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EFFECTIVENESS OF MILORGANITE® AS A REPELLENT TO PROTECT ORNAMENTAL AND AGRONOMIC PLANTS FROM DEER OVER-BROWSING

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Abstract: When deer populations become locally overabundant, browsing of ornamental and agronomic plants negatively affects plant establishment, survival, and productivity. Milorganite® is a slow-release, organic fertilizer produced from human sewage. We tested Milorganite® as a deer repellent on chrysanthemums (*Chrysanthemums morifolium*) in an urban/suburban environment, and soybeans (*Gycine max*) in a rural agriculture environment. Six beds of chrysanthemums at two sites were monitored for 28 to 35 days. Treatment plants received a top dressing of 104 grams of Milorganite® (1120.9 kg/ha). Milorganite® treated plants had more ($P < 0.001$) terminal buds and achieved greater height ($P < 0.002$) compared to controls at one site, however damage observed was similar at the second site. In a second experiment, 0.2-ha plots of soybeans (*Glycine max*) were planted on five rural properties in northeastern Georgia and monitored for ≥ 30 days. Treated areas received 269 kg/ha of Milorganite®. In 4 of 5 sites, Milorganite® delayed browsing on treated plants from 1 week to > 5 weeks post-planting. Duration of the protection appeared to be related to the difference in deer density throughout most of the study areas. Results of this study indicate Milorganite® has potential use as a deer repellent.

Key words: chrysanthemums, Milorganite®, soybeans, white-tailed deer damage

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INTRODUCTION

The white-tailed deer (*Odocoileus virginiaus*) population in North America has increased from an estimated 350,000 in the 1900s to 26 million in the 1990s (Miller et al. 2003). As this population has increased, damage to field crops (Conover 1984, Wywialowski 1994, Nolte et al. 2001), nurseries (Conover 1984) and reforestation efforts (Blackwell et al. 2002) have escalated. Increasing human populations and land development have necessitated intensive deer management strategies in some areas (Butifiloski et al. 1997). Unlike other nuisance animals, deer cannot be casually eliminated when human conflicts arise, nor can landowners be expected to carry the entire burden of support for this public resource (Craven and Hygnstrom 1994). Deer damage control can be socially and politically difficult and pose biological and logistical problems. Scare devices, repellents, and shooting can be effective strategies to control deer damage in some situations (Butifiloski et al. 1997).

Repellents are frequently used in orchards, gardens, ornamental plantings, and on agronomic crops. New repellants continue to enter the market, but efficacy varies greatly (Trent et al. 2001). Success is determined by the reduction of damage, not total elimination. Repellents generally rely on fear, pain, taste, or conditioned avoidance (Conover 2002). Repellents may be incorporated into the plant (systemic delivery), spread throughout an area (area delivery), or applied to the plant (contact delivery). Efficacy may vary depending on several factors, including deer density, learned behavior, resource availability, and seasonal changes in plant palatability (Conover 2002).

Vegetation damage caused by deer browsing represents a serious economic loss to some homeowners, foresters and farmers in the United States (Conover and Decker 1991). Conover's (1997) nationwide survey indicated that deer cause losses of $750 million in timber productivity, $251 million to households and $100 million to agricultural property annually. In recent decades, a number of deer repellents have been promoted in an attempt to reduce these losses, but most suffer from being expensive, untested, unreliable or a combination (Harris et al. 1983, Palmer et al. 1983 and Trent et al. 2001).

Wildlife food plots often are established by hunters or resource agencies to enhance the quantity and quality of food resources available and increase opportunities for viewing and deer harvest. Heavy browsing pressure can limit the hunter's selection of forage crops. Heavy-seeded annual, warm-season legumes such as soybeans (*Glycine max*), lablab (*Lablab purpureus*) and iron clay peas (*Vigna unguiculata*) are especially susceptible to browsing during their early stages of development. Hehman and Fulbright (1997) found that the intensity of use of food plots was related to standing crop and nutritional quality of food plot forages. Higginbotham and Kroll (1993) reported that soybeans and iron clay peas were heavily utilized to the point of elimination 30 days after establishment. The development of methods to delay browsing pressure on these crops would enhance the potential planting success, provide additional forage for longer periods, and provide the planter with additional forage options.

