

Dear Flying Skull user,

The enclosed study was done on Citrus Mealy Bugs by Kansas State University, Department of Entomology.

The Citrus Mealy Bug is a *very hard to kill insect* and has been described as "resilient, tough, invulnerable, tenacious and adaptable". The study was to help find new insecticides on the market and test their efficacy on the Citrus Mealy Bug. Nuke em accomplished a 60% kill rate against the Citrus Mealy Bug using the *lowest strength* listed on the label. A 60% kill rate is extraordinarily good considering the insect tested and the application of Nuke em's lowest dose! The study implies that more testing should be done to determine the dose and application modifications needed for a 100% kill. It is also important to note that over a year had passed from the date the Nuke em bottle was delivered to Kansas State University and the date it was sprayed on the Citrus Mealy Bugs. This also helps to show that Nuke em's shelf life is excellent for an organic insecticide/fungicide.

Nuke em is a new revolutionary insecticide/fungicide manufactured by Flying Skull Plant Products. Nuke em is OMRI listed, made from food grade ingredients and has been formulated to adhere to the strict rules and regulations set forth by the United States Department of Agriculture and the Environmental Protection Agency. Nuke em is skin contact friendly for humans and animals, and is also plant growth friendly as it contains no petroleum, oils, detergent or soap that can clog stomata or cover light sensitive leaf cells.

Flying Skull would like to thank The Kansas State University for including Nuke em in their study programs.

RESEARCH REPORT 2013

EFFICACY OF NUKE EM[®] AGAINST THE CITRUS MEALYBUG, *PLANOCOCCUS CITRI* UNDER GREENHOUSE CONDITIONS

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Objective

Evaluate the efficacy of different application frequencies (1, 2, and 3) of Nuke em[®] against the citrus mealybug (CMB), *Planococcus citri* on green coleus, *Solenostemon scutellarioides* plants.

Materials and Methods

A greenhouse experiment was conducted to determine the efficacy of three different application frequencies of Nuke em[®] against the citrus mealybug (CMB), *Planococcus citri*, on green coleus, *Solenostemon scutellarioides* plants.

Citrus mealybug colony

Laboratory-reared colonies of the CMB were maintained on butternut squash, *Cucurbita maxima* under $24 \pm 5^{\circ}\text{C}$, 50 to 60% relative humidity, and 14:10 (L:D) hour photoperiod in the Department of Entomology at Kansas State University (Manhattan, KS). These colonies had not been exposed to pesticides for at least 10 years.

Greenhouse experiment

Twenty-four green coleus cuttings of the cultivar 'Life Lime' were purchased from Euro American Propagators LLC (Bonsall, CA). Each rooted cutting was transplanted into a 15.2-cm container filled with Fafard[®] 2 Mix growing medium (Agawam, MA). Once the plants were established, they were infested with approximately 20 2nd to 3rd instar CMB. After three days (October 25, 2013), the first foliar application of Nuke em[®] (citric acid and potassium sorbate: Flying Skull Plant Products; Portland, OR) and water was applied to all twenty-four coleus plants using 946 mL plastic spray bottles (The Home Depot; Manhattan, KS). The lowest label rate or Normal Strength Spray of Nuke em[®] [1 ounce per 31 ounces of water (29.6 mL per 916.8 mL of water)] was used for each spray application to initially determine the effectiveness of the product against the citrus mealybug. Two more applications were conducted at three day intervals (October 28 and October 31, 2013). There were four replications per treatment and three destructive sampling dates (October 28, October 31, and November 3, 2013). Plants destructively sampled on October 28 received one treatment application, October 31 plants received two treatment applications, and November 3 plants received three treatment applications. Each plant was destructively sampled three days after the final application. In addition, CMB feeding location (leaf bottom, leaf top, and plant stem) was determined for each coleus plant. The experiment was conducted from October 22 through November 3, 2013 in a research greenhouse at Kansas State University (Manhattan, KS).

