NC1173 2012 Meeting Minutes and Annual Report

NC1173

Notes on annual meeting
January 10, 2013
Hershey, PA

In attendance: Steve Pernal, David Tarpy, Marion Ellis, Lizette Dahlgren, John Skinner, Chris Mullin, Keith Delaplane, Ramesh Sagili, John Burand, Brian Eitzer, Michael Wilson, Pat Bono, Zachary Huang, Greg Hunt, Frank Drummond, Marc Linit, Tom Webster, Marla Spivak

Call to order: Reed Johnson, Chair

Marc Linit provided a brief overview of the mission of the NC1173.

Introductions around the room.

Discussion of how to craft a report and next white paper for the next five years. Each member will complete a short report which the Chair and Vice-chair will compile into the final report. This will need to be done in the next few weeks.

There was general consensus for continuing the group. The three options are to (1) end the committee, (2) continue as a "funded" committee (NC), or (3) continue as a non-funded committee.

Motion to renew the project: Frank Drummon, Keith Delaplane (second)
No discussion.
Vote: all in favor

One last discussion was about the benefits of tying the NC1173 meeting with the ABRC and the commodity meeting. Marc strongly encouraged to highlight this in the annual report, since it is rare and benefits the group.

Agreed to meet again during the ABRC/AHPA conference in San Antonio TX in January 2014.

Motion to adjourn: Marla Spivak, Greg Hunt (second)

Steve Pernal	Agriculture and Agi-Food Canada
David Tarpy	NC State University
Marion Ellis	University of Nebraska
Lizette Dahlgren	University of Nebraska
John Skinner	University of Tennessee
Chris Mullin	Penn State
Keith Delaplane	University of Georgia
Ramesh Sagili	Oregon State University
John Burand	University of Massecheusetts
Brian Eitzer	CN Agricultural Experiment Station
Michael Wilson	University of Tennessee
Pat Bono	Seaway Trail Honey
Zachary Huang	Michigan State University
Greg Hunt	Purdue University
Frank Drummond	University of Maine
Marc Linit	University of Missouri
Tom Webster	Kentucky State University
Marla Spivak	University of Minnesota

Accomplishments:

Determined that dispersed colonies of honey bees maintain lower levels of Varroa mites than do crowded colonies (all without miticide treatments), probably because they experience less drifting and robbing (Objectives 1 and 3); NY

Determined that supplementing pumpkin fields with commercially produced colonies of the non-*Apis* bee, *Bombus impatiens*, produced on average the same yield (fruit weight per plant) as pumpkin fields supplemented with either hives of *Apis mellifera* or pumpkin fields that were not supplemented with managed bees (Obj. 9); NY

Visits to pumpkin flowers by non-*Apis* bees, especially *Bombus impatiens* and *Peponapis pruinosa*, and feral *Apis mellifera* were significantly positively correlated with pumpkin yield (fruit weight per plant) (Obj. 9); NY

B. impatiens and *A. mellifera* visited more pumpkin flowers in fields that were in landscapes characterized by diverse habitats and had a relatively significant proportion of grassland (Obj. 9); NY

In cooperation with the Florida Department of Agriculture and Consumer Services, one research technician was employed and tasked with investigating RNAi control of Varroa mites during the CRIS report period. We completed a field project in cooperation with Beeologics, Inc. through which we tested dsRNA constructs developed to silence the expression of specific genes in Varroa. My team has analyzed the colony phenotype data while our colleagues at Beeologics (now owned by Monsanto) continue to process the molecular data (Objective 1); FL

My lab remains a funded partner in the Protection of Managed Bees CAP Project. During the CRIS project period, we evaluated the role and causative mechanisms of bee pests and pathogens in honey bee colony deaths. This included (1) identifying different viruses, bacteria, and nosema found in stationary honey bee colonies in different geographic regions of the U.S., (2) quantifying viral and Nosema spp. infection levels as related to stationary colony morbidity and mortality, and multi-variable correlations with pests and pesticides, (3) quantifying stationary colony exposure to commonly used pesticides in relationship to region and crop, and (4) determining relationships between pesticides found in colonies and surrounding land use (Objective 5); FL

