# EFFICACY OF MILORGANITE® AS A DEER REPELLENT

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***Abstract:*** The objective of this study was to determine the effectiveness of Milorganite as a potential repellent to mitigate damage incurred to chrysanthemums (*Chrysanthemum morifolium*) by free ranging white-tailed deer (*Odocoileus virginianus*). Milorganite, the biosolids by-product left from the activated sludge process from the Milwaukee Metropolitan Sewer District, has had extensive use as an organic, slow releasing fertilizer and soil amendment in the past 80 years. Application of Milorganite as a top dressing, at three dose levels (1120 kg/ha, 2500 kg/ha, 5000 kg/ha) reduced damage ($P < .05$) to planted chrysanthemums by white-tailed deer over the 35 day study. While not significantly different ($P > .05$) compared to the lowest treatment level (1120 kg/ha), there was a trend toward a dose response effect as determined by analysis of plant area from digital photographs. Protection appeared to be directly related to the topical application of the deterrent to the plant with odor from adjacent treated and control areas within a plot having no measurable influence on reducing plant damage. Based on these results, Milorganite was determined to be effective at reducing plant damage by the browsing of free-ranging white-tailed deer.

***Key words:*** chrysanthemum, Milorganite®, repellent, white-tailed deer

Proceedings of the 12th Wildlife Damage Management Conference (D.L. Nolte, W.M. Arjo, D.H. Stalman, Eds). 2007

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## INTRODUCTION

The population growth of white-tailed deer (*Odocoileus virginianus*) in North America is often considered a success story for conservation. However, as this population increased damage to field crops (Conover 1984, Wywialowski 1994, Nolte and Wagner 2001), reforested areas (Blackwell et al. 2002), nurseries (Conover 1984, Nolte and Wagner 2001) and complete alteration of ecological communities (Stromayer and Warren 1997) have been clearly documented.

Drake and coworkers (2003) reported an annual economic impact of approximately $640 million in 13 Northeastern states as a result of deer damage. In a national survey, damage incurred by deer included losses of $750 million in timber, $250 million to homeowners' ornamental plants and gardens, and $100 million to agricultural property (Conover 1997).

While various options exist, repellents represent a significant approach to limit deer damage. Repellents typically rely upon altering the taste, inducing fear or pain, and in some cases are intended to induce a conditioned avoidance response (Conover 2002). Efficacy of any particular repellent may be influenced by deer density, availability of alternative food sources and

climatic conditions (Mason 1998, Conover 2002). Additionally under certain conditions deer have been reported to become habituated to some repellents rendering them to be completely ineffective (Gallagher et al. 2000). A multitude of repellents continue to be available to consumers, however most have not been critically evaluated (Trent et al. 2001).

Milorganite, the biosolids product left from the activated sludge process from the Milwaukee Metropolitan Sewer District, has had extensive use as an effective organic, slow releasing fertilizer and soil amendment in the past 80 years. In recent years, Milorganite has been indicated as a potential deer repellent. However, critical evaluation of the compound has been limited. Lutz and Swanson (1997) concluded that Milorganite was not an effective deer repellent when tested with a relatively high density of captive deer. In a more recent field study, Milorganite was found to be marginally effective at an application rate of 1120 kg/ha, in reducing damage to chrysanthemums from free-ranging white-tailed deer (Odin et al. 2005). Odin and coworkers (2005) also reported Milorganite (269 kg/ha) to be effective on the short term basis for newly germinated soybeans to the degree that plants were sufficiently established to survive browsing damage.

Therefore, the objective of this study was to establish the effectiveness of Milorgante as a repellent on free-ranging white-tailed deer and to determine effective dose levels in an urban/suburban type of environment.

## METHODS

This experiment was conducted on the Berry College campus in Northwest, Georgia, August 12 - September 19, 2005. Deer population on the wildlife refuge area (1417 ha) of the main campus was estimated at 1 per 4 ha (T. Touchstone, Georgia Department of Natural Resources, personal communication). Deer within this environment are significantly habituated to human presence and represent a similar population to those encountered in an urban/suburban environment.

Six plots were established within the wildlife refuge area on the main campus of Berry College. Each site was a minimum of 0.25 km apart. Locations were selected on the basis of providing a similar environment for each sequentially paired plots. This was necessary to provide an adequate comparison for plots receiving multiple treatment application of Milorganite.

Each plot consisted of 4, 3-m rows arranged in a square pattern. Distance between perpendicular lines were approximately 10 m. This was done to reduce the potential effect of odor drift between treatments. In order to minimize plant preference by treatment interactions, all plots utilized a single plant variety of chrysanthemums (*Chrysanthemum morifolium*). Each line of the square contained 10 mums, planted at approximately 30 cm spacing. Each line was assigned as control or one of three treatment levels of Milorganite designated in an array. Levels of Milorganite applied were initially based on the amount of the compound found to have marginal effectiveness in a previous study (1120 kg/ha equivalent) (Odin et al. 2005). The two additional treatment levels of Milorganite were determined by approximately doubling the previous dose levels, thus providing a sufficient application range to determine a dose-response effect. Each treatment was applied as a top dressing directly on the respective plant rows at the appropriate dose level. Habituation of deer to the treatment was expected, therefore, 3 of the plots (1,3,5) received additional applications of their respective treatments on 14 day post-planting intervals of the 35 day study.

To facilitate data collection and ensure no damage to plants occurred prior to treatment, all plants in plots 1, 3 and 5 were planted and treated on the same day. Plots 4-6 were planted and received treatment application 3 days later. All plants were inspected on an every other day basis and hand watered when necessary.

