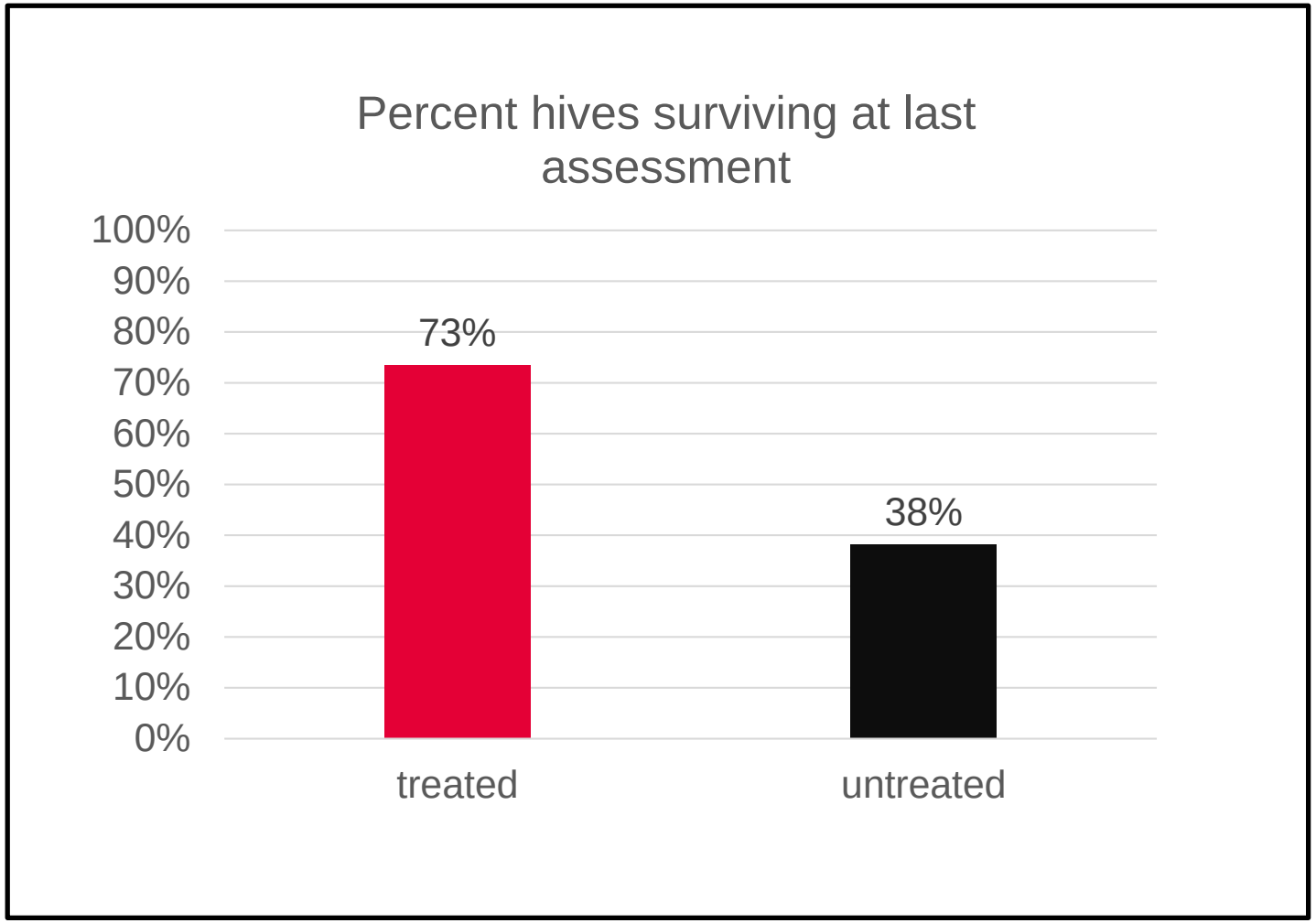
S — Sample for mite counts

S,T — Sample and treat

T — Treat only

Lesson 1: *Varroa* infestations kill bees

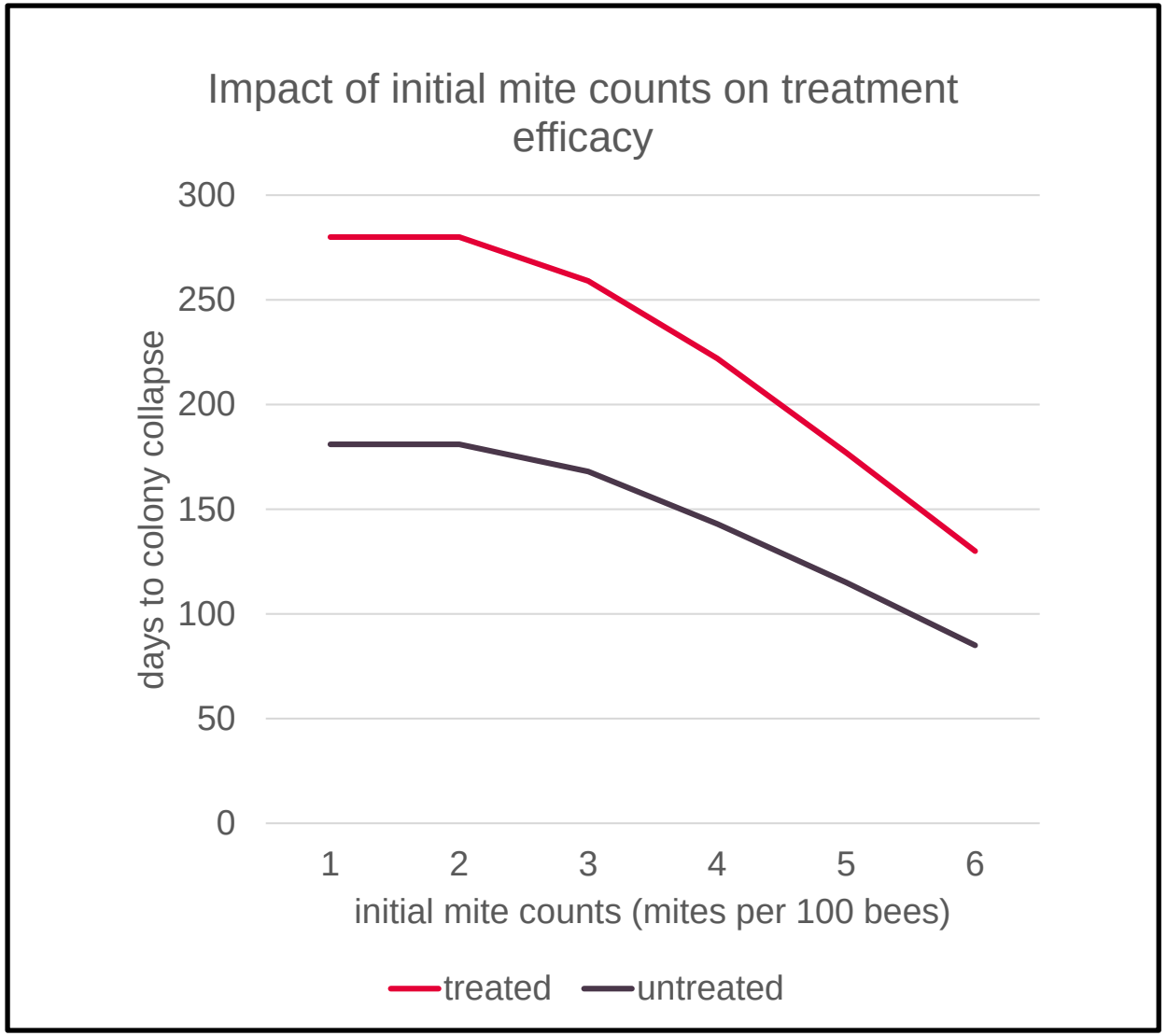
Take measures to control *Varroa* levels

