SARE Final Report – January 2011

FOOD GRADE MINERAL OIL/THYMOL FOG APPLICATON AS A NATURAL ALTERNATIVE TO TREATING HONEY BEE VARROA MITES

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1. Goal

Honey bee (*Apis mellifera*) colonies are diminishing because of developing resistance of *Varroa* mites (*Varroa destructor*) to chemicals and pesticides, thus stressing the importance and need of a natural and sustainable mite control method. Being conducted by Bee-mus Honey, this SARE project investigated the use of food grade mineral oil (FGMO) and thymol (a natural plant extract) in the form of a fog as a natural and economic alternative to pesticide use for the control of the parasitic *Varroa* mites within honey bee colonies. FGMO/thymol fog works adversely on the mites by 1) creating a slippery surface making it difficult for the mites to hold on to the honey bees; 2) acting on the nervous system of the mites; 3) disturbing the respiratory system of the mites; 4) and increasing the grooming behavior of the bees, resulting in mites being physically removed. Therefore, the primary goal of this project was to replicate and test the effectiveness and sustainability of FGMO/thymol fog as a *Varroa* mite control method, and subsequently prove that it is a safe, extremely cost-effective, and an environmentally friendly acaricide for honey bees.

2. Farm Profile

Originating as a hobby with the purchase of two packages of honey bees, Bee-mus Honey was established in 2004. Of the thirty bee hives we currently have, fifteen have been the SARE research hives. All fifteen research hives are within the same yard with approximately ten meters distance between the control and research hives (to eliminate potential drifting of the fogging materials from the experimental hives to the control hives). Our bee hives are located on our land in Bemus Point, New York, and the honey (and products) is sold to customers from our home, local shops, and local markets. Our honey is chemical-free; no chemicals or pesticides are used on our hives.

For the last three years, food grade mineral oil/thymol fog treatment has been used on our hives as a natural control of *Varroa* mites and has shown to improve the overall health of our colonies (resulting in healthier bees, stronger colonies to over winter, and increased honey production), while also demonstrating environmental stewardship. It was vitally important to investigate and test a mite treatment that is not only cost-effective for beekeepers, but also honey bee and environmentally friendly, especially with increasing mite resistance to chemical pesticides and rising prices in the agricultural sector.

3. Participants

As a result of a job transfer at the beginning of my grant, I have remained without a technical advisor for my research project. But, I have received endless valuable assistance and mentoring from a longtime beekeeper and pioneer in the area of fogging with food grade mineral oil and thymol, Dr. Pedro Rodriguez. I am in contact via e-mail and telephone with this gentleman often, and he provides me with insight and suggestions that I gratefully appreciate. It is Dr. Rodriguez's exact formula and research protocol that I am using for this SARE grant.

4. Project Activities

Bee-mus Honey researched the efficacy and specific application techniques of food grade mineral oil (FGMO) /thymol fog with the use of a Burgess Propane Fogger to determine its value as a preventative control for *Varroa* mites. Research was conducted on fifteen bee hives - ten randomly selected were experimental and the remaining five, untreated controls. Fifteen packages of Russian bees were purchased from Walter T. Kelley Co., Inc. (in Kentucky) to keep the stock of bees and queens as similar as possible. All colonies of bees were in the same location to minimize any variation. Bees were placed on new foundation to reduce variability and to rule out residues in old combs.

Dr. Rodriguez generously provided me his exact formula and fogging instructions for FGMO and thymol. (See Appendix #1 for complete details of formula and protocol.) FGMO/thymol was fogged weekly into the entrance of the hive between the months of May and October. The specific procedure for fogging is as follows. The fogger is filled, set on a level surface, and lit (allowing two minutes to warm up before use). The outer cover of the hive is lifted so that the fog will move from the hive entrance out the top (creating a chimney effect). Holding the fogger parallel to the ground (NOT downward!) the trigger of the fogger is pulled 3-4 times (for four to five seconds). Once the fog is visible exiting out of the top of the hive (within seconds), the outer cover is replaced on the hive and fogging is complete. The fog provides the bees with a film of FGMO/thymol creating a slick surface to which the mites cannot cling. No treatment in the form of FGMO/thymol fogging or sticky boards will be done during the winter months.