Collection of data occurred at 7 day intervals, from day 0 (planting) to day 35 post-planting. Data was collected by taking individual digital photographs from a single camera (Kodak SX4530, Eastman Kodak Company, Rochester, NY) of each plant from a consistent distance and height. A white easel was used as a backdrop for each plant to eliminate color contrast between the plant and surrounding vegetation.

Area of foliage ($cm^2$) of each individual plant depicted on digital photographs was utilized to monitor degree of deer damage inflicted. A transparent plastic grid designed to determine the rib-eye area of meat (Art Services, Washington, D.C.) was modified to encompass sufficient area of a computer screen to facilitate determination of plant foliage area. Area of foliage from each photograph was determined by one of two evaluators utilizing the same laptop computer (Compaq Presario, 12XL510, Hewlett Packard Co., Palo Alto, CA) throughout the study.

Univariate analysis of variance procedures of SPSS 13.0 (SPSS 2004) were utilized to compare differences in foliage area among treatments within and between plots.

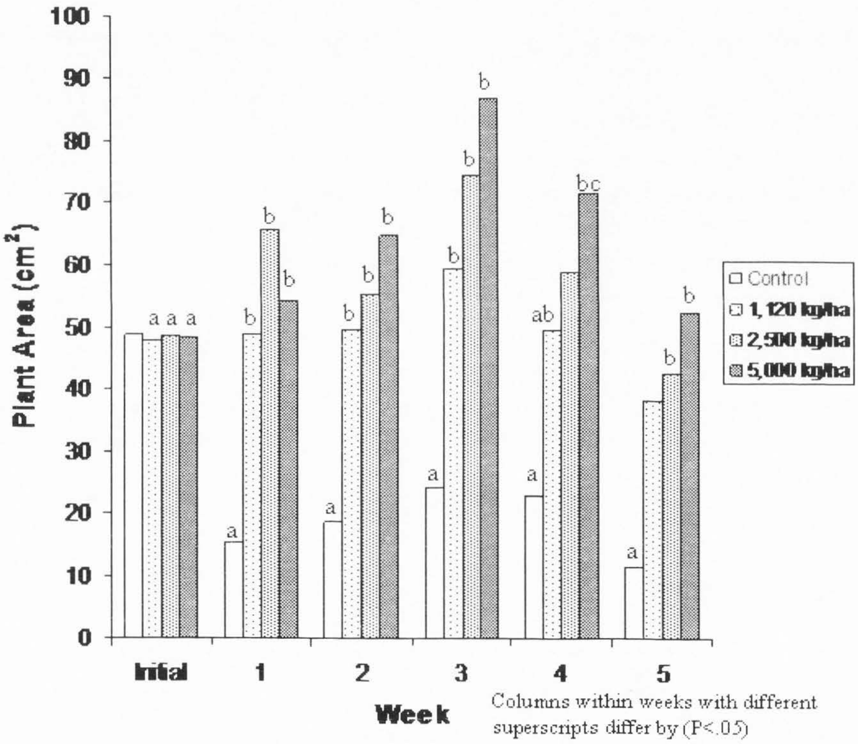


**Figure 1. Browsing damage as measured by plant area ($cm^2$) of Chrysanthemums (*C. morifolium*) following application of Milorganite at three levels.**

## RESULTS AND DISCUSSION

Application of Milorganite reduced damage ($P < .05$) to planted chrysanthemums by free-ranging white-tailed deer over the 35 day study (Figure 1). While not significantly different ($P > .05$) compared to the lowest treatment level, there was an observable trend toward a dose response effect as determined by the analysis of digital photographs.

Among the six campus plots developed for this project, three plots (2, 4, 6) received only one application of Milorganite at the designated respective levels among the four lines of plants within each plot. Plots 1, 3, 5 were retreated with the appropriate levels of Milorganite on days 14 and 28. No differences ($P > 0.27$) were observed in degree of damage to plants as assessed by the analysis of plant area from digital photographs. There were no treatment by group interactions ($P > 0.25$). Since there was no difference between the single and multiple treated plots, data was pooled for all six plots to complete all analysis.

During the first three weeks post planting, no differences ($P > 0.10$) between plots were observed. However, during the final two weeks, two plots received different levels of overall damage. Plot 2 received much less damage than the average, while Plot 4 received extensive damage. Both plots were among the three (2, 4, 6) receiving only one treatment application of Milorganite. This differential damage effect is likely the primary cause of the greater standard error values observed in plant area. Regardless, damage within these two plots tended to follow the same dose dependent response to respective levels of Milorganite. It should also be noted that during the study, typically 2-3 plants per plot (40 total plants/plot) received significant damage presumably by deer trampling or natural plant death. This event was considered to be random among the plots and treatments within each plot and also contributes to the observed standard error values.

While variation in degree of damage between plots was expected, the duration of effectiveness of Milorganite was not anticipated. It was expected that a single application of the product would be effective for no more than 14 days. Plots receiving a single application maintained effectiveness throughout the duration of the study. Habituation to the product was also not apparent. No plant damage or burning as a result of receiving the topdressing application was noted at any plots.

One concern in designing the experimental plots related to the potential "drift effect" of odor influencing adjacent lines of mums receiving different treatments. For example, one line receiving the highest level of Milorganite being adjacent to the control line of mums in a given plot, might influence consumption of the control plants due to wind moving odor toward the controls. Results of this study indicated that odor drift did not occur. Milorganite was primarily effective on plants receiving the direct top dressing of the product. This aspect may be of particular advantage in the urban/suburban environment if odor influences are associated with quality of life.

Based on these results, Milorganite was found to be effective at reducing plant damage by the browsing of free-ranging white-tailed deer. There was also a dose response trend related to degree of plant protection. Plant protection appeared to be directly related to the direct application of the deterrent to the plant with odor in adjacent areas having virtually no influence on reducing plant damage.

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