Mineral Salts: An Innovative Approach for *Varroa* Control

Project No.: **08-POLL7-Ahumada/Wardell**

Project Leaders: Fabiana Ahumada-Segura
S.A.F.E R&D, LLC
2000 E. Allen Road
Tucson, AZ 85719
(520) 670-6380 ext. 134
E-mail: fabita4@gmail.com

Gordon Wardell
S.A.F.E R&D, LLC
2000 E. Allen Rd
Tucson, AZ 85719

Project Cooperators and Personnel:
Dr. Gloria De Grandi-Hoffman, USDA-ARS

Objectives:

The main objective of the research project is to test mineral salts against *Varroa* mites based on preliminary field trials performed in Europe between 1984 through 1994. The mineral salts tested were: copper gluconate, calcium gluconate, potassium citrate and magnesium gluconate.

The project objectives are as follows:

1. Determine the threshold levels of the salts in solution
2. Determine the concentration of the salts to be used in the field trial treatment
   a. Feeding preferences
   b. Bee toxicity: *In vitro* and *in vivo* trials
3. Field trial treatment and application
   a) Mite monitoring
      1. Mite drop method
      2. Mite cell infestation levels
   b) Monitor bee behavior

Interpretive Summary:

The need for alternative treatments to control the ectoparasitic mite set pressure once again on the research community to explore for innovative methods for *Varroa* control.

The application of mineral salts considered as natural in biological agriculture, led Popeskovic et al. in 1984 to discuss and research that some salts such as copper sulphate might have an impact in mite physiology. Research on this subject performed in France in the early and mid 1990's reported that bees fed with copper gluconate in sugar syrup did not suffer at all, on the contrary, their physiological state was favored by expanding their life-span as well as protecting them against intoxication by synthetic pesticides. Since that time no further research has been done on this subject and we found this as an opportunity to explore this area.

Materials and Methods:

The research project was performed in Tucson, AZ, at the Carl Hayden Bee Research Center by feeding mineral salts to *Varroa* infested nucleus colonies. The optimum feeding concentration of the salts was determined *in vitro* by feeding newly emerged bees in cages at various concentrations. Once the concentration was determined, the mineral salts were dissolved in high fructose corn syrup diluted in water 50:50 and fed to the colonies as needed. *Varroa* mites were monitored weekly by the sticky board method and the field trial was performed over a 5 weeks period.

Results:

The first research step was to test the solubility of the mineral salts and performed *in vitro* cage studies to determine toxicity levels and the appropriate concentrations for the *in vivo* feeding trials. Sucrose solution and high fructose corn syrup (HFCS) were tested for solubility and both performed well.

Based on the solubility studies, HFCS was used for the *in vitro* and *in vivo* feeding trials. The optimum feeding concentration for the salts is described in the table below.

Mineral Salt	Feeding concentration	Solubility in 1:1 H_2O-HFCS	pH
Copper Gluconate	0.02%	Total	4.0
Calcium Gluconate	0.5%	Total	5.6
Magnesium Gluconate	0.5%	Total	5.8
Potassium Citrate	0.5%	Total	5.0

Once the feeding concentrations were determined for each mineral salt, the field feeding trial was started and run for 5 weeks. A set of four nucleus colonies was assigned for each treatment along with control colonies that were fed only HFCS. Mite drop was monitored weekly by inserting sticky boards in the colonies. The boards were removed after three days, counted and the data was recorded. Colony observations were performed on the treatment and control colonies and normal behavior was observed throughout the trial. The obtained results for potassium citrate and magnesium gluconate from the field trial are shown in **Figures 1 and 2** and these two were the most effective over the 5 week treatment period.

Figure 1. Average mite drop in potassium citrate colonies.