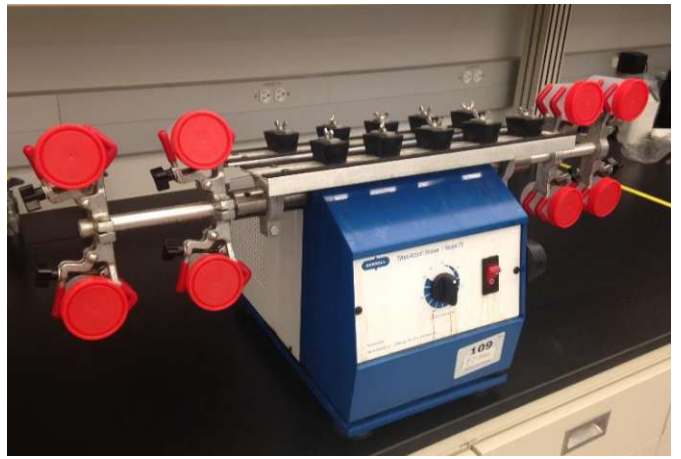


Hopelessly Queenless
Less than 1 frame of bees

Lesson 2: Hard to recover from bad infestations

Don’t let *Varroa* levels get too high

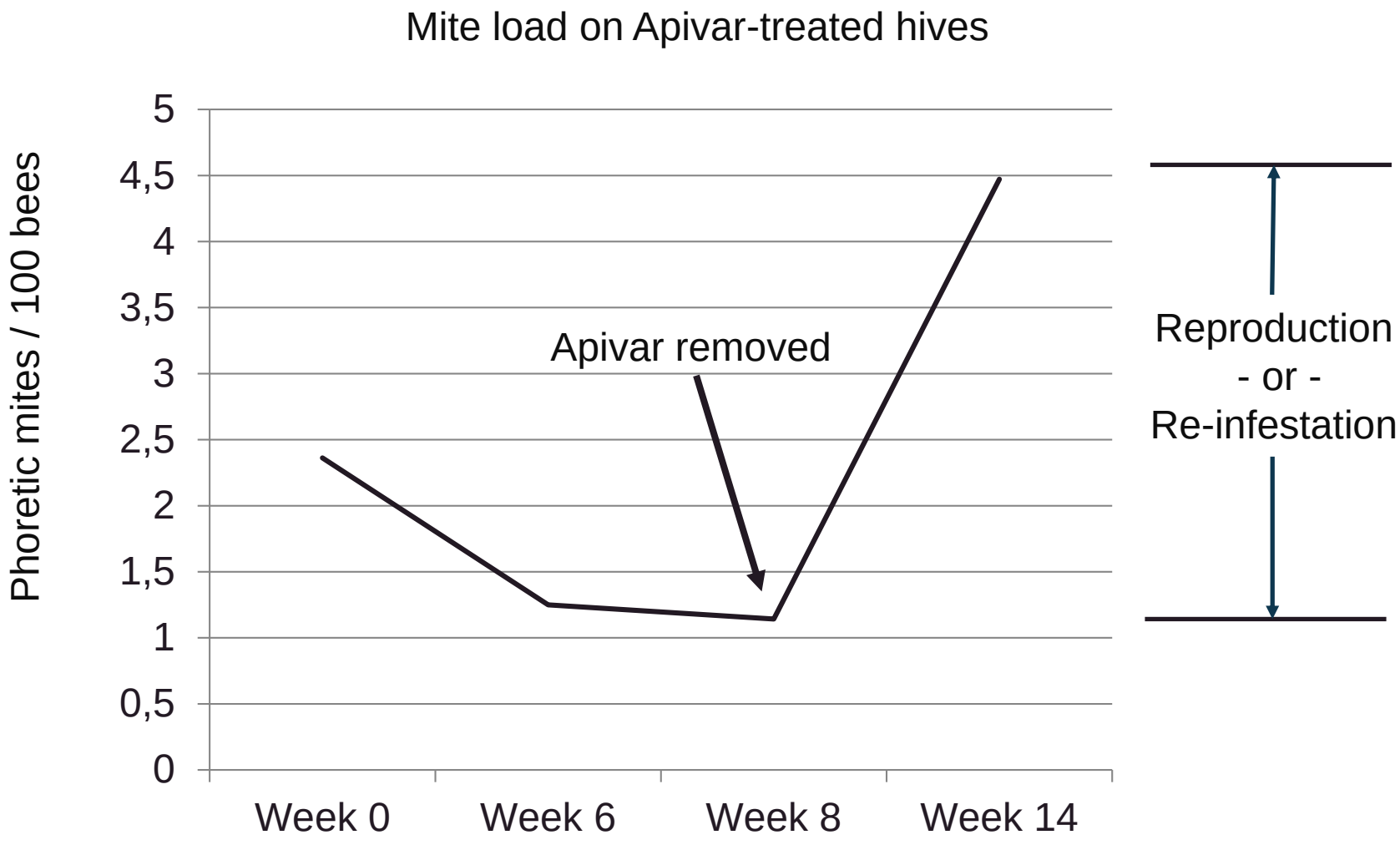




Mite Counts by Ethanol was method
Reported as mites per 100 bees

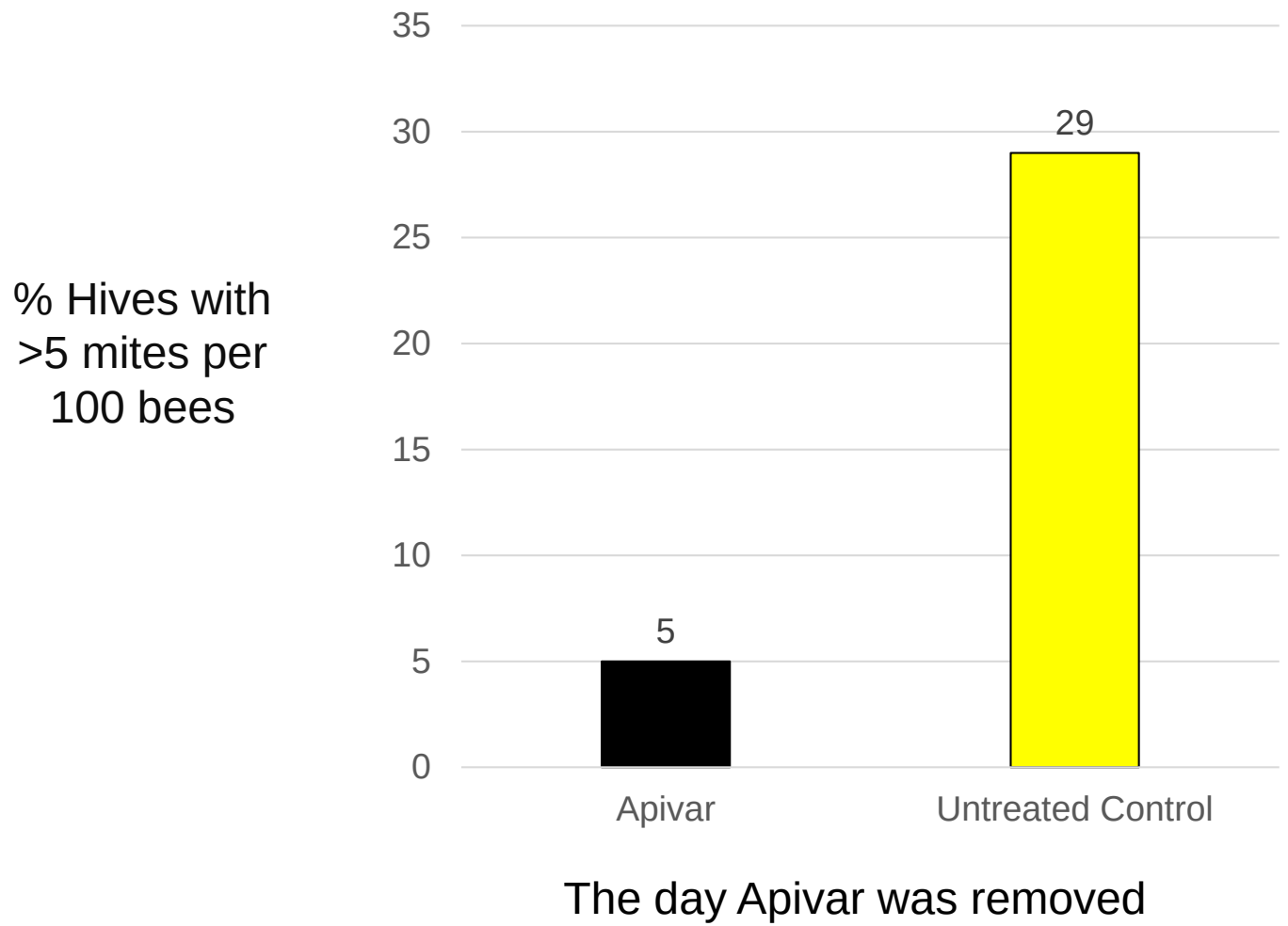
Lesson 3: *Varroa* populations can recover quickly after treatment