All hives were installed with screened bottom boards to allow for mites to drop away from the hives (and not re-enter) when fog treatment is not occurring. All hives had sticky boards installed (beneath the screened bottom board) immediately before fog treatment and left in place for 24 hours. The sticky boards were covered with FGMO that created a “sticky” surface to capture the falling mites. Mites were counted twenty-four hours after treatment to distinguish treatment mite drops from natural mite drops.

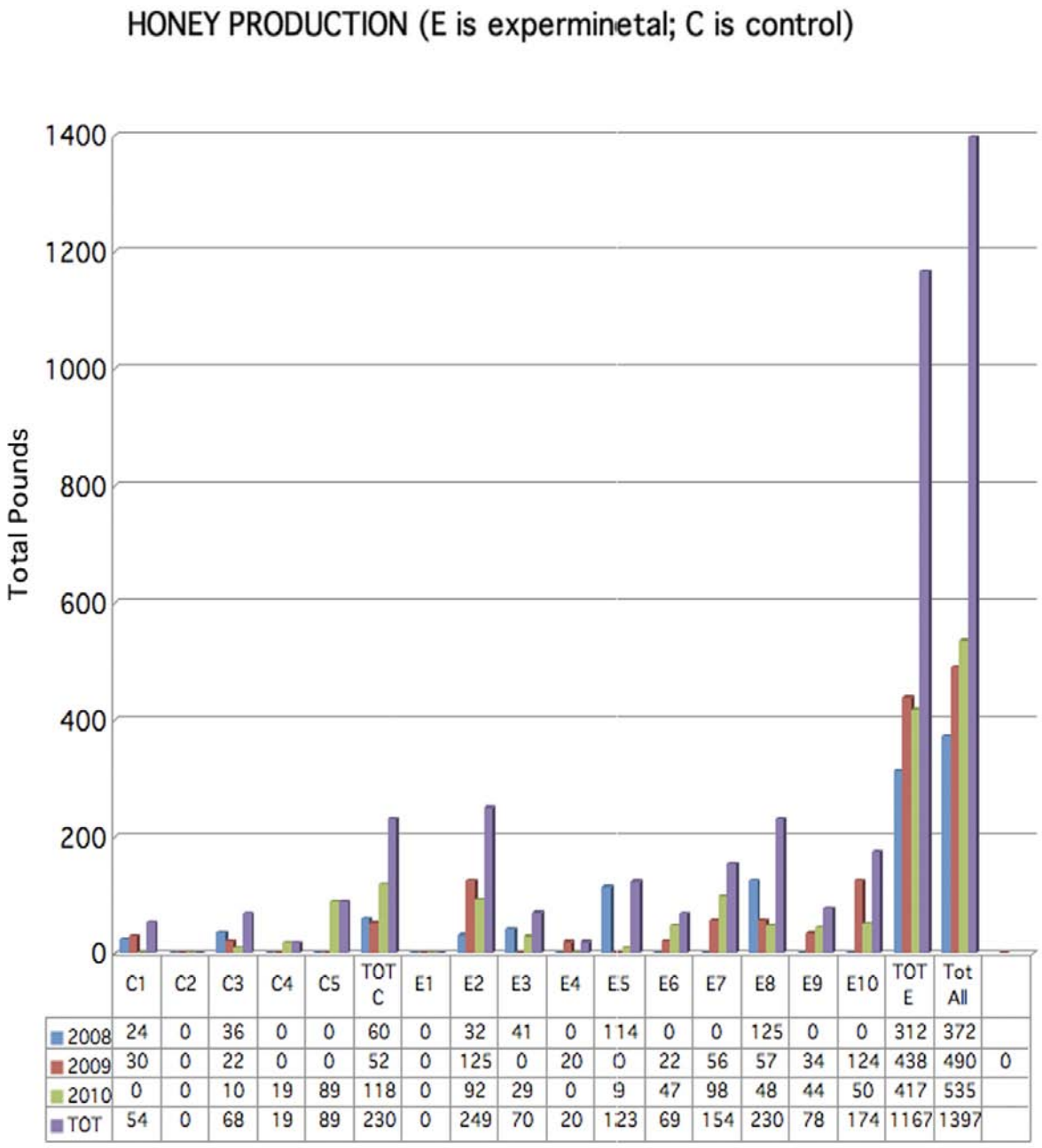
Research commenced in May of 2008 and continued through October of 2010. It is vitally important to mention that FGMO/thymol application applied using Dr. Rodriguez’s exact formula is 100% safe while honey supers are on. Research continued for a total of three years (2008, 2009, 2010) to obtain sufficient data through replication. Winter colony losses were replaced with Russian bee packages from Walter T. Kelley in the early spring to maintain a total of fifteen.