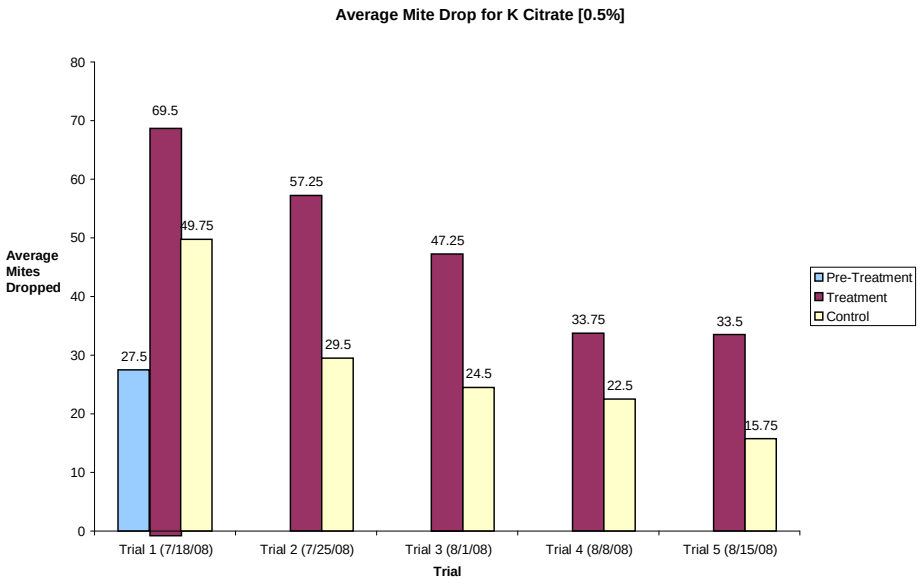
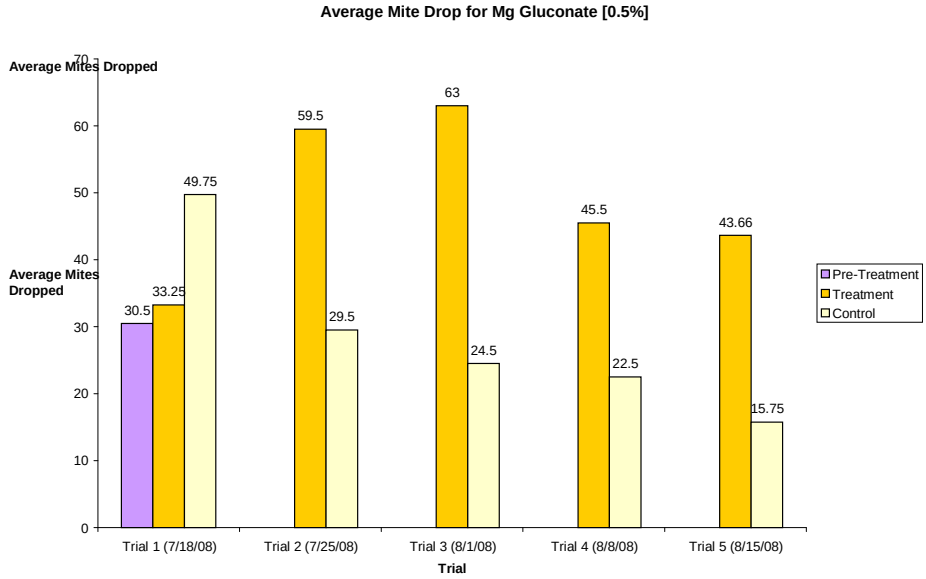


Figure 2. Average mite drop in magnesium gluconate colonies.



Discussion:

The four mineral salts were tested *in vitro* and *in vivo* at the appropriate concentrations and no signs of toxicity were seen on the bees. Throughout the *in vitro* trial we were able to determine the appropriate solubility media and feeding concentrations. The results obtained from the field feeding trial demonstrated that mineral salts can be applied as an alternative treatment for *Varroa* in the colonies. From all the four salts tested, potassium citrate and magnesium gluconate showed to be the most effective on mite control over the 5 weeks treatment.

Throughout this preliminary study we were able to determine the optimum feeding concentrations and this will allow us to explore different mineral salts as well as combinations to be tested in the colonies for mite control.

The next step in the research is to determine the effect of the mineral salts in queen egg laying, brood development and survivorship along with adult bee longevity.

Acknowledgements:

We would like to thank Ashley Lopez, Robert Sullivan, Quinn Wardell, Kathy Liu, Veronica Banuelos, Laura Hook, Tomas Deeby and Mona Chambers for their help in the project.