Milorganite® is a low-potency, organic fertilizer (6-2-0) produced from human sewage (sludge) (Anonymous 2003). The processing method allows for an extended duration of decomposition and subsequently persistent odor. This slow-release, organic fertilizer is approved by the U. S. Environmental Protection Agency for use on food crops and golf courses. Milorganite® has been recognized as a potential deer repellant by home owners and land managers, although definitive research on its efficacy has not been conducted. Milorganite® is listed in the Georgia Department of Natural Resources guide to managing deer damage (Kammermyer et al. 2001). Milorganite® is commercially available at a cost per 18.14 kg bag ranging from $7.00 to $10.00.

In the only published study conducted to date, Lutz and Swanson (1995) indicated that Milorganite® was not effective as a repellent. However this research was conducted in penned settings with excessive deer densities. Research is needed with free-ranging deer to assess the efficacy of Milorganite® as an area repellent. Therefore, we tested the efficacy of Milorganite® to repel free-ranging deer from ornamental and agronomic plants. Our specific objectives were to determine the effectiveness of Milorganite® as a temporary deer repellent when applied to newly planted ornamental plants during the summer and the effectiveness of Milorganite® as a temporary deer repellent when applied immediately after planting an annual, warm-season wildlife food plot.

METHODS

Ornamental Plant Study

This experiment was conducted on the Berry College campus and the Oak Hill Gardens in Northwest, Georgia, September 12 through October 22, 2003. Deer population on the wildlife refuge area (1417 ha) of the main campus is estimated at 23 per km^2 (T. Touchstone, Georgia Department of Natural Resources, personal communication). Observations of deer at the Oak Hill Gardens indicate a population exceeding 46 per km^2 on the 71.7 ha facility. Deer at both locations are generally habituated to the typical human activities.

Three new bedding plots (3 m x 3 m), greater than 0.5 km apart, were established on the Berry College campus. Each plot was within 50 m of an academic building and paved road. Number of terminal buds and plant height to the tallest terminal bud on non-flowering chrysanthemums (*C. morifolium*) were recorded. Plants were sorted to balance number of terminal buds and assigned to each plot prior to planting. Each plot consisted of two rows of ten plants each, planted at 30 cm spacing with each row 3 m apart. One row of each plot received a topdressing application of 107g of Milorganite® (1120.9 kg/ha). The remaining row of plants at each plot served as controls. Water was provided on an as needed basis. Every 7 days, number of remaining terminal buds and height of each plant were recorded for a 35-day period.

Two established formal gardens of the Oak Hill Gardens were divided into three plots. Two connecting "U" shaped plots, 2.15 m x 55.38 m were sectioned into two respective control and treatment sites. Two additional strip gardens, approximately 1.85 m x 18.46 m were assigned as a third treatment and control plot. All plots were planted with several varieties of chrysanthemums (*C. morifolium*), at a density of 9 per m^2. Milorganite® was applied at an equivalent of 1120.9 kg/ha in the U shaped plots (3.2 kg) and in the strip treatment plot (2.7 kg) on the same day as planting to eliminate any pre-test plant damage by deer. Twenty plants uniformly distributed throughout each treatment and control plot were labeled and utilized as a sample subset population. Number of terminal bites and plant heights were recorded at 7-day intervals for 28 days.

Multivariate analysis procedures of SPSS 12.0 (SPSS 2003) were utilized to compare differences in number of terminal buds and plant height on campus plots and number of terminal bud bites and plant height at Oak Hill Garden plots.

Agronomic Plant Study

A second series of trials was conducted on five sites in the Georgia Piedmont during July 2003 to September 2003. Two sites each were located in Oconee and Madison Counties and one site was located in Clarke County. Clarke County's deer density is estimated at 10 to 14 deer per km^2. Oconee County has a deer density of 12 to 15 deer per km^2 and Madison County deer density is estimated at 14 to 17 deer per km^2. Study sites within the same county varied in deer density because of past herd management practices.

