

2005 Progress Report for  
Research Proposal submitted to the Southern Region Small Fruits Consortium

## **Sub-Lethal Effects of Honey Bee Parasites on Rabbiteye Blueberry Pollination**

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### **Objective**

To determine whether sub-lethal levels of the honey bee parasite *Varroa destructor* reduce the pollinating efficacy of honey bees in rabbiteye blueberry

### **Justification**

Rabbiteye blueberry production has been increasing throughout the Southeast over the past ten years (Krewer and NeSmith 2002, Scherm and Krewer 2003). Bee-mediated cross-pollination is considered essential for this high-value crop (Delaplane and Mayer 2000), and our lab and others have demonstrated the effectiveness of honey bees (*Apis mellifera*) in this capacity (Dedej and Delaplane 2003, 2004; Sampson and Cane 2000). However, pollination is generally regarded a limiting factor in production (Lyrene 2004).

One reason for this pollination deficit is a general collapse of feral naturalized honey bee populations throughout the Southeast due to the introduction in the 1980s of the exotic parasitic bee mite *Varroa destructor* (formerly *V. jacobsoni*). Support for this view comes from a study in California in which a feral population of honey bees was shown to collapse after the arrival of *V. destructor* (Kraus and Page 1995). Under this scenario the free background of natural pollination has been severely diminished, and it is up to managed honey bee colonies to pick up the slack (managed colonies can be treated for the parasite). A corollary to this view is the notion that even moderately parasitized bees (ie., managed bees that receive treatment but nevertheless endure sub-lethal parasite loads) are behaviorally or physiologically compromised in their efficiency as pollinators. Support for this view comes from a study in which it was shown that moderately mite-infested bee colonies fielded a smaller number of pollen foragers (Janmaat and Winston 2000). It is generally assumed that pollen-foraging bees are the effectors of pollination (Delaplane and Mayer 2000). Thus, it is possible that two interacting effects are at work causing the pollination deficit: (1) there are fewer honey bee pollinators, and (2) even moderately mite-infested honey bees may be pollinating at sub-optimal capacity. Our lab has addressed hypothesis (1) by showing that honey bee pollination of rabbiteye blueberry increases as bee density increases (Dedej and Delaplane 2003); however hypothesis (2) is untested. In this first year's work we began what I hope will become a comprehensive project appraising the effects of honey bee nest invaders on pollination in the Southeast. If hypothesis (2) proves true, then it is possible that there are problems with current mite control practices – problems that could explain bee shortages like the kind currently affecting the \$1.42 billion California almond industry <http://www.cfbf.com/agalert/1996-00/2000/aa-0216c.htm> and <http://www.cfbf.com/ffn/2004/archive.cfm?month=11&day=29>.

After submitting the proposal I decided to add a second nest invader to our experimental design: the exotic small hive beetle (SHB), *Aethina tumida*. This nitidulid beetle scavenges for stored

honey and pollen in bee hives. Among other harmful effects, my lab has documented reduced honey bee flight activity in colonies with SHB (Ellis et al 2003), suggesting a pollination-inhibiting effect similar to that found by Janmaat and Winston (2000) for Varroa. SHB has been steadily expanding its range in the Southeast since 1998 and is considered the second and third highest research priority by beekeepers in South Carolina and Georgia, respectively, based on a 2003 beekeeper survey I conducted with my Clemson colleague, Dr. Mike Hood.

## **Methods**

In 2005 we used cage studies to appraise the hypothesis that sub-lethal levels of nest invaders compromise honey bee pollination efficiency. Treatments consisted of plots, each with two mature 'Climax' rabbiteye blueberry plants that were either tented with bees, without bees, or left open as controls. Tents are 1.8 x 1.8 x 1.8 m frames covered with Lumite screen (Bioquip Corp). Bee colonies, each with 3200 bees, were caged under two mature blooming 'Climax' bushes and two or more potted pollenizers. Dedej and Delaplane (2003) demonstrated that this bee and plant density is non-limiting in either pollinator performance or availability of pollenizer pollen.

Five treatments were established: (1) bee pollinators with 'high' levels of Varroa mites ( $n=6$  cages) (2) 'high' levels of SHB ( $n=6$ ), (3) bee pollinators managed to have 'low' or no nest invaders (with Varroa, zero-levels are nearly impossible to achieve) ( $n=3$ ), (4) no bee pollinators (tent with no bees, negative control) ( $n=3$ ), and (5) open pollinated (open tent, positive control) ( $n=3$ ). Bees for the 'high' Varroa levels were taken from full-sized field colonies shown by standard sampling procedures (Delaplane and Hood 1997) to have comparatively high mite densities. Bees for the 'high' SHB treatment received on average 300 beetles from our laboratory rearing facility. Bees from the 'low' pest treatment came from colonies undergoing standard acaricide treatment for Varroa and receiving no supplemental SHB. These colonies continued receiving acaricide treatment during the test to maintain their low pest levels.

