



Thiamethoxam sublethal exposure increases mortality and inhibits *Nosema ceranae* infections in the honey bee *Apis mellifera*

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Numerous crops depend on bee pollination, particularly from honey bees



More than 35% of honey bee colonies collapse every year in North America. Why?

- Honey bee mortality has been found to be associated to factors such as:

The factors most frequently associated to colony losses are pesticides and parasites

Neonicotinoid insecticides

Parasites
(*microsporidium*
Nosema ceranae)

Sublethal exposure



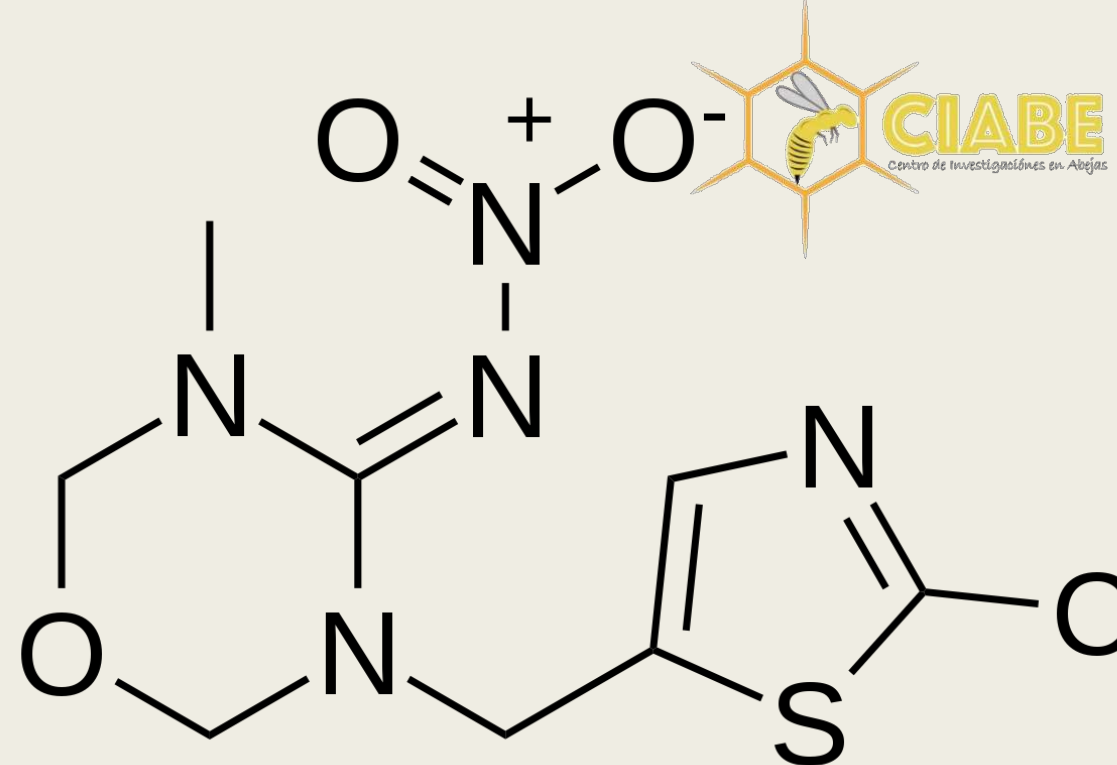
As pollinators, honey bees are routinely exposed to a wide variety of pesticides that impair colony health



Neonicotinoid pesticides are neurotoxic insecticides that are used globally on multiple crops visited by honey bees