5. Results

Data obtained throughout this three-year project clearly suggests the success of FGMO/thymol fogging as a natural, cost-effective and sustainable method of *Varroa* mite control on the honey bee.

Much of the success of FGMO/thymol fog for *Varroa* mite control is evident in the data provided on the average mite count graphs below, but there are also many indirect and informal observations that support the use and recommendation of fogging. Some of these observations include overall strength and vitality of the experimental hives (observed by activity of honey bees at the hive entrance), honey production, over wintering success, and swarming (due to the vigor and population of the experimental hives).

Honey production was much higher in the experimental hives than the control hives (see "Honey Production" graph below). The higher honey production values for the experimental hives can be attributed to healthier colonies. It is also safe to assume that honey production would have been higher if there were not so many late season swarms in the experimental hives. For specific details on pounds of honey extracted, please refer to the raw data under "Honey Production" in the Excel attachment.



	C1	C2	C3	C4	C5	TOT C	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	TOT E	Tot All	
2008	24	0	36	0	0	60	0	32	41	0	114	0	0	125	0	0	312	372	
2009	30	0	22	0	0	52	0	125	0	20	0	22	56	57	34	124	438	490	0
2010	0	0	10	19	89	118	0	92	29	0	9	47	98	48	44	50	417	535	
TOT	54	0	68	19	89	230	0	249	70	20	123	69	154	230	78	174	1167	1397	