We initiated an effort to determine the impacts of 13 pesticides on (1) gene expression patterns in developing bee larvae and pupae, (2) cell death levels in larval, pupal, and adult bee midguts, and (3) adult honey bee foraging behavior (Objective 3); FL

My lab manages two extension programs that facilitate our efforts to educate beekeepers about best management practices for disease/pest control and for beekeeping in general. The UF Bee College is an annual two-day event catered to beekeepers with all levels of expertise (>300 beekeepers attended in 2012). The UF Master Beekeeping program is a tiered program through which ~250 beekeepers are engaged in research and extension efforts (~8% of FL beekeepers are involved in the program). Both programs are used to facilitate knowledge transfer (Objective 7); FL

A PhD student in my laboratory is conducting an assessment of honey bee pathogens within the *Apis mellifera* and non-*Apis* pollinator communities in North Central Florida. This will help us determine the spread and prevalence of honey bee pathogens in the environment. In some preliminary trials, we have discovered Black Queen Cell Virus and Deformed Wing Virus in non-*Apis* bee species, both in adult and immature bees (Objective 9); FL

To determine the effects of pesticides and other environmental chemicals on honey bee colony health.
Over 47% of pollen and wax had both in-hive miticides fluvalinate and coumaphos combined with up to 99 ppm of chlorothalonil. Chorothalonil, a contact fungicide, was found to be a pesticide marker for entombing behavior in bee colonies associated with poor health.
An improved, automated version of the proboscis extension reflex assay was used to measure the olfactory learning ability of honey bees treated orally with sublethal doses of the most widely used spray adjuvants on almonds in California. Organosilicones were more active than the nonionic adjuvants, while the crop oil concentrates were inactive.
A method for analysis of organosiloxane, nonylphenol and octylphenol polyethoxylate surfactants in bee hive matrices was developed. Nonylphenol more than organosiloxane and octylphenol polyethoxylates were found in wax samples, while pollen and particularly honey residues were lower (Objective 3); PA

To determine the effects of interactions among various factors affecting honey bee colony health.

Through use of the statistical approach of classification and regression tree analysis with 55 different variables measuring colony stress, six of the variables having the greatest discriminatory value were pesticide levels in different hive matrices. These included coumaphos in brood and wax, chlorothalonil in wax, and dicofol in beebread (Objective 5); PA

Our approach in documenting pesticides in apiary samples has been to search for a wide sweep of pesticides that are used frequently in hives and around bees where they forage. Although we have found 132 different pesticides and metabolites in beehive samples, no individual pesticide amount correlates with recent bee declines. Our residue results based on 1300 samples do not support sufficient amounts and frequency of imidacloprid in pollen to broadly impact bees. Indeed, if a relative hazard to honey bees is calculated as the product of mean residue times frequency detected divided by the LD50, the hazard due to pyrethroid residues is three-times greater than that of neonicotinoids detected in pollen samples. Lipophilic pyrethroid prevalence and persistence in the hive likely has more consequences for colony survival than the water-soluble neonicotinoids such as imidacloprid. However, higher residues of the less toxic neonicotinoids acetamiprid and thiacloprid or of pyrethroids in pollens with even higher amounts of fungicides may have considerable impact on bee health via their synergistic combinations. Over 47% of pollen and wax had both in-hive miticides fluvalinate and coumaphos combined with up to 99 ppm of chlorothalonil. Chorothalonil, a contact fungicide, was found to be a pesticide marker for entombing behavior in bee colonies associated with poor health. Through use of the statistical approach of classification and regression tree analysis with 55 different variables measuring colony stress, six of the variables having the greatest discriminatory value were pesticide levels in different hive matrices. These included coumaphos in brood and wax, chlorothalonil in wax, and dicofol in beebread. This study used an unbiased analysis of multiple factors that might be associated with Colony Collapse Disorder, and certainly indicates that pesticides are very likely involved and that interactions with other stressors are likely factors contributing to the decline of honey bee health. High numbers and diversity of active ingredient residues suggest that more generic formulation inerts or adjuvants that co-occur across classes of pesticides may be involved. An improved, automated version of the proboscis extension reflex assay was used to measure the olfactory learning ability of honey bees treated orally with sublethal doses of the most widely used spray adjuvants on almonds in California. Learning was impaired after ingestion of 20 µg organosilicone surfactant, indicating harmful effects on honey bees caused by agrochemicals previously believed to be innocuous. Organosilicones were more active than the nonionic adjuvants, while the crop oil concentrates were inactive. A method for analysis of organosiloxane, nonylphenol and octylphenol polyethoxylate surfactants in bee hive matrices was developed. Nonylphenol more than organosiloxane and octylphenol polyethoxylates were found in wax samples, while pollen and particularly honey residues were lower. The impact of synergistic pesticidal blends on bees cannot be fully understood without identification and risk assessment of inert residues and their agrochemical interactions; PA