Statistical analysis

Percent CMB mortality was analyzed using SAS statistical Software Program version 9.2 (SAS Institute, 2002) in an analysis of variance (ANOVA) with treatment as the main effect. Percent CMB mortality was calculated by dividing the number of dead mealybugs per coleus

plant by the total number of mealybugs recovered from each coleus plant. Percent CMB mortality values were then normalized using arcsine square-root transformation and a one-way ANOVA was performed (SAS Institute, 2002). Significant treatment means associated with percent CMB mortality were separated using Fisher's protected least significance difference (LSD) test at $P \leq 0.05$. All data presented are non-transformed.

Results

Results indicated each assessment date (October 28, October 31, and November 3, 2013) had significantly higher percent CMB mortality associated with the Nuke em[®] treatment compared to the water control (Figure 1). For the coleus plants treated with Nuke em[®], 34% CMB mortality was observed, which was significantly ($F=13.6$; $df=1, 7$; $P=0.0102$) higher than plants that were treated with water (4%).

For the second assessment (October 31, 2013), there was significantly ($F=12.8$; $df=1, 7$; $P=0.0117$) higher CMB mortality (43%) on coleus plants treated with Nuke em[®] compared to the plants treated with water (22%). Results from the third assessment date (November 3, 2013) indicated significant differences ($F=28.9$; $df=1, 7$; $P=0.0017$) among the treatments with higher CMB mortality (60%) associated with coleus plants treated with Nuke em[®] compared to plants treated with water (15%).

In addition, most CMB were located on the leaf top (42%) and leaf bottom (39%), and 19% were located on the plant stem on the first assessment date (Table 1). Similarly, for the second assessment date, 33% and 39% of CMB were located on the leaf top and leaf bottom. Citrus mealybugs feeding on the leaf stem increased to 28%. Throughout the experiment, the highest percent mortality to percent location ratio was observed on the leaf top (Table 1). This maybe be

a response of CMB, feeding on the leaf top, being more susceptible to Nuke em[®] foliar applications because they are more likely to come into direct contact with the insecticide.

Conclusion

Overall, the efficacy of the lowest label rate or Normal Spray Strength of Nuke em[®] increased, with multiple applications, every three days against CMB on coleus plants under greenhouse conditions. The initial CMB mortality was approximately 34% with mortality increasing to 43% and 60% after the second and third applications, respectively. Additional research may be warranted to evaluate the two higher spray rates of Nuke em[®] (Enhanced Strength Spray: 1.5 ounces per 30.5 ounces of water and Strong Strength Spray: 2 ounces per 30 ounces of water) against the citrus mealybug.

References

SAS Institute. 2002. SAS/STAT user's guide for personal computers, version 9.2 SAS Institute, Cary, NC.

