# 2021 Abstract Award Winners

## Activity of native tick kinins and peptidomimetics on the cognate target G protein-coupled receptor from the southern cattle tick, *Rhipicephalus microplus* (Acari: Ixodidae)

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**Abstract:**

Kinins are multifunctional neuropeptides that regulate key insect physiological processes such as diuresis, feeding, and ecdysis. However, the physiological roles of kinins in ticks are unclear. Furthermore, ticks have an expanded number of kinin paracopies in the kinin gene. Silencing the kinin receptor (KR) in females of *Rhipicephalus microplus* reduces reproductive fitness. Thus, it appears the kinin signaling system is important for tick physiology and its disruption may have potential for tick control. We determined the activities of endogenous kinins on the KR, a G protein-coupled receptor, and identified potent peptidomimetics. Fourteen predicted *R. microplus* kinins (Rhimi-K), and 11 kinin analogs containing aminoisobutyric acid (Aib) were tested. The latter incorporated tick kinin sequences and/or were modified for enhanced resistance to arthropod peptidases. A high-throughput screen using a calcium fluorescence assay in 384-well plates was performed. All tested kinins and Aib analogs were full agonists. The most potent kinin and two kinin analogs were equipotent. Analogs 2414 ([Aib]FS[Aib]WGa) and 2412 ([Aib]FG[Aib]WGa) were the most active with $EC_{50}$ values of 0.9 and 1.1 nM, respectively, matching the $EC_{50}$ of the most potent tick kinin, Rhimi-K-14 (QDSFNPWGa) ($EC_{50}$ = 1 nM). The potent analog 2415 ([Aib]FR[Aib]WGa, $EC_{50}$ = 6.8 nM) includes both Aib molecules for resistance to peptidases and a positively charged residue, R, for enhanced water solubility and amphiphilic character. These tick kinins and pseudopeptides expand the repertoire of reagents for tick physiology and toxicology towards finding novel targets for tick management.

Significance of the work:

The southern cattle tick, *Rhipicephalus microplus*, a major pest impacting cattle production in the southern hemisphere. It transmits the deadly pathogens of cattle *Babesia spp.* and *Anaplasma spp.* Vector control is still the most efficient approach to block disease transmission. However, resistance to the most commonly used acaricides is present worldwide and novel targets are needed for tick control. Silencing the kinin receptor in females of *Rhipicephalus microplus* reduces reproductive fitness. Thus, it appears the kinin signaling system is important for tick physiology and its disruption may have potential for tick control.

This study is the first report of activity of kinin peptides on any tick species. Ticks have an expanded number of kinin paracopies encoded in the kinin precursor gene. This study characterized the functional activity of 14 kinins predicted from *R. microplus* on the recombinant tick kinin receptor. Twelve of them showed similar high potency on the receptor at nano-molar level. In addition, this study confirmed the high potency of eight 'double-Aib-containing' analogs ([Aib]FX$^{1}$[Aib]WGa) with enhanced biostability. The findings are significant as new chemical approaches would have potential application for control of the southern cattle tick and help in the fight to prevent its re-establishment across large regions of the U.S. Secondly, the identification of ligands that could be used as research tools to investigate yet unknown kinin physiology in ticks.

Seasonal population dynamics of bermudagrass mite and associated mites in turf

Matthew Brown and JC Chong

Bermudagrass mite infestation causes distorted growth, poor stem and root development, and plant death in bermudagrass grown as turfgrass or hay. Its ecology is largely unknown but crucial to developing an effective management program. In this study, we monitored bermudagrass mite damage and populations to determine their seasonal dynamics. We also documented other mite taxa associated with bermudagrass mite. To monitor mite damage, we counted the numbers of symptomatic shoots biweekly for 6−18 months at three locations in North and South Carolina. To monitor bermudagrass mite populations, we collected 10 symptomatic and 10 asymptomatic shoots monthly from the same three sites, counted the numbers of mites and eggs, and observed for the presence of other mite taxa in the shoots. Bermudagrass mite damage and populations followed similar patterns over time at all sites, i.e., rising rapidly to a peak in the spring and collapsing during early summer. During population peaks, we found bermudagrass mites on 30-60% of asymptomatic grass samples. Associated mites (tarsonemids, tydeids, and others) arrived on dates with peak bermudagrass mite populations and increased until bermudagrass mite populations experienced a sharp decline. This pattern indicates that the population dynamics of bermudagrass mite and these associated mites may be related. The rapid rise in bermudagrass mite damage and populations evident in this study emphasize the difficulty in timely management of this pest. This study provides information to improve monitoring and timing of management strategies against bermudagrass mite.

Supplementary text:

Bermudagrass mite outbreaks ruin the growth and playability of high-value turf on golf courses and athletic fields. Miticides are commonly used to control bermudagrass mites, but this strategy is expensive and often ineffective. Therefore, better information about mite ecology and alternative control strategies are required to develop an effective management program. This study provides information about seasonal dynamics of bermudagrass mite damage and populations, which is critical to effectively schedule monitoring and management efforts. The literature identifies June and July as the period of peak bermudagrass mite damage. However, our study identifies April as the peak of both mite damage and populations, with variability from year to year, suggesting that miticides may have to be applied earlier than previously recommended. Additionally, most previous research has only examined mite damage, not mite populations. This study correlates mite population size with mite damage and provides an evaluation approach for the true efficacy of control strategies. The existing literature states that bermudagrass mites only exist on symptomatic bermudagrass, but we found up to 60% of asymptomatic grass samples with bermudagrass mites, thus identifying the mechanism by which the mite population persists. The mite taxa associated with bermudagrass mite may be natural enemies or antagonists, which may be further studied and developed as biological control agents. Future research needs to determine what effect the associated mite taxa have on bermudagrass mite populations, how miticides used against bermudagrass mite affect these mites, and where these mites originate (e.g., nearby ornamentals, weeds, or flowering plants).