Thiamethoxam

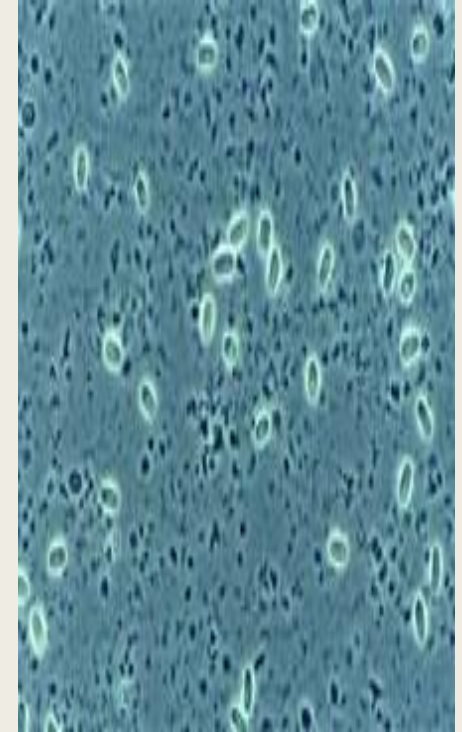
- Is a systemic neonicotinoid insecticide widely used worldwide because of its broad spectrum against many types of insects



The Food and Agriculture Organization (FAO) classifies thiamethoxam as an acutely toxic insecticide to bees

Nosema disease

- Caused by microsporidian fungi: *Nosema apis* and *Nosema ceranae*
- Affect digestive functions and survivorship of honey bees
- *Nosema* has been found to act in synergy with insecticides such as fipronil, increasing its toxicity to bees
- More work is still needed to corroborate potential interactions between *Nosema* fungi and neonicotinoid insecticides on honey bee health
- Nothing known about how the combined effects of *N. ceranae* and neonicotinoids affect the health of different genotypes of honey bees



Effects of *Nosema ceranae* and thiamethoxam in *Apis mellifera*

There is no knowledge about the combined effects of *Nosema* and thiamethoxam on the cellular immune system of honey bees

Nothing is known on how the combined effects of thiamethoxam and *N. ceranae* affect the health of Africanized honey bees.



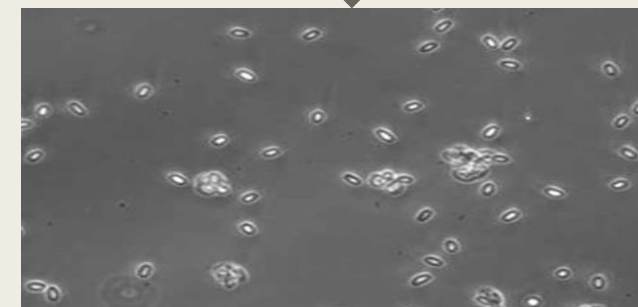
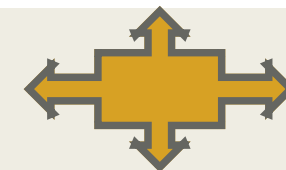
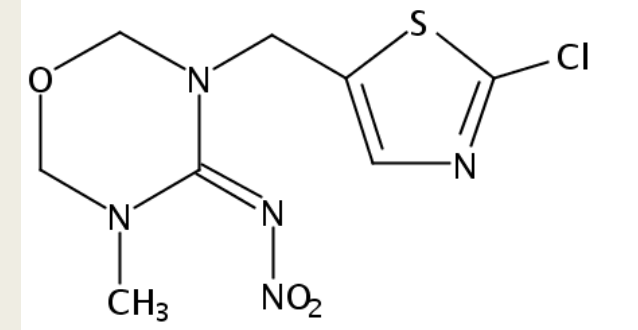


Research questions

- Do sublethal exposure to neonicotinoid insecticides (thiamethoxam) or to *Nosema ceranae* infection affect the health of Africanized honey bees?
- Can the two stressors interact and impact the health of Africanized honey bees?