Monitoring mite levels is essential



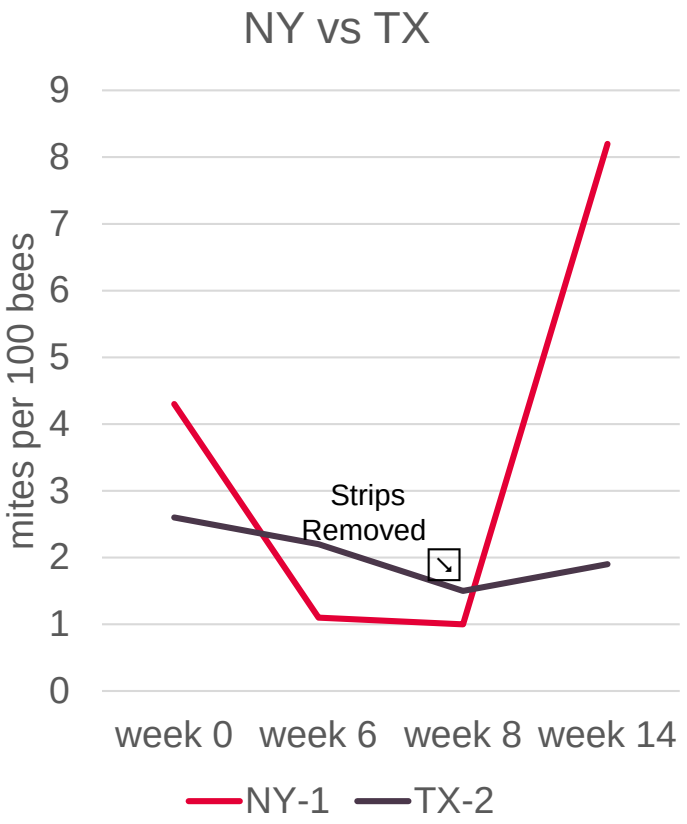
Lesson 4: Treatments don’t work all the time

Post-treatment monitoring is essential

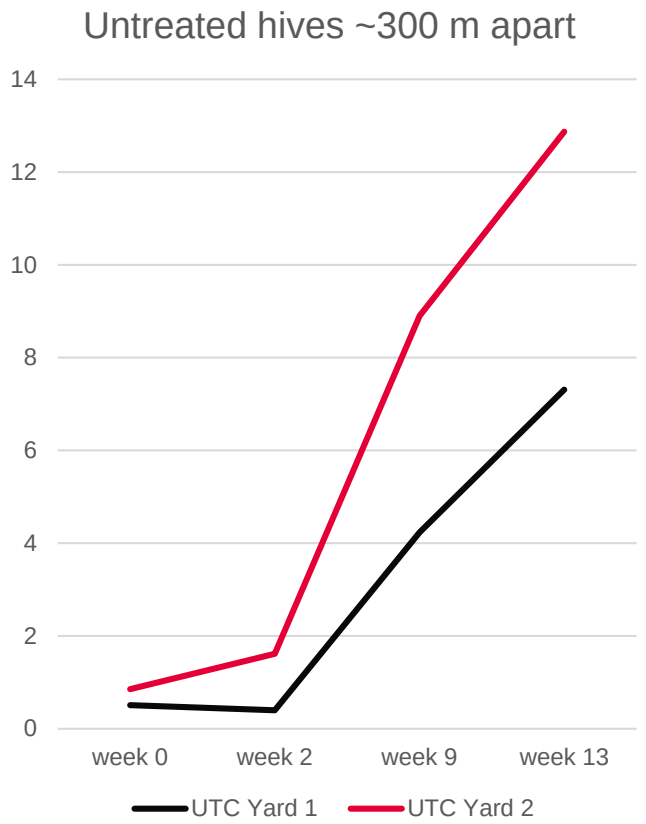


Lesson 5: Results vary by state, by region, and even by hive

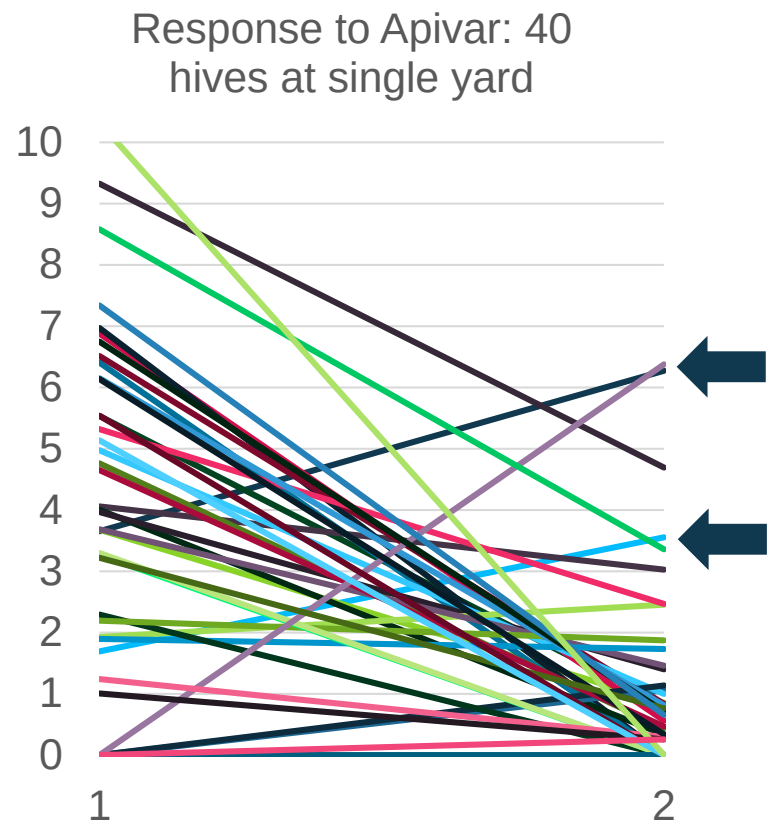
Don’t rely on your neighbor’s assessment