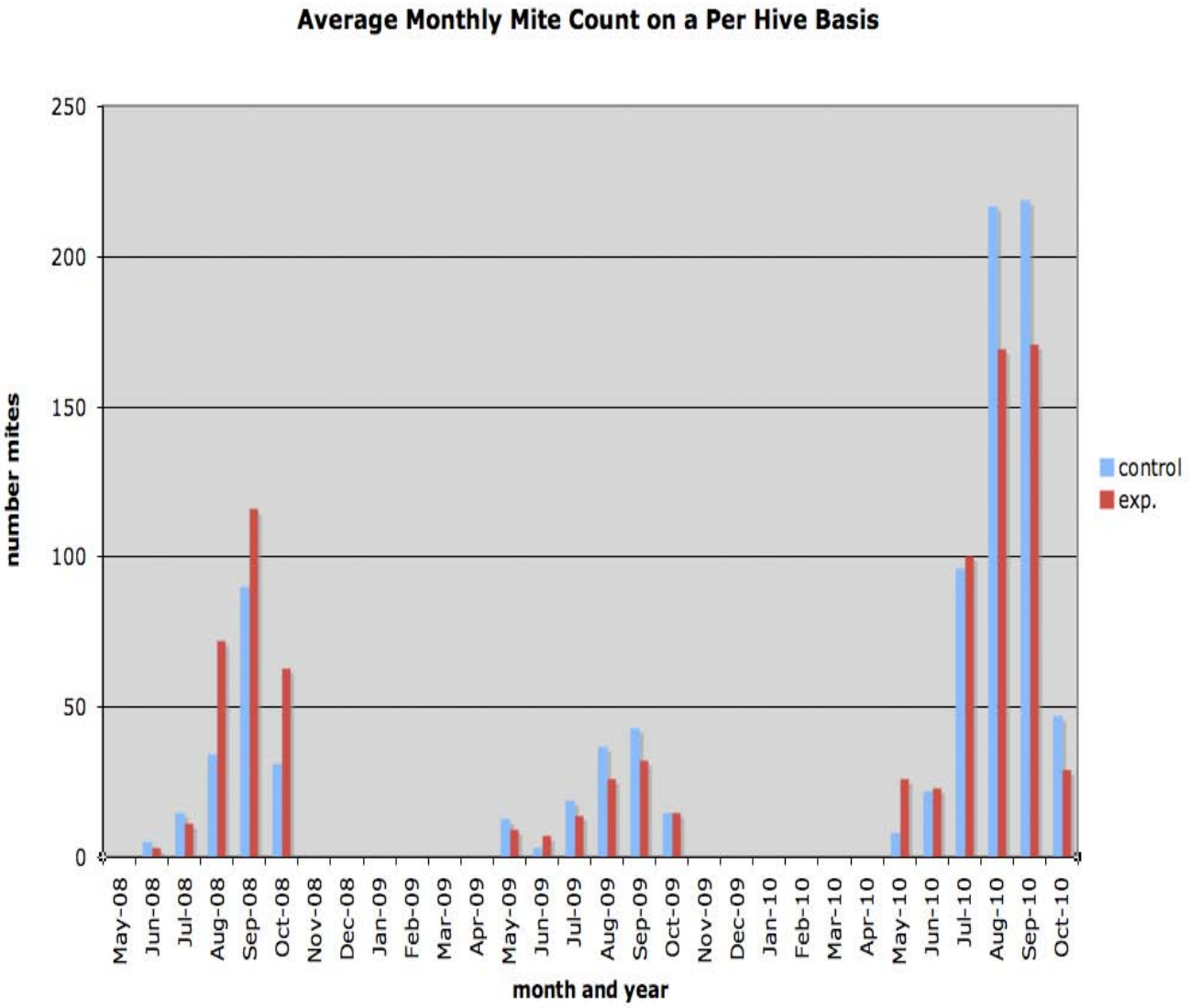
On the contrary, supercedures of queens occurred more frequently in the control hives than the experimental, possibly suggesting weaker and more stressed hives (due to mites).

Data for the control hives demonstrate higher mite counts, higher winter mortality, and smaller honey production. Data for the experimental hives reveal a lower mite count, lower winter mortality (with the exception of the late season swarms), and a larger honey production. Please refer to the graph and table below titled "Comparison of Average Monthly Mite Count on a Per Hive Basis". This graph displays a detailed explanation of the average monthly mite counts per hive for both the control and experimental hives. No data was collected between the months of November and April. All raw data and individual yearly mite count graphs can be found in the Excel attachments.