Objective

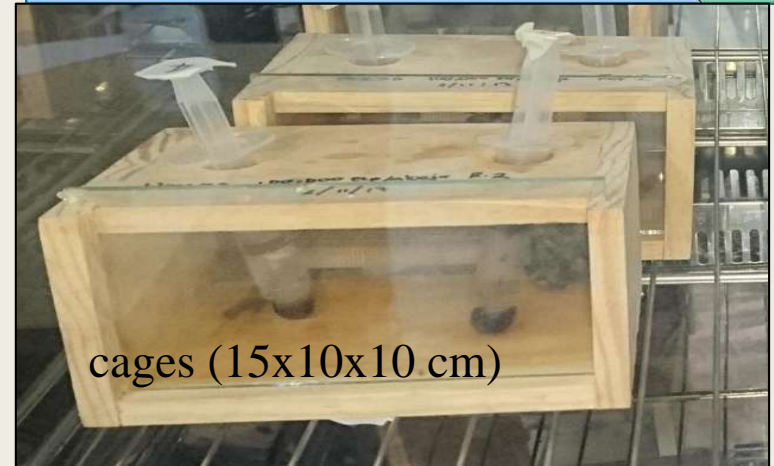
To examine the effects of a neonicotinoid insecticide (thiamethoxam) and the fungus *Nosema ceranae* on infection development, survivorship and cellular immune responses of Africanized honey bees