state



region



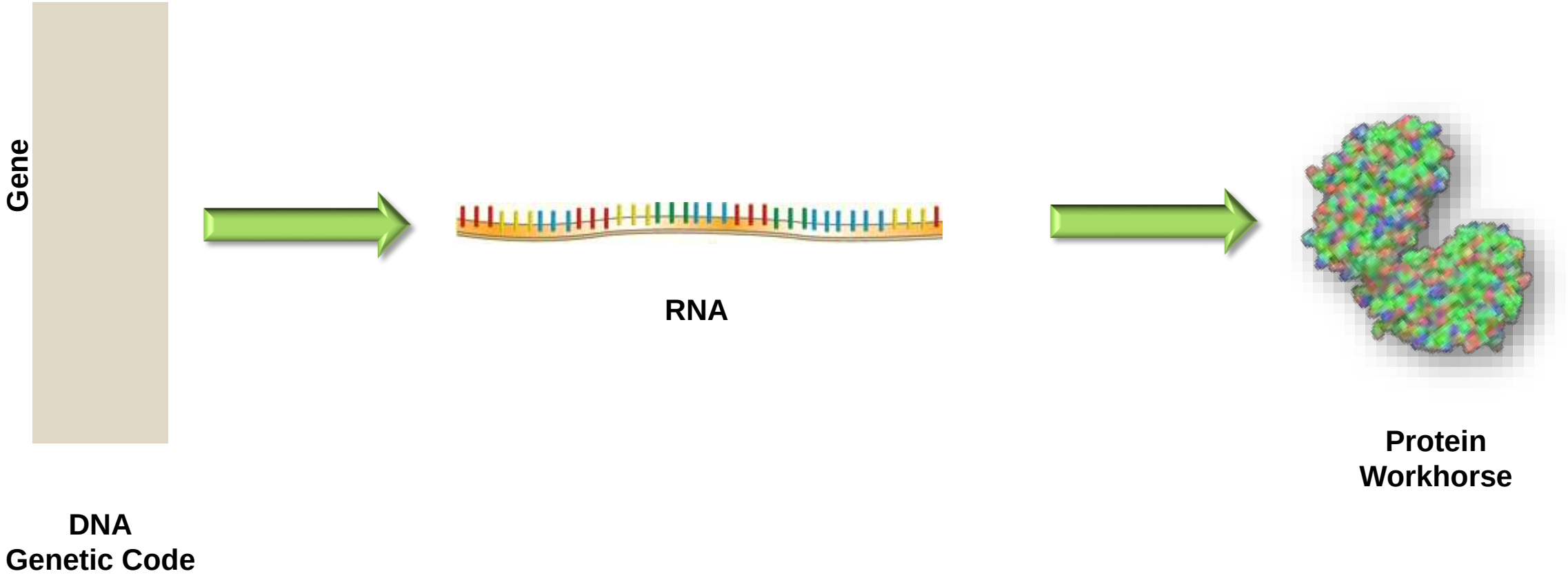
hive

Developing a novel *Varroa* control product called BioDirect™

1. Induces the natural RNA interference (RNAi) pathway in *Varroa*
2. Highly specific to *Varroa*
3. Targets the reproductive stage of the *Varroa* life cycle
4. Reduces mite levels and increases colony survival rates

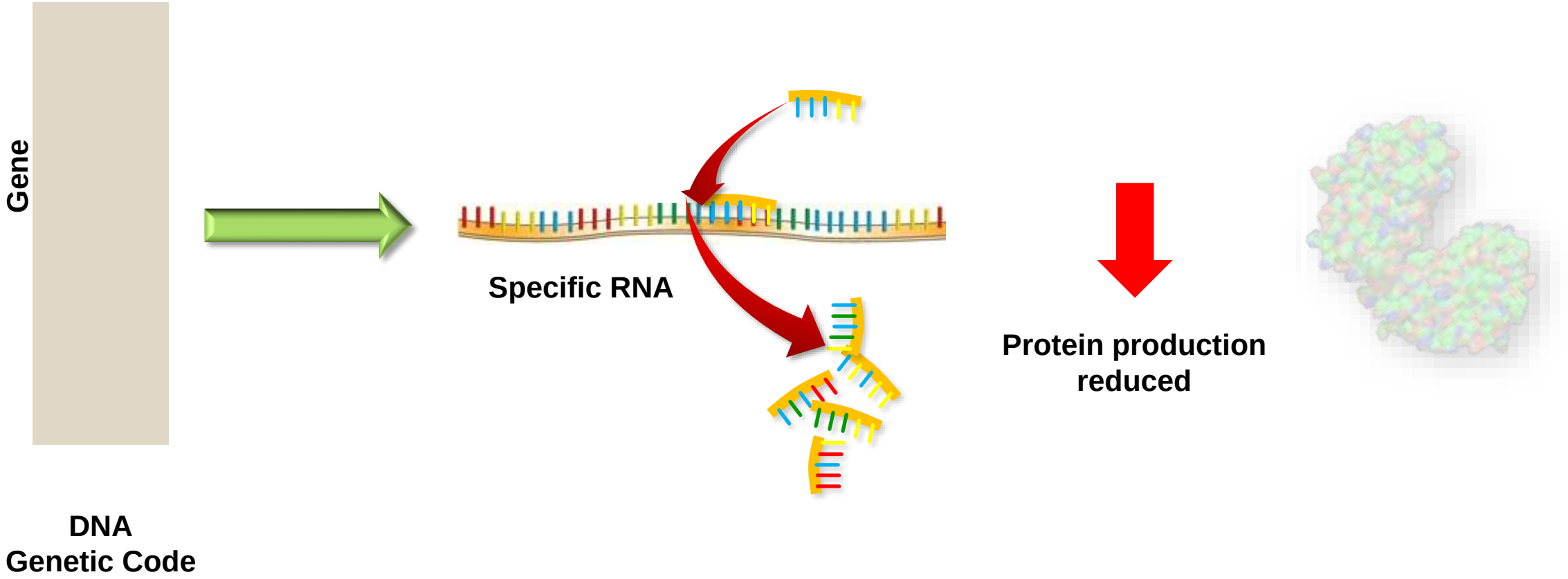
BioDirect™: a topical way to induce RNA interference in *Varroa*