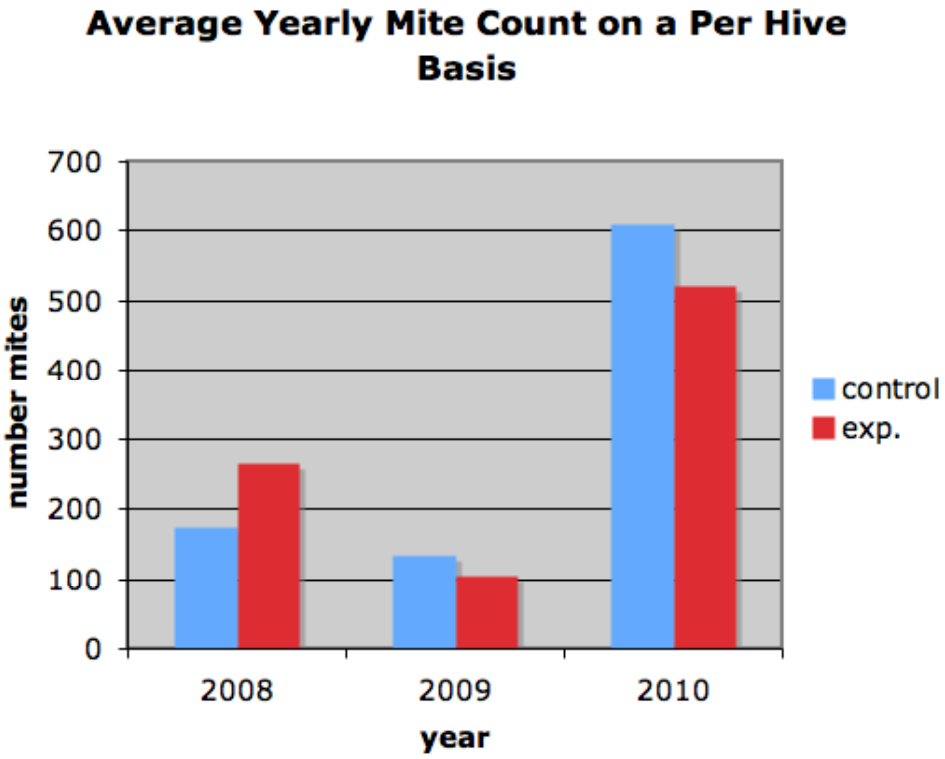
Note: three experimental hives had unusually high mite counts throughout a particular year (E8 in 2008, and E2 and E5 in 2010). I attribute this to inherent genetics of queens. These queens were susceptible to mites - even though treated with the FGMO/thymol fog. Therefore, the extremely high mite counts in these hives is attributed to a genetic factor, skewing the overall display of data in the graphs for the mite count during the 2008 and 2010 seasons. Please refer to the "Experimental Hives Mite Counts" raw data in the Excel attachment for mite count details and additional graphs.

COMPARISON OF AVERAGE MONTHLY MITE COUNT
ON A PER HIVE BASIS

	2008	2009	2010
May Control	0	13	8
May Exp.	0	9	26
June Control	5	3	22
June Exp.	3	7	23
July Control	15	19	96
July Exp.	11	14	100
August Control	34	37	217
August Exp.	72	26	169
September Control	90	43	219
September Exp.	116	32	171
October Control	31	15	47
October Exp.	63	15	29


Average Monthly Mite Count on a Per Hive Basis
number mites
250
200
150
100
50
0
control
exp.
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
month and year

The graph below titled "Average Yearly Mite Count on a Per Hive Basis" gives an overall description of the average number of mites found in the experimental and control hives during each of the three years that data was collected. Please keep in mind the three experimental hives with abnormally high mite counts that affected the overall display of data (E8 in 2008, E2 and E5 in 2010).



It is also vitally important to remember that beekeeping, and bees, have many variables that affect the overall success of research. Conditions are discussed in more detail in the next section.

6. Conditions

Beekeeping is an element of agriculture that is affected by many uncontrollable conditions, some of which are weather, queen productivity, and swarming (which one can attempt to prevent, but is difficult). The research results strongly suggest the effectiveness of FGMO/thymol fogging as a sustainable mite control, but these other factors and conditions must be acknowledged as well. A harsh winter or a very wet, cool summer may negatively have an impact on the strength and productivity of a bee hive. Weather in the northeastern US is often unpredictable and may affect the local nectar sources and overall condition of a hive. Likewise, commercially produced queens occasionally may demonstrate a lack of fertility, thereby resulting in multiple supercedures or simply a

weak hive.

Late season swarming in the experimental hives (especially in 2009) might have been the result of very vigorous hives and strong bee populations (see Excel attachment "Swarms"). Although it is encouraging to know the colonies were healthy and robust, it is difficult for the hive to recover so late in the season (inability of the new queen to find drones to mate with, and loss of worker bees to the swarm). Hence, assumption can be made that late season swarming during 2009 might have had a negative influence on fall honey production, and the result of dead-outs over the winter.