At each site we established two 0.2 - ha plots (control vs treated) located 15-300 m apart. Prior to planting, fertilizer and lime were applied to each site according to soil test recommendations. Soybeans (*Gycine max*) were planted in each food plot at a rate of 67.3 kg/ha. The treatment plots received one application of Milorganite® at a rate of 269 kg/ha after first plant emergence. Milorganite® was broadcast using a tractor-mounted fertilizer spreader. On each plot, we marked the beginning and end of five rows of 100 plants each. Browse levels were subjectively rated according to percentage of the plant removed: 0 – 0%, 1 – 25%, 2 – 50%, 3 – 75%, 4 – 100%. We collected data for > 30 days after first plant emergence. After data collection was completed, browse rating categories 1, 2, and 3 were condensed into a single category for analysis (category 0 = no browse, 1 = partly browsed, 2 = completely browsed). Precipitation data were obtained from the National Oceanic and Atmospheric Administration (NOAA) recording sites located 15 to 30 km from the research sites. Precipitation data were used to determine if rainfall had an influence on the effectiveness of the repellent.

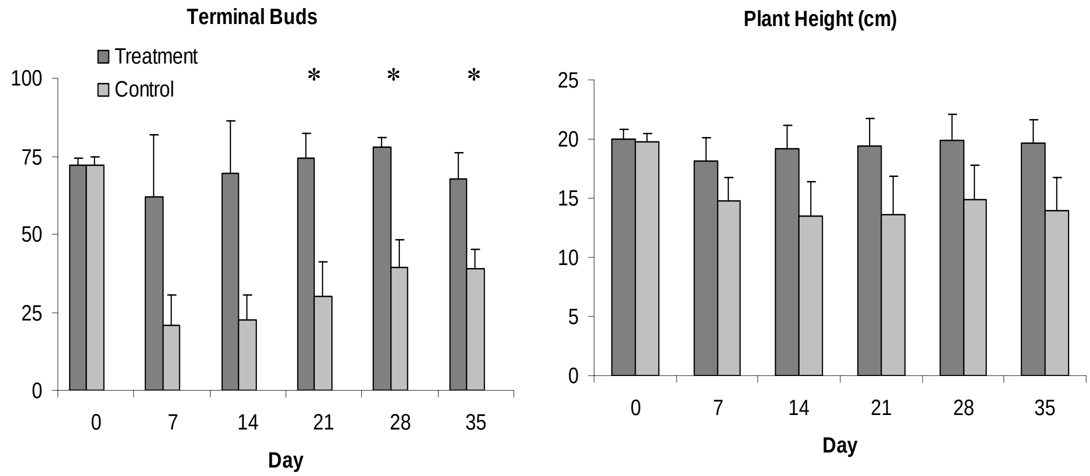
Equal availability of plants between treatment and control plots at the same site was assumed because plots were planted nearly side by side. The ANOVA (analysis of variance) model in SAS (Statistical Analysis System) with repeated measures procedure was used to analyze the data. Significance was assumed at an alpha level of 0.05. The null hypothesis was Milorganite® will deter deer browsing on soybeans up to four weeks with one application of 269 kg/ha.