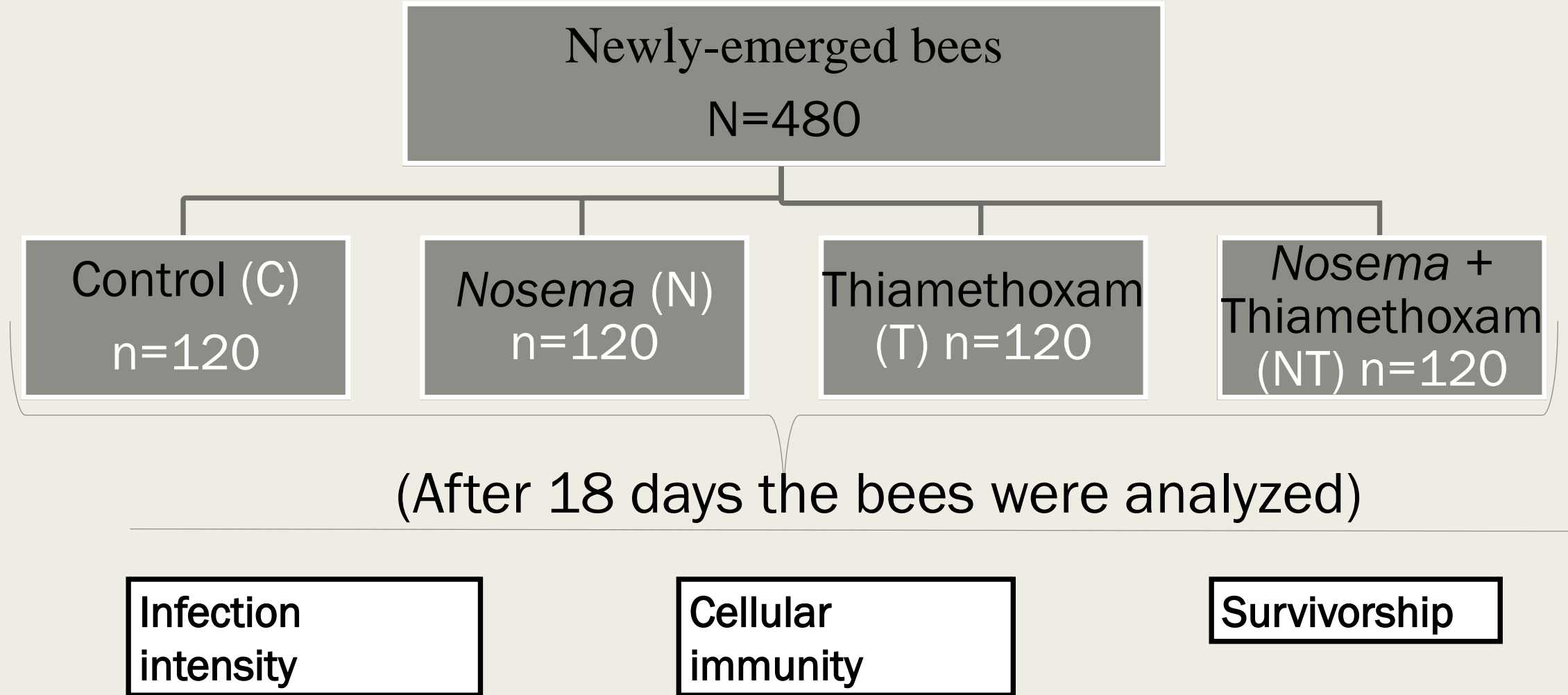
Materials and methods

- Experiments were conducted at the Bee Research Centre of the University of Guadalajara in Jalisco, Mexico
- *N. ceranae* spores were extracted and purified from infected Africanized bees (McGowan et al. 2016). Newly emerged Africanized bees were inoculated.
- Thiamethoxam (Syngenta TM) was used at a sublethal concentration concentration (0.25 mg/ μ l) and provided to caged bees in sugar syrup over 18 days.



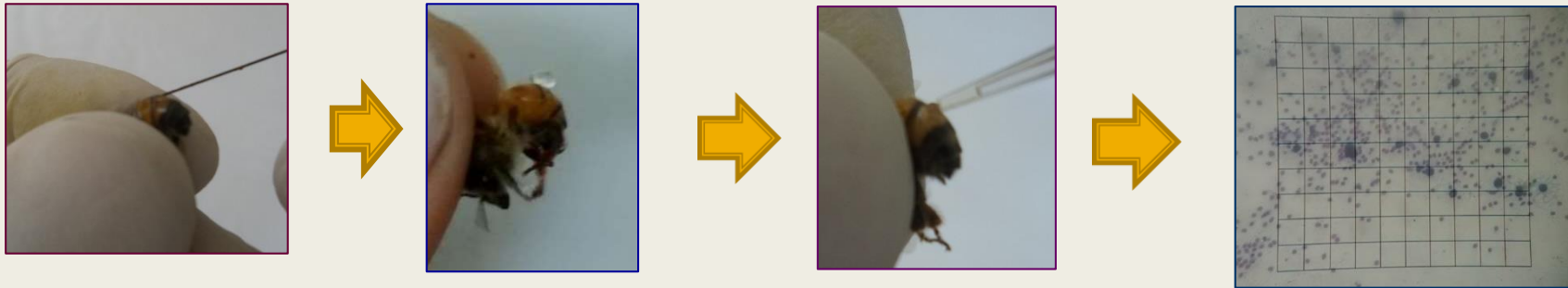
cages (15x10x10 cm)