Graduate student, Mike Goblrisch, studied the pathogenicity and effects of *Nosema ceranae* on honey bee physiology and behavior. He found that 7-day old Nosema infected bees had lower levels of the storage protein, vitellogenin (Vg), and higher levels of Juvenile Hormone (JH), compared to uninfected bees. Nosema infected bees foraged significantly more and at earlier ages compared to uninfected bees. Vg and JH are important hormonal and protein regulators of development and behavior, and their disruption can lead to precocious foraging and shortened life-span in infected bees (Objective 5); MN

In collaboration with Dr. V. Krischik, Dept Entomology, Univ MN, we fed imidacloprid in sugar syrup to large field colonies at doses of 0, 50ppb, 100ppb and 200ppb all summer in 2011. Sublethal effects were observed after 3 months of treatment: 200ppb treated colonies had significantly less sealed brood, less stored pollen, fewer pollen foragers, and higher levels of *Nosema ceranae* compared to untreated controls. All treated colonies had significantly higher levels of three viruses, DWV, BQCR, and IAPV by July compared to control colonies. Judy Wu, PhD student, is studying effects of IMD in sugar syrup (0, 20ppb, 50ppb and 100ppb) on queen bee egg laying and activity patterns. At two higher doses, the number of eggs the queen lays per unit time, and her distance traveled over the comb are significantly reduced compared to the 20ppb and control colonies (Objective 3); MN

In MN, we established one of seven replicate apiary sites (WA, TX, FL, ME, PA, CA) to evaluate the factors that lead to colony death. The data are being analyzed by collaborating labs across the country, and will include analyses of nutrition, levels of parasitic mites (Varroa and tracheal mites), Nosema disease, viruses, Small Hive Beetles, analysis of pesticide residues in comb and in pollen, and assessments of colony strength over 4 years time (Objective 5); MN

We have developed Tech Transfer Teams that work closely within a region's commercial beekeeping community to help beekeepers conduct long-term monitoring of diseases and pest loads in their colonies, and to help U.S. queen bee breeders incorporate traits that help honey bees resist pathogens and parasitic mites in commercially available stocks. Thus far we have developed two teams – one in Northern California to work with commercial bee breeders, and one in the Upper Midwest to assist migratory beekeepers. The original team (in No. CA) was initiated by Marla Spivak and is now (like all others) funded through BIP, beekeeper contributions, and other grants. The Bee Tech Teams are modeled after independent professional consultants that work for other grower groups, but are uniquely designed to meet the needs of the specific group of beekeepers they cater to. Data from all the teams are entered into a secure Bee Informed database which in turn generates reports that are promptly returned to beekeepers, allowing them to make educated treatment decisions (Objectives 7 and 8); MN