RESULTS AND DISCUSSION

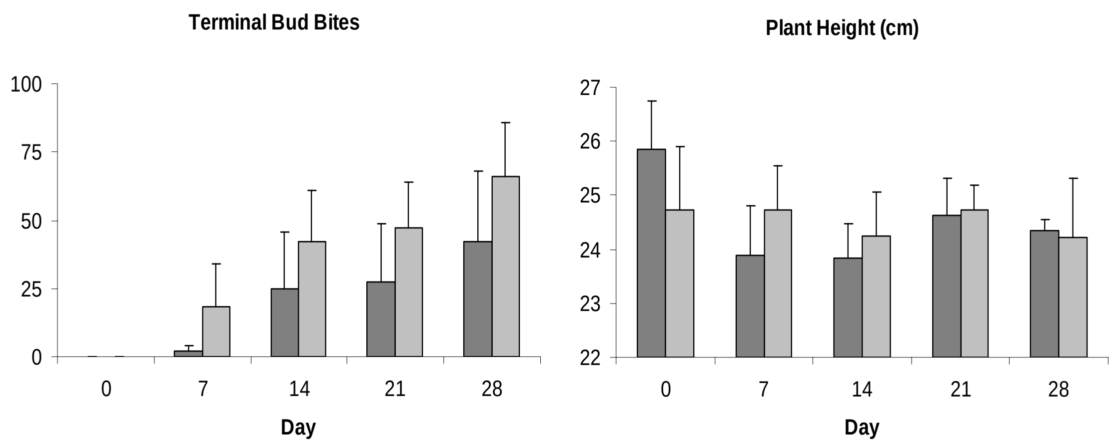
Ornamental Plant Study

Results of damage observed to the planted chrysanthemums on 7-day intervals are presented in Figure 1. While browsing of terminal buds was clearly evident among the controls, high variation in damage to treated plants across plots was noted. Differences in degree of damage between treated and control chrysanthemums were not evident during the 7-day periods until the 21-day data collection period. While variability in damage was observed among plots of chrysanthemums planted in new beds, across all plots Milorganite®-treated plants exhibited more ($P < 0.001$) terminal buds per plant (70.5 ± 4.2) and greater ($P < 0.002$) plant height (19.4cm ± 0.7) compared to respective controls (37.3 ± 5.0 15.1cm ± 1.0). Milorganite®-treated plants in the established beds at the Oak Hill Gardens received similar damage across all plots and time periods compared to controls (Figure 1). Terminal bud bites for treated plants were 19.3 ± 7.9 and 34.7 ± 8.6 for the controls ($P = 0.199$). Plant height for treated plants (25.5cm ± 0.3) and control plants (24.6cm ± 0.4) were also similar ($P = 0.969$). While Milorganite® application reduced deer damage overall, a high degree of variation in effectiveness was observed between plots and locations. While types of forages differed between the Campus sites and Oak Hill Gardens, alternative forages appeared available at both locations. Additionally, both locations have higher deer populations compared to the regional average (14 to 15 per km²), with the Oak Hill Garden population at least twice as high compared to the Berry College main campus. This higher density of animals may have contributed to the greater observed damage to the plant material. Habituation to a repellent as a result of previous exposure to organic fertilizers and numerous repellents that had been frequently utilized at the Oak Hill Gardens, may also have contributed to the limited effectiveness of Milorganite® at this location. The rapid conditioning of deer to common repellents has been documented (Gallagher and Prince 2001).

CAMPUS SITE



OAK HILL GARDEN SITE



- **indicates a significant difference, $\underline{P} < 0.05$.**

Figure 1. Mean number of terminal buds, terminal bud bites and plant height (cm) on chrysanthemums at Berry College in Floyd County, Georgia during September – October 2003. Bar indicates standard error.