Africanized bees exposed to thiamethoxam and *N. ceranae*



Methods

Cellular immune response through hemocyte counts



Infection intensity through *N. ceranae* spore counts



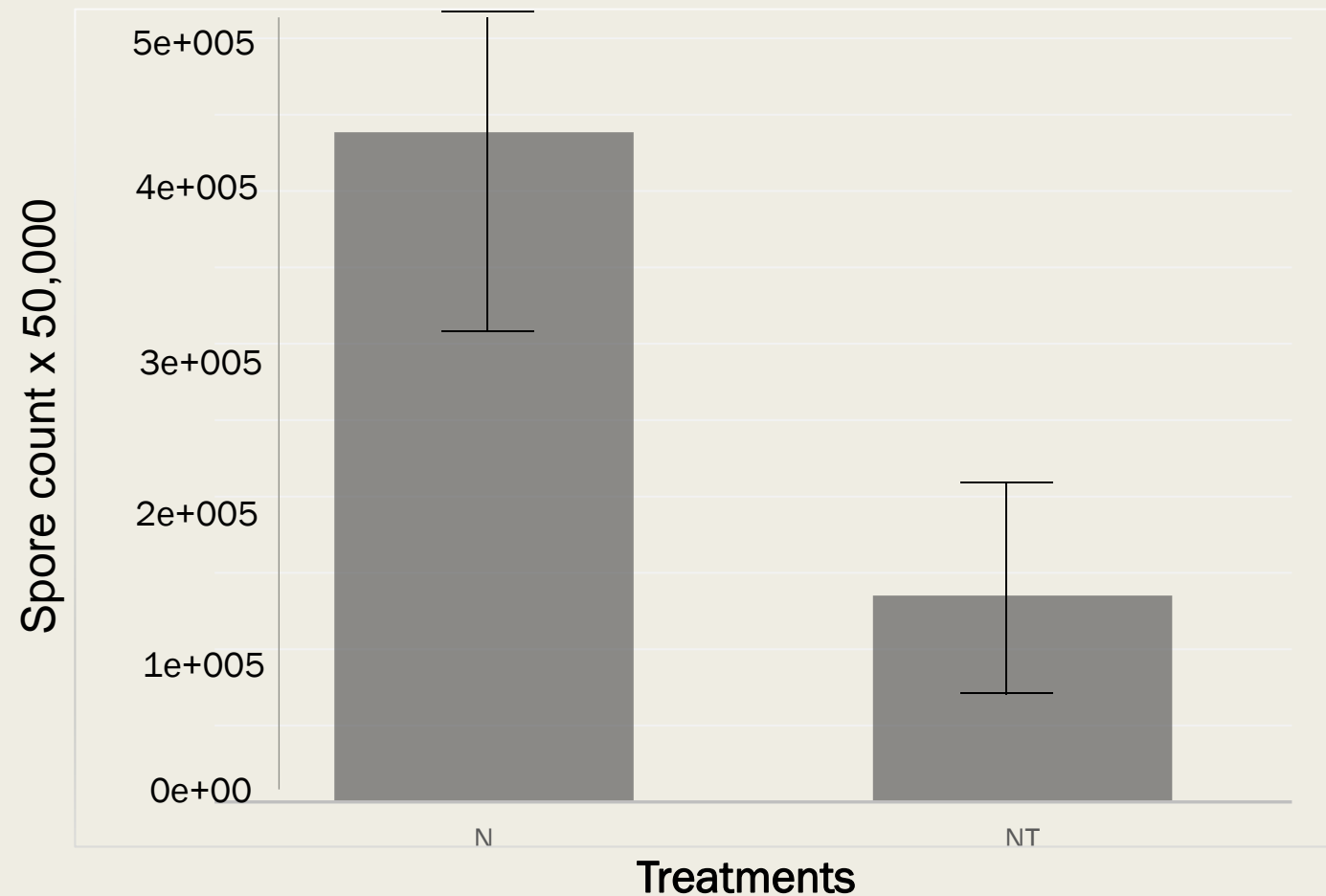
Mortality was recorded daily ➡ Survivorship ➡ % mortality over time

Statistical analysis

- Data on *N. ceranae* infection intensity (development) were subjected to a Wilcoxon test
- Data on hemocyte counts were log-transformed and analyzed by ANOVA
- Mortality data were analyzed using the Kaplan-Meier method