Determined that the microsporidium *Nosema ceranae* is, like *Nosema apis,* a midgut pathogen; no other host tissues are invaded. The spores are not regurgitated but do contaminate mouthparts of communally caged bees due to hygienic behavior. (Objective. 2); IL

Determined that *Nosema ceranae* produces significantly more mature spores over a 20-day infection period than does *N. apis.* (Objective. 2); IL

Determined that *Nosema ceranae* is released from control by fumagillin at higher concentrations of the drug than is *Nosema apis.* Fumagillin apparently impacts honey bee proteins and, in the laboratory, allows *N. ceranae* to hyperproliferate when concentrations are very low, similar to treated hives in the summer months. (Objective. 2); IL

Our goal of identifying candidate genes that influence the two principal mechanisms of honey bee resistance to Varroa mites is considered complete (objective 2). Identification of candidate genes for mite-grooming behavior and Varroa sensitive hygiene (VSH) was performed. This was a collaboration between the Hunt lab and and Managed Pollinator CAP collaborators at the USDA Baton Rouge Bee Lab, and a collaboration between the Hunt lab and the Mexican agricultural research service (INIFAP). Two publications included sequences of specific probes that can be used to follow the inheritance of alleles for genes that potentially influence mite-resistance traits for marker-assisted selection. Sequences of the SNP probes along with the maps have been deposited in dbSNP at NCBI and will be linked to the map in the NCBI MapViewer. Additional crosses were made in the fourth year to increase the grooming-behavior trait in the Purdue breeding lines. Stock is being made available through a specialty crops grant to the Indiana State Beekeepers Association; IL

Analyses of routes of exposure of honey bees to pesticides from the Hunt lab were published (Objective 3). This was the first indication in the US that neonicotinoid seed coats were abrading and causing bee kills. Since that publication and other extension efforts, there have been over a hundred bee kill incidents investigated in the US and Canada that coincided with corn planting. Results were communicated in a webinar, in a publication that was mirrored in the two major trade journals (Hunt et al. 2012) and at workshops at national, regional and state beekeeper meetings, and at a public science seminar in Lafayette IN. Dr Hunt served on a scientific advisory panel on risk assessment to pollinators for the EPA in September 2012. Additional semi-field studies were conducted at Purdue in the fall of 2012 that involved feeding clothianidin-spiked pollen patties; IL

Last year we helped write a successful proposal that was awarded to the president of the Indiana State Beekeeping Association obtained a grant to distribute and propagate Purdue stocks selected for Varroa mite tolerance (Objective 8). This year we participated again by providing queen rearing and instrumental insemination workshops and propagation of breeding stock; IL

Stoner and Eitzer found that the neonicotinoid insecticides imidacloprid and thiamethoxam can translocate from soil application into the nectar and pollen of squash plants where they would be available to bees. (Objective 3); CT

Eitzer along with collaborators from scientists at Purdue University found that there were high levels of neonicotinoid pesticides in corn seed planter dust, and that the neonicotinoid pesticides could be found in soils and dandelions around planted fields. (Objective 3); CT

Long-term monitoring of pesticides in pollen trapped from honey bee colonies in two locations has continued. Samples from 2007-2011 have been analyzed using a multi-residue extraction technique known as QuEChERS (quick, easy, cheap, effective, rugged, and safe) as in previous year. (Objective 3); CT

As part of the new SCRI grant, in 2012, we counted bees pollinating winter squash and pumpkin in 21 fields across Connecticut, in a coordinated project looking at whether there are pollination deficits that would affect yield, and factors affecting the abundance and diversity of pollinators. We collected squash bees, *Peponapis pruinosa*, and the common eastern bumble bee, *Bombus impatiens*, as well as honey bees for pathogen analysis (Objective 9); CT

Also as part of the SCRI grant, pollen and nectar samples were collected from 14 pumpkin and winter squash farms across the state in order to determine the extent and level of pesticide contamination of cucurbit pollen and nectar under real field conditions. Trapped pollen was also collected from 4 honey bee hives near cucurbit fields at different farms. (Objective 3); CT