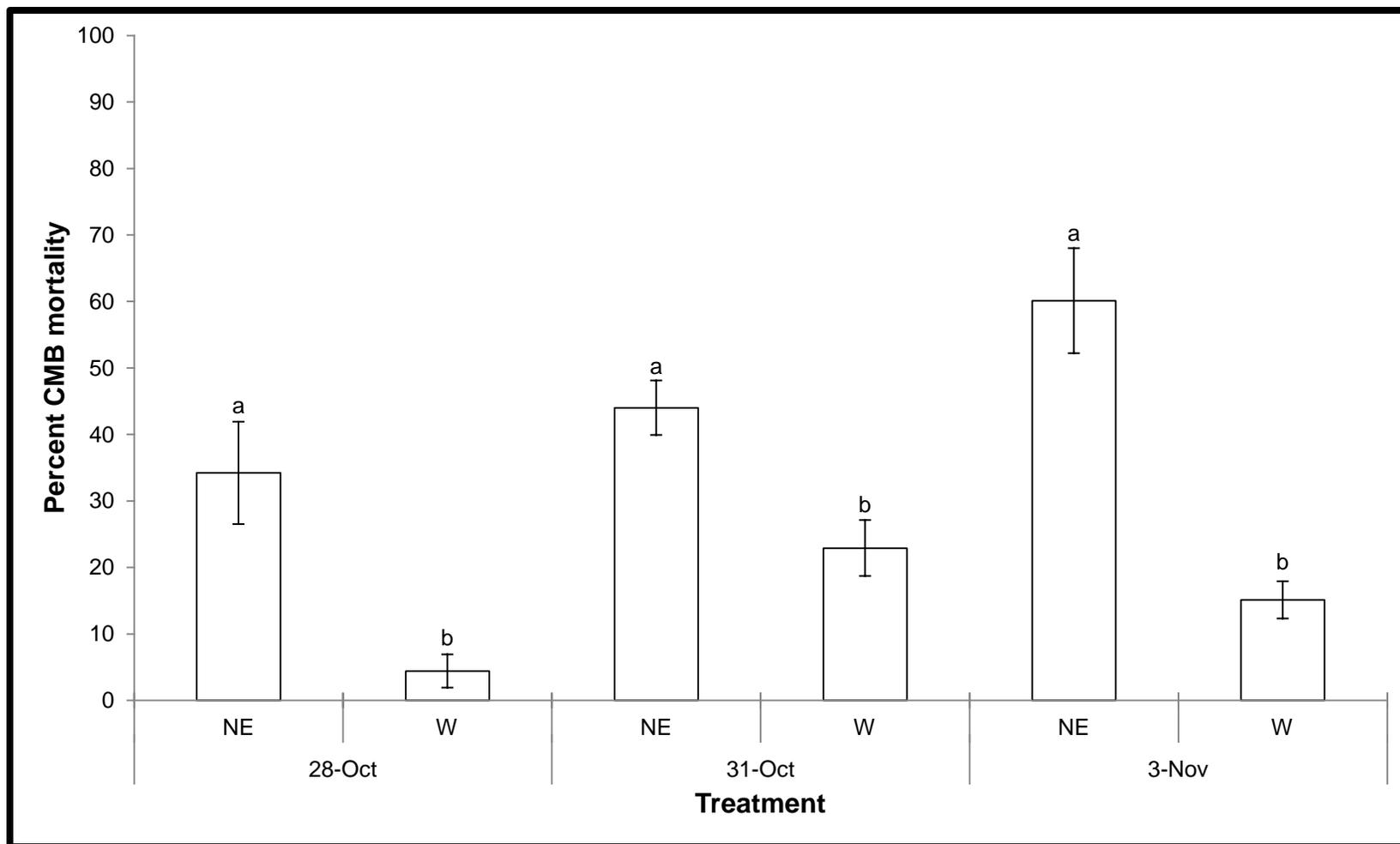


Figure 1. Mean percent mortality of the citrus mealybug (CMB), *Planococcus citri* for Nuke em[®] (NE) at the Normal Strength Spray (1 ounce per 31 ounces of water) and water (W) on green coleus, *Solenostemon scutellarioides* plants. Plants sampled October 28 received one treatment application, October 31 plants received two treatment applications, and November 3 plants received three treatment applications. Each plant was destructively sampled 3 days after the final treatment application. Bars with different letters within an assessment date are significantly different from each other ($P \leq 0.05$) based on Fisher's protected least significant difference (LSD) mean separation test. Vertical lines indicate standard error of them mean.

Table 1. Percent citrus mealybug (CMB), *Planococcus citri* associated with the 3 locations (plant stem, leaf top, and leaf bottom) of the coleus plants, percent CMB mortality in each location, and mortality to location ratio for each date coleus plants were destructively sampled (October 28, October 31, and November 3, 2013).

CMB location	October 28, 2013			October 31, 2013			November 3, 2013		
	% location	% mortality	ratio	% location	% mortality	ratio	% location	% mortality	ratio
Plant stem	19.4	0	0.0	28.2	2.4	0.09	28.9	4.1	0.1
Leaf top	41.7	15.7	0.4	33.1	24.2	0.7	37.1	32.0	0.9
Leaf bottom	38.9	1.9	0.04	38.7	5.6	0.1	34.0	1.0	0.03