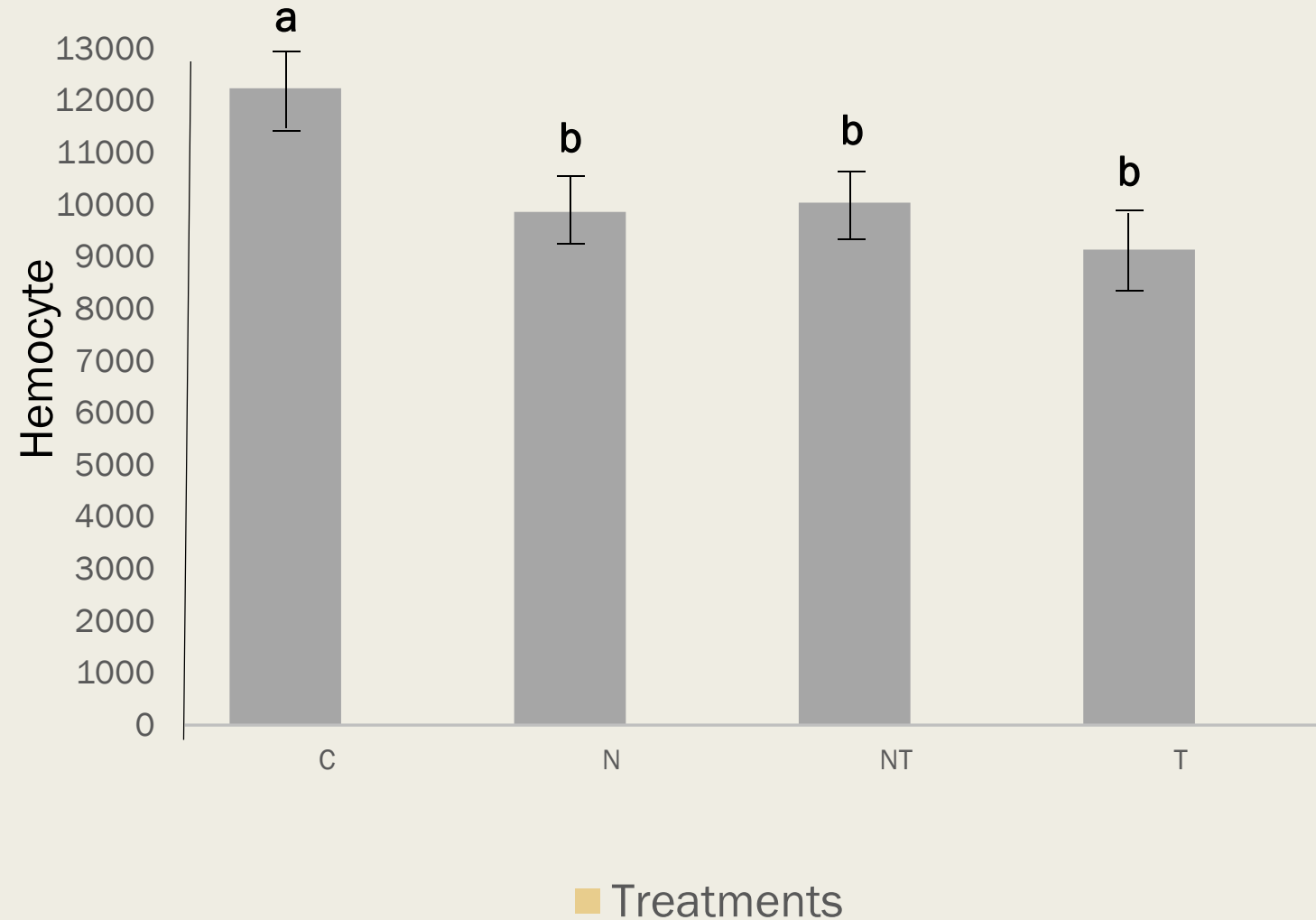
N. ceranae Infection intensity

- Africanized bees inoculated with *N. ceranae* only, developed 3.2 times higher infection levels than bees exposed to both stressors