How a cell works
Over-Simplified



BioDirect™: a topical way to induce RNA interference in *Varroa*

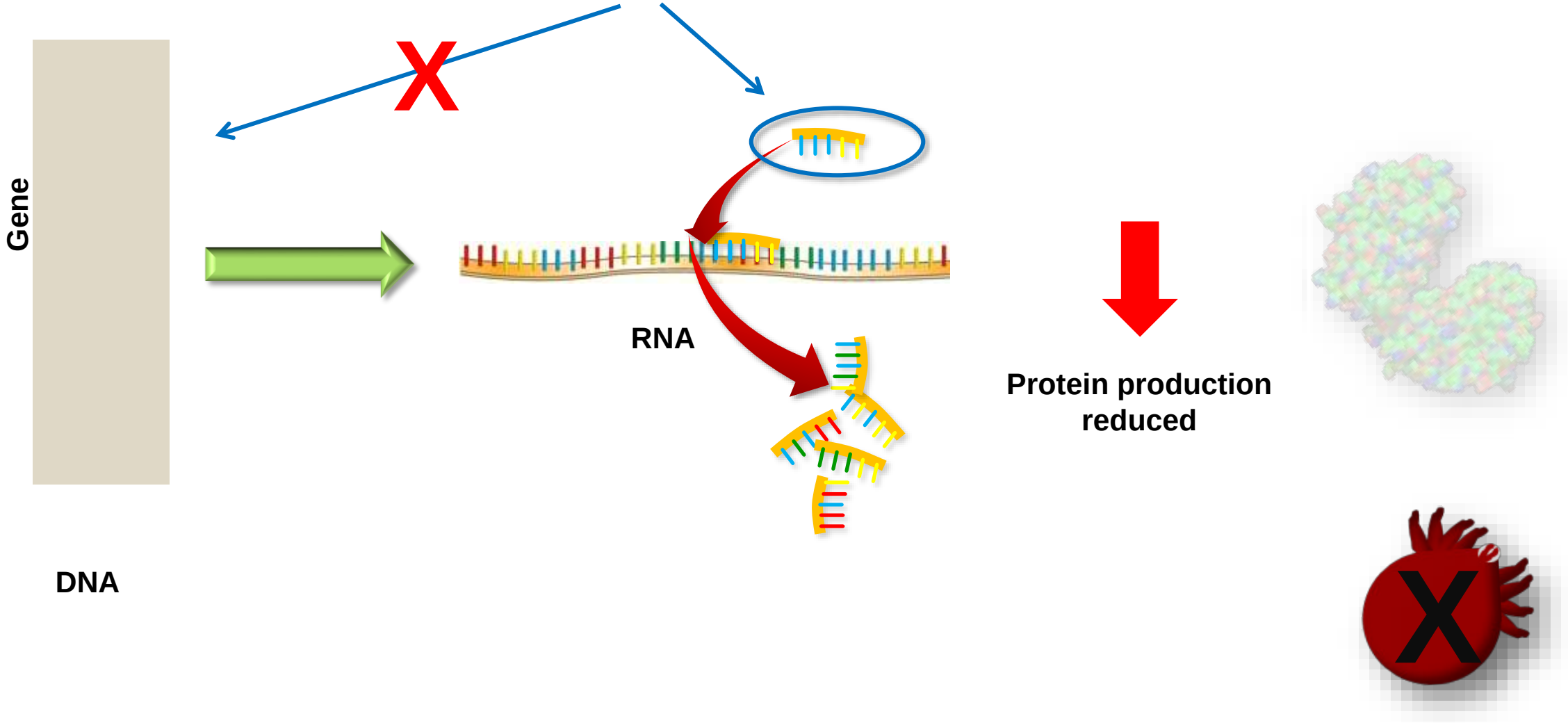
RNA interference (RNAi)