In collaboration with scientists at Purdue University we are analyzing dosimeters placed around fields as they were planted to determine transport of neonicotinoids during planting. (Objective 3); CT

Determined that the fungicide Pristine, alone and in combination with a spray adjuvant, had no detectable effect on honey bee queen success through adult emergence (Objective 3); OH

Educational programs (113) were conducted including the 20 hour, fee-based beemaster program in 5 locations; in-service training (3); regional (15), multi-county (85), state (8) and local (2) association meetings, workshops, field days, videos, 3 new websites (1 at UT and 2 National) and 3,500 + contacts via email; TN

NC1173 Leads to other grant funded programs In the past three years the University of Tennessee has become the national leader in electronic research based information on bee health. This started with a Northern Region Project (Now NC1173) that expanded, becoming national and resulted in forming a team and submitting a successful USDA/NIFA CAP proposal; TN

We were funded as part of a 21 member national USDA/NIA/CAP team from 17 institutions to reverse managed bee decline. As lead institution we formed, certified and maintained the eXtension Bee Health CoP with 38 leaders and 120 members from 37 states who provide 298 pages of content and use YouTube Bee Health channel to provide 31 videos for stakeholders; TN

The Managed Pollinator CAP Grant We have executed research that strikes at the center of the systemic issues surrounding bee decline; we have coordinated labs in a way that reduces redundancy and draws upon expertise previously outside the circles of bee science; we have built linkages with ARS and with sister consortia in Europe; in the eXtension website http://www.extension.org/bee%20health we have founded quite simply the best on-line site for science-based information available on bee health; and most recently we have partnered with a sister CAP – the Bee Informed Platform – to create the largest integrated superstructure for delivering bee health knowledge in the history of North America. These are not the kinds of outcomes one gets with independent grants and labs. These are the kinds of outcomes of a coordinated entity – the Managed Pollinator CAP; TN

An eXtension.org Community of Practice (CoP) was initiated in 2008 with the purpose of disseminated accurate web-based information about bees. As of April 28th, 2011 The Bee Health CoP now has 38 leaders and 65 members with relevant experience in bee research and extension. The CoP utilizes various web tools to engage the public, with the primary center of the effort at http://www.extension.org/bee_health .There are 376 pages that make up the Bee Health website on eXtension.org. We also have a YouTube Bee Health channel http://www.youtube.com/beehealth which is used as a convenient place to upload videos and reach a wider audience. There are 31 videos currently uploaded. An evaluation of the public usage of this effort follows utilizing data from Google Analytics and YouTube; TN

Although there are too many individual content pieces to mention many, all basic information article additions are referenced in our newsletter at http://www.extension.org/pages/25040/bee-health-cop-updates a few are listed here (TN):

- The Best Management Practices For Beekeepers Pollinating California's Agricultural Crops
- 11 updates from subjects being researched by the Managed Pollinator CAP team
- *Varroa* Sensitive Hygiene and mite reproduction
- American Bee Research Conference proceedings with video

Websites Generated and maintained to support and promote the objectives of NC1173:

- http://www.extension.org/bee_health
- http://www.youtube.com/beehealth
- http://www.beeccdcap.uga.edu/
- http://beeinformed.org/

Determined the effects of single species and mixed species infections of the fungal pathogen, Nosema apis and Nosema ceranae on honey bee physiology and behavior (Obj 3). Determined the effects of carbon dioxide on honey bee mortality either by itself or when combined with Nosema ceranae infection (Objective 3). Determined the genes important for varroa survival and reproduction (Objective 3); MI

Impacts:

Gave talks to five beekeeper associations, including the annual meeting of the Eastern Apiculture Society, in which I reported on my studies of how honey bees in the wild are persisting with Varroa but without receiving pesticide treatments (Objective 1); NY