7. Economics

Fogging for *Varroa* mites with FGMO/thymol is an economic alternative to the use of many of the chemicals available today. Because FGMO/thymol fogging for the control of *Varroa* mites has proven to be a successful and cost-effective treatment, other beekeepers can utilize the exact protocol and formula as a natural and sustainable acaricide. Furthermore, fogging reduces the use of expensive pesticides and chemicals used to treat mites, thereby preventing agricultural pollution. Please refer to the table below for approximate expenses of fogging:

ITEM	PRICE
Portable Propane Insect Fogger	$65.00
Propane cylinder	$3.50
One gallon food grade mineral oil (3, 785 ml or cc's)	$25.00
100 grams pure thymol	$25.00

The exact FGMO/thymol formula (as described in Appendix #1) uses 1,000 cc's food grade mineral oil (or approximately one-fourth a gallon at a cost of $6.25), and 50 grams pure thymol (1/2 a bottle at a cost of $12.50). Therefore, one batch of the fog would cost roughly $19.00. One batch of this formula is more than sufficient for ten hives being treated once a week for five months (most likely with surplus for more hives, or to be saved for the following season). In addition to the initial cost of a fogger (and an occasional propane cylinder refill), the cost of mite treatment per hive for a season would be approximately $2.00!! It is evident that FGMO/thymol treatment is extremely cost-effective as an acaricide resulting in a reduction of costs for the beekeepers.

Because healthy bees without mites will produce more honey, beekeepers will have improved productivity, thereby increasing the net farm income. The results obtained from the research performed are now readily available to benefit all beekeepers (in the Northeastern US and worldwide) interested in enhancing sustainable beekeeping and protecting their honey bee colonies from pesticides, while at the same time being good stewards to our environment.

8. Assessment

In conjunction with this treatment being environmentally safe, cost-effective, and honey-bee friendly, Dr. Rodriguez's research (following his exact formula and protocol as found in Appendix #1) has proven that honey and beeswax taken from FGMO/thymol treated hives revealed no traces of either residue (FGMO or thymol), thereby guaranteeing the wholesomeness of hive products and safety of the environment.

Unfortunately, other companies have altered this FGMO/thymol formula resulting in the impairment and contamination of honey and beeswax. Therefore, it is imperative that this research be replicated to further support the evidence of Dr. Rodriguez et. al.'s research in Spain, and Clinton Benrose's research at the University of Michigan, that no FGMO or thymol residue is found in either honey or beeswax IF (and only if) the exact formula and protocol are used. Consequently, the next step would be to continue with the FGMO/thymol treatment as an alternative means to control *Varroa* mites, with the addition of researching the effects of fogging on honey and beeswax (thereby proving through scientific data that no residue is found).

9. Adoption

This SARE project has successfully proven that FGMO/thymol fog is a safe and sustainable method for the control of the parasitic *Varroa* mite on honey bees. Therefore, I will continue to utilize the fogging procedure as Bee-mus Honey's exclusive method of parasitic *Varroa* mite control. Bee-mus Honey does not use any pesticides on our hives, keeping our honey and beeswax 100% pure and safe. I am very confident in the efficacy, safeness, cost-effectiveness, and environmentally- friendly method of FGMO/thymol fogging on our bee hives.

10. Outreach

Outreach to educate the beekeeping community (and general public) on the efficacy and importance of *Varroa* mite control using the FGMO/thymol fog consisted of four different components. First, from the commencement of the research, updates and progress were given at the Chautauqua County Beekeepers Association's monthly meetings. Any questions about the research or procedure of the fogging were answered at this time.

Secondly, a fogging demonstration was performed at the site of the research hives to exemplify the exact procedure of using the FGMO/thymol fog as a mite control. The fogging demonstration announcement was sent to all beekeepers presently on the Chautauqua County Beekeepers Association's mailing list. Beekeepers were initially given a handout that explicitly clarified the exact formula used for the fog (see Appendix #1), followed by their active participation in the actual fogging event. After the fogging demonstration, beekeepers were encouraged to ask any further questions. In addition to the main fogging demonstration, many individual beekeepers came to our bee hives to have a "private" education session on the procedure for fogging. This was an excellent way for the beekeepers to familiarize themselves with the fogging process, and to

experience how efficient and uncomplicated it truly is!