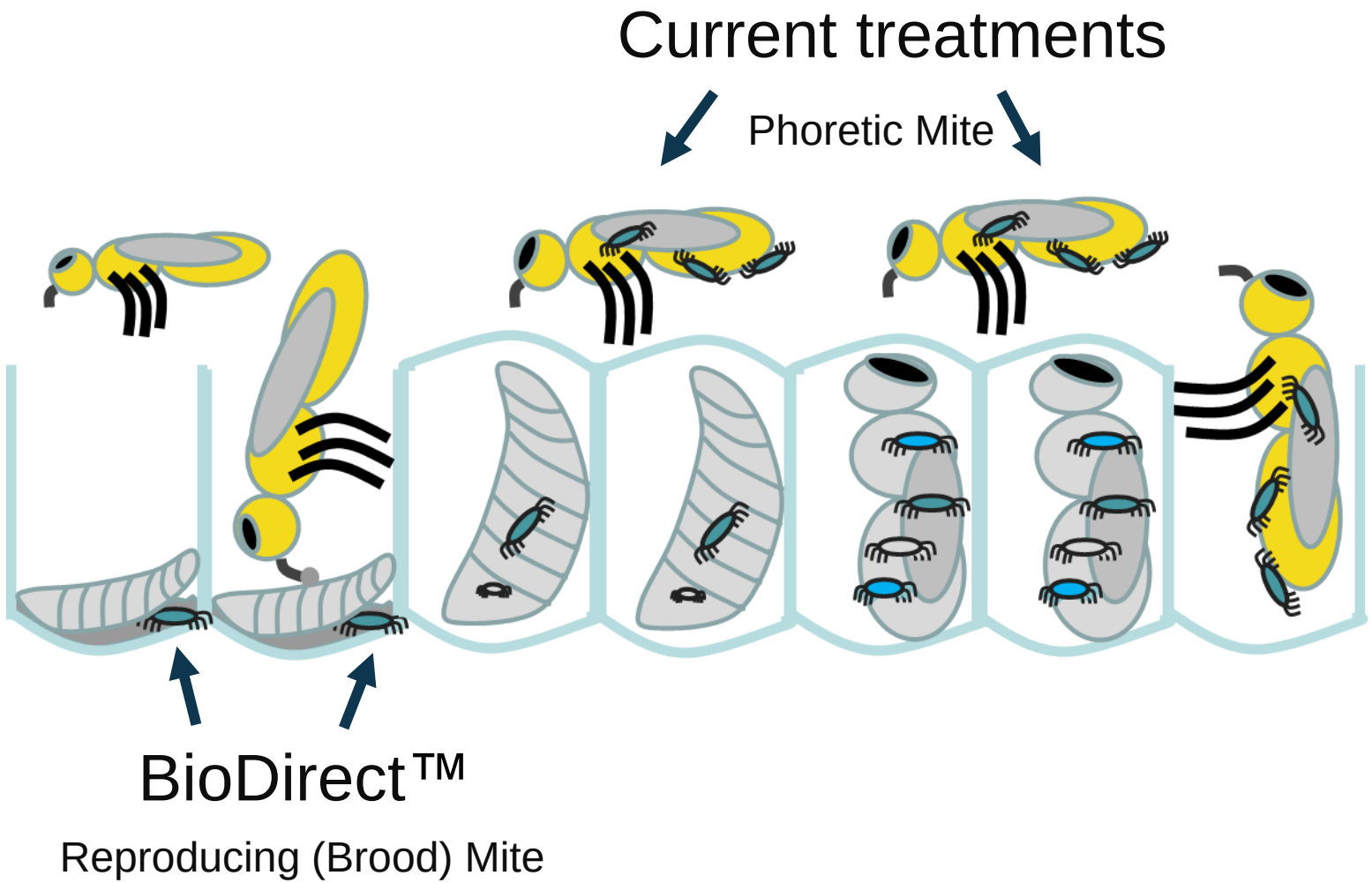
BioDirect™: a topical way to induce RNA interference in *Varroa*

BioDirect™

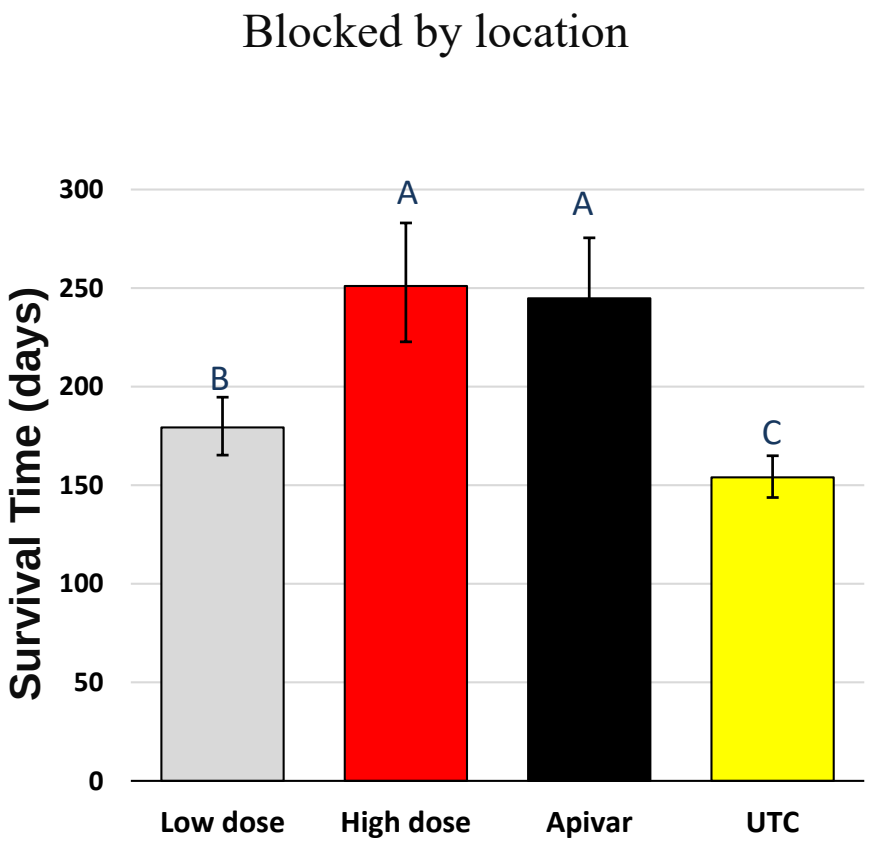
The initiating dsRNA sequence targeting *Varroa* is supplied from "outside"