In light of our recent accomplishments, pumpkin growers may either reduce or eliminate costs associated with pollination services by managed bees in certain pumpkin fields and will rely exclusively on wild non-*Apis* bees and feral *A. mellifera* for pumpkin pollination (Objective 9); NY

Our pesticide research is highlighting novel impacts of pesticides on bees. We hope, in the near future, to expand our toxicology research to include investigations on pesticide impacts on queen and drone honey bees (Objective 3); FL

(1) The extension programs my team and I initiated have resulted in an increase in beekeeper knowledge as indicated by post-program surveys. Since the inception of the Master Beekeeper Program, 244 beekeepers have been awarded “Apprentice Beekeeper” status. Of those, 70 have achieved “Advanced Beekeeper” status and 26 achieved “Master Beekeeper” status by the end of the report period in 2012. To become an advanced beekeeper and a master beekeeper, candidates must obtain at least 5 and 10 public service credits respectively. For example, candidates can give a presentation, write a document, start an observation hive, etc. By September 2012, the Florida Advanced and Master Beekeepers participated in 921 public service credits that reached ~2.9 million people! Furthermore, the UF Bee College received a 4.8/5 for "overall quality of the UF Bee College". 100% of surveyed beekeepers said they learned something that would make them better beekeepers or that they would use in their own operations. 100% of surveyed non-beekeepers said they would become a beekeeper as a result of attending the Bee College (Objective 7); FL

(2) I participate actively in the European Union COST Action COLOSS (Colony Losses). This action was created to address honey bee colony losses globally. The most significant output of this group will be the 3-volume BEEBOOK of which I am one of 3 co-editors. The purpose of the BEEBOOK is to provide a single publication on standardized research methodologies for honey bees. The three volumes include methods on general honey bee research (Volume 1), honey bee pest/pathogen research (Volume 2) and honey bee hive products (Volume 3) (Objective 7); FL

Honey bees are highly-susceptible to crop protection chemicals and serve as an excellent bioindicator of environmental quality. Our focus is on study of the role of pesticides in honey bee and overall pollinator decline. Colony Collapse Disorder (CCD) is estimated to have produced a loss of about one third of all honey bee colonies in the U.S. during each of the last six winters from 2006-12. Bee disappearances threaten the production of nuts, berries, fruits, vegetables and seeds, where their pollination is responsible for over $15 billion in added crop value. Systemic pesticide uses, particularly neonicotinoids, have greatly increased recently through transgenic seed treatments and other crop, ornamental, turf and structural applications.

Studies have focused on action of a single pesticide. Given the synergistic nature of certain combinations, we are concerned that active ingredients may affect honey bees differently depending upon inert ingredients in a particular product formulation or on active ingredient mixtures that dominate field use. There is a new tendency to market pesticide blends including seed treatments that contain multiple classes of insecticides or fungicides, or their mixed combinations. These blends usually require proprietary co-formulants and adjuvants to achieve high efficacy and broadly control many pests. We are in the process of identifying common inerts in pesticide formulations used frequently around honey bees or in their preferred foraging areas. Presently the fate and toxicity of formulation and spray adjuvants in modern agrochemical technologies, and their potential movement into honey/pollen are unknown. We are determining acute and sub-lethal effects of pesticides, their formulation ingredients, important metabolites and selected combinations on bee physiological and behavioral systems. More recently we are investigating the impacts of inerts or co-formulants found in hives alone or in combination with coincident pesticide residues on honey bee survival and behavior. To achieve this, we have developed analytical methods, particularly using LC-MS, to monitor and determine the fate of pest control chemicals and their formulants within bee ecosystems. By first identifying and quantifying key formulation inerts or adjuvants and major co-occuring pesticides and metabolites in pollen, nectar, bees, brood and other hive matrices, we can then test identified inerts and combinations with pesticides for their short- and long-term toxic effects on brood and adult honey bees in the lab and field. We have delivered numerous presentations on pollinator decline, CCD and the potential role of pesticides at local, state, regional and national beekeeping conferences. The impact of systemic pesticides, seed treatments, formulation additives, and other pesticides and their combinations on non-target species, and their role in honey bee and other pollinator health are of global consequence to food security and future crop protection strategies. Practical outcomes include developing both selective pest control strategies and regulatory processes that assure safety for pollinators and products from the hive; PA