The following dependent variables were determined for each plot following standard methods (Dedej and Delaplane 2003): bee flower visitation rate, fruit set, seed number, and berry weight. Data were analyzed with a randomized design analysis of variance and means separated by Duncan's test.

## **Results for 2005**

Data for 2005 are given in the table, except for seed number which has not been completed. In spite of manipulating a divergence of pest densities in the treatments, we did not detect deleterious effects of elevated pest densities on pollination parameters. In fact, fruit-set and berry weight were numerically highest in the beetle treatment.

<b>Results for 2005 trial.</b> Bee colonies were manipulated to achieve different levels of Varroa mites and small hive beetles; ending values for Varroa (24-hour sticky sheet method) and SHBs (direct counts) are given in the first two columns. Values are mean $\pm$ SE, except for the first two columns which give SD. Values in parentheses, <i>n</i> . Column means with different letters are different by Duncan's test at a $\alpha \leq 0.05$ .					
Treatment	Ending Varroa Densities	Ending SHB densities	Bee flower visits/2 min	Fruit-set	Avg. berry wt (g)
Varroa	14.4 $\pm$ 6.7 (6)	0	41.0 $\pm$ 2.5 (42) a	50.1 $\pm$ 2.2 (198) a	0.78 $\pm$ 0.02 (165) ab
SHB	4.3 $\pm$ 2.4 (6)	157 $\pm$ 74 (6)	33 $\pm$ 2.7 (42) a	50.2 $\pm$ 2.2 (211) a	0.82 $\pm$ 0.02 (168) ab
Low pest	8.8 $\pm$ 7.1 (3)	0	35.5 $\pm$ 3.1 (21) a	38 $\pm$ 3.2 (105) b	0.78 $\pm$ 0.03 (73) ab
No bees	NA	NA	NA	16.1 $\pm$ 2.7 (100) c	0.59 $\pm$ 0.04 (37) c
Open	NA	NA	2.9 $\pm$ 0.7 (21) b	37.1 $\pm$ 2.0 (208) b	0.72 $\pm$ 0.02 (161) b

### Conclusions

The most evident trend was the overwhelming benefit of artificial pollinator supplement afforded by tenting honey bees with the target plants, a benefit that exceeds the background pollination indicated in the open plots. Apparently the benefit of optimized pollinator densities eclipses small-scale handicaps in the physiology or behavior of those pollinators caused by nest invaders, however lethal or insidious they are at the colony level.

There are three reasons we believe this work warrants another year of replication. (1) The 2005 results are unintuitive, based on our understanding of the parasites' negative effect on pollen foraging behavior in bees (Janmaat and Winston 2000, Ellis et al 2003) and the general understanding that pollen foragers are positively associated with pollination performance (Delaplane and Mayer 2000). Replication is the only way to ensure that our 2005 results are not anomalous. (2) We want to improve our techniques for experimentally creating divergent pest densities. We encountered unexpected difficulty reducing Varroa levels in the 'low' pest treatment, an apparent case of chemical resistance. For 2005 we plan to reduce Varroa with a combined use of botanical oils (Api-Life VARTM, Chemicals LAIF, Italy) and powdered sugar; dusting bees and mites with powdered sugar has been shown to dislodge a large fraction of the mite population (Fakhimzadeh 2001). (3) It is possible that hypothesis (2) developed in the introduction is, in fact, unsupported by experimental challenge. It is not always certain that parasites negatively affect the host behavioral or physiological parameters that experimenters choose to measure. For example, there are at least three published reports that fail to show an association between Varroa mite infestation and bee brood production (Korpela et al 1992, Delaplane 1995, Delaplane and Hood 1997). More recently, in a study related

to this one, my student and I found that *Varroa*-parasitized bees had higher flower visitation rate in rabbiteye blueberry (Ellis and Delaplane, unpublished); this reduces fitness for the bee colony (fewer calories gained per flower), but arguably increases fitness for the plant as rapid flower visitation is understood to positively affect pollination (Delaplane and Mayer 2000). However, replication is the only way to work out the ambiguities in our present body of data.

### **Impact Statement**

There is evidence to suggest that honey bee pollination efficiency in blueberry is damaged by nest invaders of honey bees in one or two ways: (1) the invaders outright destroy feral, unmanaged bee colonies, and (2) even managed colonies suffering moderate levels of invaders may be impaired as pollinators. This project is testing hypothesis (2). If hypothesis (2) is supported, then it would shine light on a formerly overlooked aggravating factor in the pollination problem – economic costs associated with sub-lethal levels of nest invaders. Such a conclusion would warrant revising our economic thresholds for the pests, as well as the control practices themselves to render bee hives as pest-free as possible. If hypothesis (2) is not supported, it would affirm current economic thresholds and pest control practices.

### **Citations Arising from this Project**

None yet

### **References**

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