BioDirect™ targets different *Varroa* populations

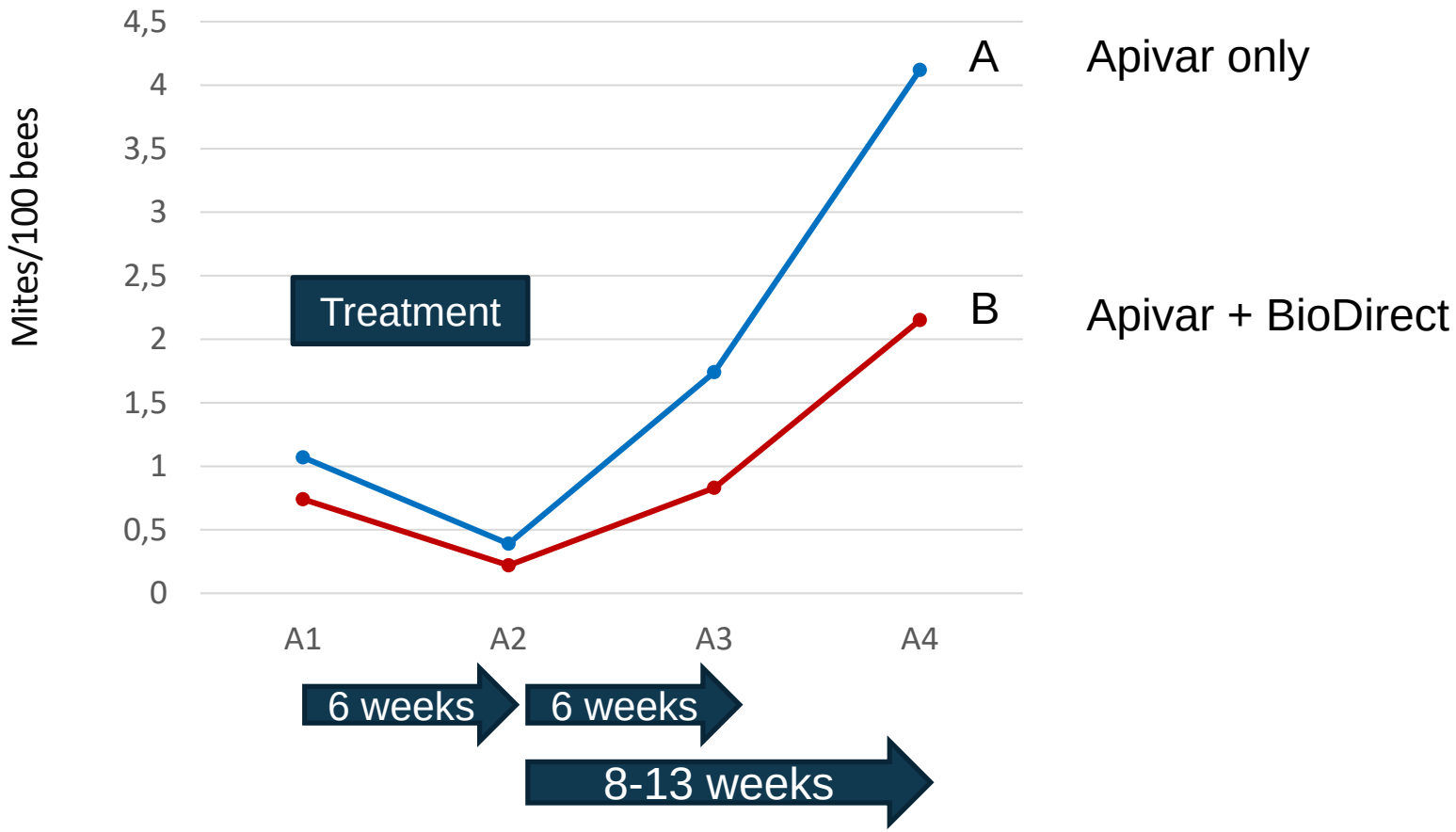


BioDirect™ protected hives as well as Apivar

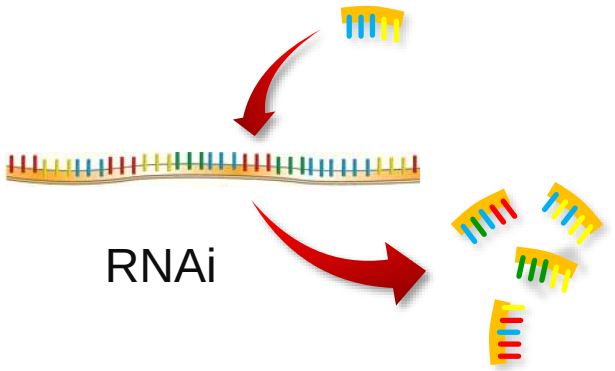


Model: Weibull Failure Time model for censored data
Error bars are confidence intervals of the mean
α=0.1

BioDirect + Apivar provided enhanced *Varroa* control



General Summary



BioDirect™ shows potential as a new type of *Varroa* control product

We've learned a lot about mite management while testing BioDirect™

- It's difficult to recover from high mite loads
- Mite populations can increase rapidly after treatment
- Treatments don't work all the time
- Response to treatment can vary from hive to hive

Final Lesson: Don’t put your hives in a flood plain