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high efficacy and broadly control many pests. We are in the process of identifying common inerts in pesticide formulations used frequently around honey bees or in their preferred foraging areas. Presently the fate and toxicity of formulation and spray adjuvants in modern agrochemical technologies, and their potential movement into honey/pollen are unknown. We are determining acute and sub-lethal effects of pesticides, their formulation ingredients, important metabolites and selected combinations on bee physiological and behavioral systems. More recently we are investigating the impacts of inerts or co-formulants found in hives alone or in combination with coincident pesticide residues on honey bee survival and behavior. To achieve this, we have developed analytical methods, particularly using LC-MS, to monitor and determine the fate of pest control chemicals and their formulants within bee ecosystems. By first identifying and quantifying key formulation inerts or adjuvants and major co-occuring pesticides and metabolites in pollen, nectar, bees, brood and other hive matrices, we can then test identified inerts and combinations with pesticides for their short- and long-term toxic effects on brood and adult honey bees in the lab and field. We have delivered numerous presentations on pollinator decline, CCD and the potential role of pesticides at local, state, regional and national beekeeping conferences. The impact of systemic pesticides, seed treatments, formulation additives, and other pesticides and their combinations on non-target species, and their role in honey bee and other pollinator health are of global consequence to food security and future crop protection strategies. Practical outcomes include developing both selective pest control strategies and regulatory processes that assure safety for pollinators and products from the hive; PA

Results on Nosema ceranae experiment accepted for publication in PlosOne. Results are communicated to beekeepers at association meetings, and a summary article will be published in the USDA-BeeCAP column in American Bee Journal and Bee Culture magazines (Objective 2); MN

Results of colony level imidacloprid exposure are being written up for publication. All results are communicated to research and beekeeping association meetings locally and nationally by M. Spivak and Judy Wu (Objective 3); MN

Articles on portions of our methods and results have been published in the USDA-BeeCAP column in American Bee Journal and Bee Culture magazines, and are communicated to state and national beekeeping meetings (Objective 5); MN

Commercial bee breeders and beekeepers are supportive of the Tech Teams and have agreed to make them financially sustainable through fee-for-service. Results of breeding progress for resistance traits will be documented by graduate student Katie Lee as part of her PhD degree at the Univ of MN. We have published the results of our evaluations of stock from the bee breeders in MN in two U.S. beekeeping trade journals (Objectives 7 and 8); MN

Elucidating the tissue tropism and spore production of *Nosema ceranae* provides better understanding of transmission mechanisms and competitiveness of this microsporidium in honey bee populations. Studies on fumagillin impacts will assist beekeepers to make more informed decisions regarding treatment for nosemosis. (Objective 2); IL

Beekeepers at regional and state meetings learned how to raise their own queens and select for resistance to mites; IL

Beekeepers also learned how to report pesticide kills associated with drift from planting neonicotinoid treated corn seed. For the first time, reports of bee kills came into the state chemist office and almost all tested positive; IL

The results from these projects are being used by beekeeping organizations, environmental organizations concerned with pollinator health and conservation, and the Environmental Protection Agency in deliberations on how pesticide regulations, formulations, and application methods may be changed to protect honey bees and other pollinators, particularly with respect to neonicotinoid insecticides. Our results and publications have been cited in articles in Bee Culture, the American Bee Journal, the Xerces publication "Are Neonicotinoids Killing Bees?" and in the White Paper prepared by the EPA for the Scientific Advisory Panel on the Pollinator Risk Assessment Framework; CT

Contributed to guidance on IGR insecticide use during bloom in almonds to protect immature honey bees from exposure to developmental toxicants. (Obj. 3); OH