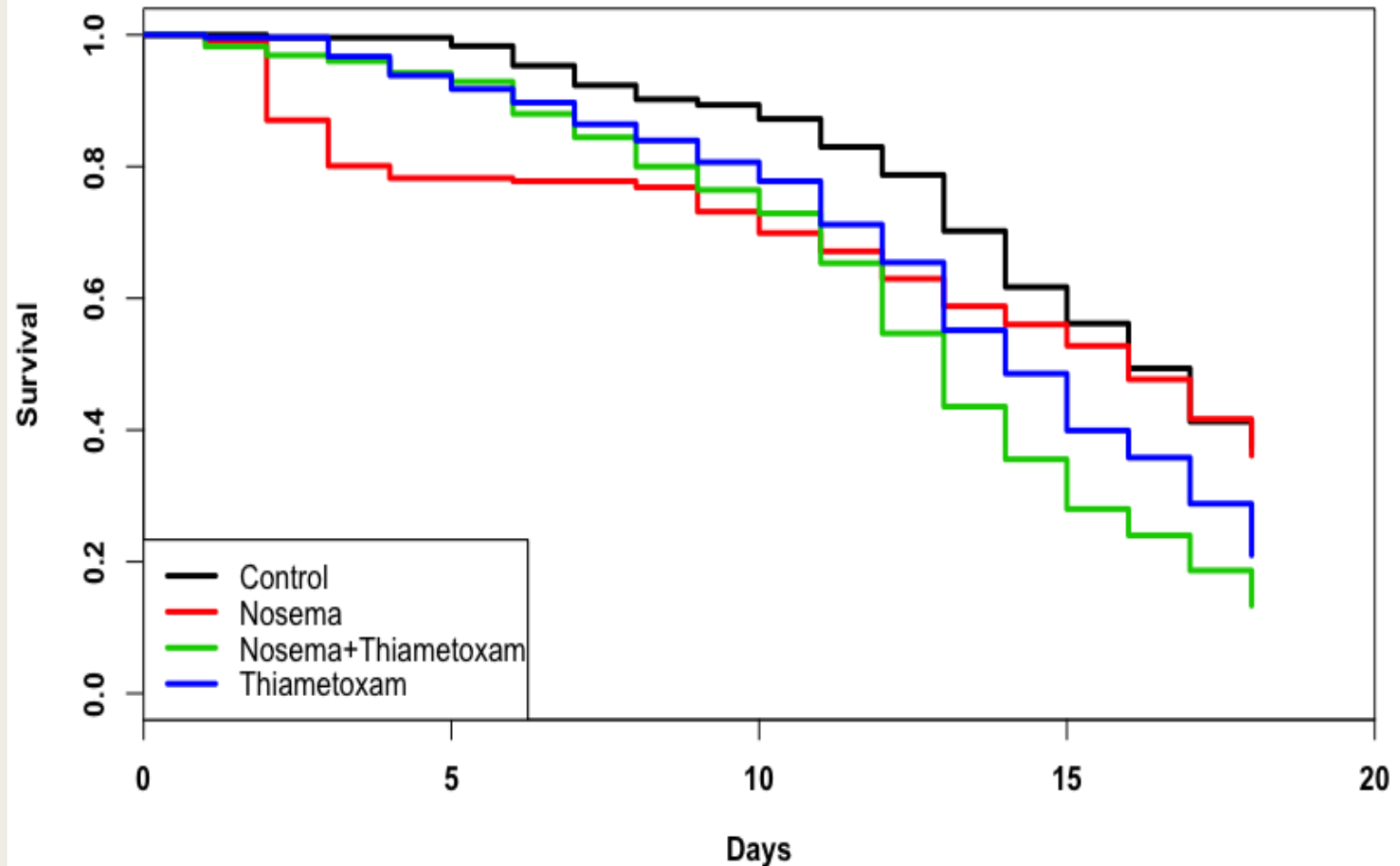
Cellular immunity

- Hemocyte counts were significantly lower in bees inoculated with *N. ceranae* as well as in bees exposed to thiamethoxam alone and to both stressors, relative to the control, untreated bees



Survivorship

- *N. ceranae* infected bees did not differ from control bees for survivorship probability at 18 days
- Bees exposed to thiamethoxam or to both stressors, had a significantly lower probability of survival than control or *N. ceranae* infected bees



Conclusions

- Thiamethoxam may inhibit the multiplication of *N. ceranae* in the gut of honey bees and along with the parasite may inhibit their immune cellular responses, which could make them more susceptible to other stressors
- Africanized bees appear to be sensitive to sublethal exposure to thiamethoxam, which could have negative implications in their populations and in their pollinating services



Thank you