An article was also featured in the local newspaper, the Jamestown Post Journal (http://www.post-journal.com/page/content.detail/id/541317/Keeping-Up-The-Good-Work.html). The article informed the general public of the importance of beekeeping with recognition of this SARE grant and the importance of mite control.

Lastly, the Chautauqua County Beekeepers Association participated in a local radio program featuring honey bees. I was once again given the opportunity to present information on the importance of mite control on the honey bee, and the details of my SARE grant. Chautauqua County is a rural, farming community, and any outreach is effective to educate and inform the public about the significance of honey bees.

11. Report Summary

Honey bee populations have suffered catastrophic losses within the last few years, predominantly because of *Varroa* mite infestations, thereby affecting pollination, survival of the bees, and overall success of beekeepers. This SARE project investigated the use of food grade mineral oil (FGMO) and thymol (a natural plant extract) in the form of a fog as a natural and economic alternative to pesticide use for the control of *Varroa* mites within honey bee colonies.

Bee-mus Honey researched fifteen bee hives (ten experimental and five control) for the efficacy and specific application techniques of FGMO/thymol fog to determine its value and success as a preventative control for *Varroa* mites. The experimental hives were fogged weekly using a very specific formula of FGMO and thymol. Fogging occurred during the months of May and October for a three-year period (2008-2010). All hives were installed with sticky boards immediately before fog treatment and left in place for twenty-four hours. *Varroa* mites were then counted and recorded.

Research results from this SARE project clearly demonstrate the overall effectiveness and sustainability of FGMO/thymol fog for the control of *Varroa* mites on honey bee colonies. Experimental hives that were fogged had an overall lower mite count, produced more honey, over wintered better, and were generally more robust and stronger than control colonies that were stressed by a higher mite infestation. Because of the adverse effects (and added expense) of chemicals on honey bees (and the environment), and developing resistance of *Varroa* mites to these chemicals, beekeepers need to consider a more natural, cost-effective and sustainable method of mite control. Because of the proven success of this SARE project, Bee-mus Honey will continue to use FGMO/thymol fog as our chosen method of hive treatment on *Varroa* mites.

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Tarpy, D.R., and Summers, J. 2006. Managing Varroa Mites in Honey Bee Colonies. Department of Entomology Apicultural Program, North Carolina State University. Published by North Carolina Cooperative Extension Service. April 2006.

APPENDIX #1

FGMO/THYMOL FORMULA AND INSTRUCTIONS FOR BURGESS FOGGER

Ingredients needed for fogger:
1000 cc mineral oil at 0.86 density (860 grams)
50 grams thymol

Instructions for diluting thymol:
Remove 100 cc FGMO from the 1000 cc intended for mixture. Place 100 cc FGMO in a mason jar. Add 50 grams thymol and secure cap tightly. Place a metal container filled with water (i.e. cooking ware) on a heat source. Place glass jar with the 100 cc FGMO and thymol in the water of the heating vessel. Swish/swirl jar as the water heats up until thymol dissolves completely. Solution will become slightly amber in color (normal change). The solution is now ready to add to the rest of the FGMO intended for use in the fogger. This will result in a 5.49% FGMO/thymol solution.

Instructions for fogging:
Fill the fogger container. Set fogger on a level, steady surface. Turn gas valve to the left 1/4 turn. Listen for a slight hissing sound from the fogger. Light the fogger from underneath (using a butane stove lighter). Wait one to two minutes. You should notice a drop or two of oil dripping from the spout of the fogger. Next, you should notice a small emission of oil mist similar to that of a lit cigarette. Next, the fogger will emit a larger puff of oil mist. The fogger is now ready for fogging. Holding the fogger parallel to the ground, point the nozzle directly at the hive entrance. DO NOT AIM THE FOGGER DOWNWARD! Pull the trigger of the fogger 3-4 times, while counting 1001, 1002, 1003, and 1004, depending on the population size of the hives. Never add any other ingredient to the fogger when following this procedure. Do not use foggers that may have been used for spraying pesticides previously. When fogging is complete, allow the fogger to continue to burn for two minutes before turning it off so any additional FGMO/thymol will burn out of the fogger.