Beekeepers were provided with a research-based guide for avoiding harmful synergistic interactions when honey bees are exposed to more than one drug or miticide and how miticides interact with selected fungicides applied to orchard crops (Obj. 3); CT

TN Beemaster Program participants (75) improved average knowledge 33.6% [test scores (pre vs post)] 30%, 35%, 32%, 33%, and 38%, respectively in 5 locations at Dresden, Chattanooga, Waverly, Knoxville and Johnson City. This program now has more than 2,200 enrolled; TN

In 2012 use of “Bee Health”: eXtension website increased 17.4% to 182,761 page views. YouTube channel subscribers increased 49.4% to 1444. YouTube Views increased 54% to 394,510; TN

We estimate beekeeping research and extension programs in Tennessee have aided beekeepers to reduce their losses of colonies to parasitic mites and other causes by 15%; TN

The value of each lost colony is approximately $575.0.00 for bees, hive parts, medications and honey production; TN

We estimate that beekeepers following recommendations have saved 10,500 colonies of bees valued in excess of $5,750,000 annually; TN

Beekeepers were provided with reports of our studies (how nosema infections affect bees and what genes are important for varroa reproduction) at extension meetings and implications for beekeeping (Objective 3); MI

Grants:

New York State Agriculture & Markets Specialty Crops Block Grant, 2012. B. Nault (PI) and S. Reiners. Increasing the production value of vine crops in New York State. $55,000 (1 yr); NY

Federal Formula Funds Initiative Program, 2012. B. Nault (PI). Role of local and landscape features on bumble bee foraging in pumpkin fields and impact on yield. $60,000 (2 yrs); NY

Specialty Crop Research Initiative USDA, NIFA. Integrating Native Bees into Sustainable Pollination Strategies for Specialty Crops. $95, 691 (2012-2017); FL

National Honey Board. The impacts of pesticide exposure during larval development on adult worker honey bee (Apis mellifera) foraging performance and general fitness. $49,352 (2012-2013); FL

Pam. Using RNAi technology to increase the susceptibility of Varroa to mitcides. $37,541 (2012-2013); FL

North Dakota Beekeeping Association. Bee Informed Partnership: Honey Bee Tech-Transfer Team to Monitor Colony Health in the Upper Midwest. $29, 873. (2012-2013); MN

National Fish and Wildlife Foundation-Wells Fargo Environmental Solutions for Communities 2012. Bee Squad: Pollinator Education and Stewardship. $75,000. (2013-2014); MN

USDA-NIFA (PI: D. vanEngelsdorp, Penn St: total award $5.1 M). Bee Informed Platform (BIP): A nationwide network for monitoring and maintaining honey bee health and pollination services. $459,235 (2011-2016); MN

National Honey Board: A Long-Term Plan to Improve Honey Bee Genetics: Formation of a Tech Transfer Team. $10,000 (2010-2012); MN

USDA CSREES CAP. (Total subaward $162,000) Sustainable solutions to problems affecting health of managed bees. $50,000 (2011-2013); IL

Multistate Hatch $30,000; IL

NSF, Epigenetic influences on the honey bee transcriptome and behavior. $639,000 (20120-2015); IL

Eitzer and Stoner are Co- PI's in a Speciality Crop Research Initiative Grant titled "Pollination Security for Fruit and Vegetable Crops in the Northeast"; CT

Eitzer is a participant in a NC-IPM grant awared to Christian Krupke at Purdue entitled "Assessment of the environmental exposure of honeybees to particulate matter containing neonicotinoid insecticides"; CT

OARDC SEEDS Grant. Comparative toxicogenomics of bees important to agriculture in Ohio. $49, 816 (20120-2013); OH

Ohio State Beekeepers Association. Comparing success of urban, suburban and rural honey bee colonies in Central Ohio. $2,477.50 (2012); OH

Project Apis m. Pristine effects on queen rearing. $29, 690 (2012); OH

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