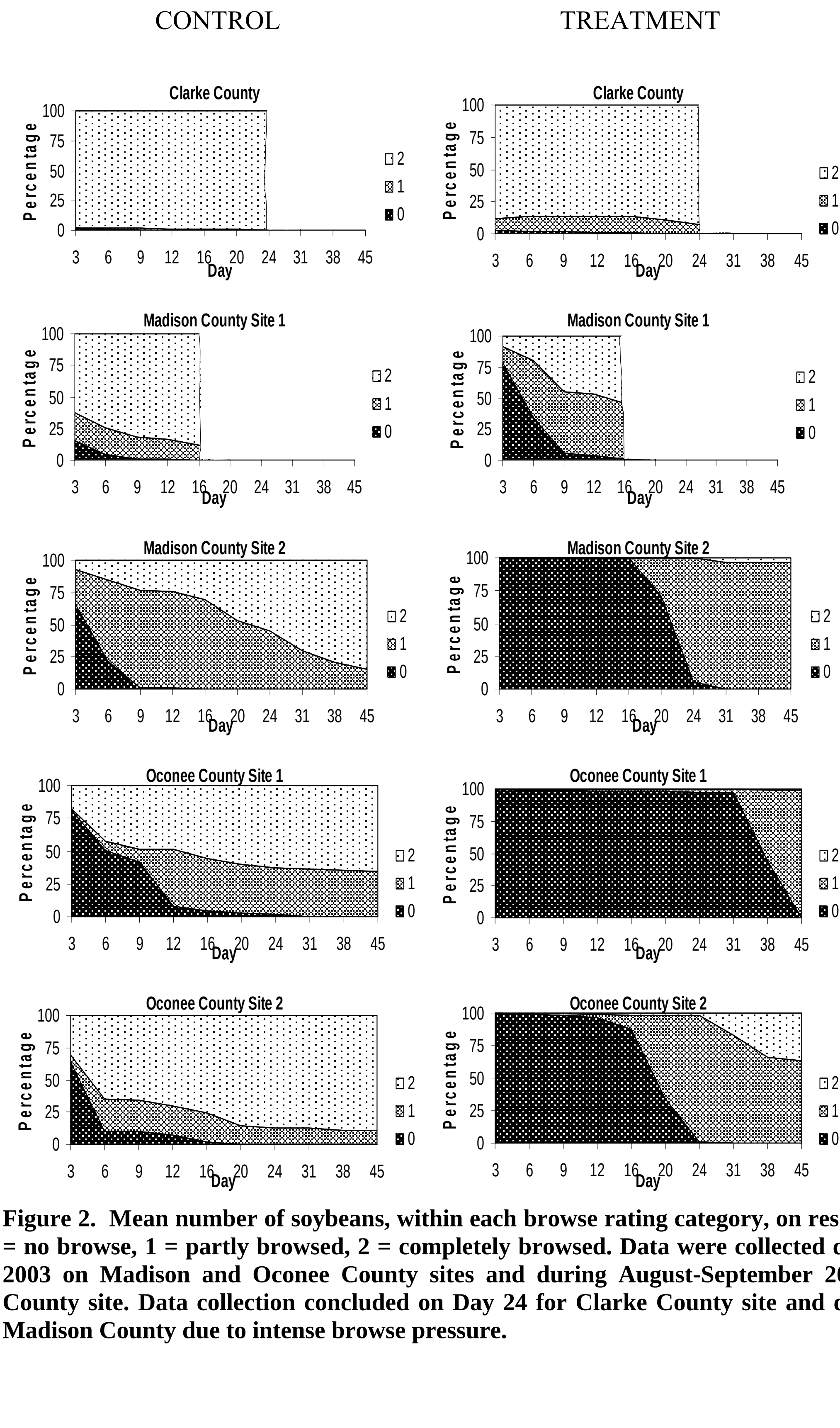


Figure 2. Mean number of soybeans, within each browse rating category, on research sites where 0 = no browse, 1 = partly browsed, 2 = completely browsed. Data were collected during July-August 2003 on Madison and Oconee County sites and during August-September 2003 on the Clarke County site. Data collection concluded on Day 24 for Clarke County site and day 16 for site 1 in Madison County due to intense browse pressure.

Agronomic Plant Study

In the Clarke County plots, treatment areas had fewer plants ($P < 0.05$) completely browsed from the beginning of the study to day 20 (Figure 2). At Madison County site 1, the treatment plot had fewer plants completely browsed than the control plot at day 3 ($t_{20} = -11.06$, $P < 0.01$), while number partially browsed remained similar at days 3 ($t_{20} = -1.79$, $P = 0.4938$) and 6 ($t_{20} = 2.99$, $P = 0.0677$). On days 9, 12 and16, number of plants partly browsed in the control plot was greater ($P < 0.01$) than in treatment plots. Throughout the sampling period, the treatment plot had fewer ($P < 0.01$) plants completely browsed compared to the control plot. At Madison County site 2, the treatment plot had more ($P < 0.01$) plants not browsed from day 3 to day 20 than the control plot**.** From day 9 to day 45, the treatment site had significantly fewer plants ($P < 0.01$) completely browsed compared to the control site.

At Oconee County site 1, the treatment plot had more ($P < 0.01$) plants without browse than the control plot during day 6 to day 31. The plots had similar number of plants partly browsed during day 3, 6, 9, and 38. On days 3, 6, 9 and 38, the treatment plot had similar plants completely browsed ($P > 0.01$) compared to the control plot. At Oconee County site 2, the treatment plot had more ($P < 0.01$) plants not browsed from day 3 to day 20 than the control plot. The number of plants partly browsed differed between sites except during days 3 ($t_{20} = -0.83$, $P = 0.9585$) and 16 ($t_{20} = -2.29$, $P = 0.2448$).

The degree of protection to soybean plants appeared to be directly related to deer densities on study areas. At the Clarke County and Madison County site 1, deer densities were greater than other sites and Milorganite® provided limited protection (0 to 1 week). On the other sites (Madison County site 2, Oconee County sites 1 and 2) very little browsing was observed on all treatment sites during the first 2 weeks post treatment. In addition, because of the apparent effects of Milorganite®**,** once increased browsing evidence was observed, 2 to 4 weeks post-treatment**,** plants were of sufficient maturity that subsequent deer browsing had little detrimental effect on the plants. On all 3 of these sites, soybean plants persisted throughout the 45-day sampling period.

Precipitation was similar between the Oconee and Madison sites. Both sites had greater amounts of rainfall than the Clarke County site during the study period. Research at the Clarke County site was conducted a month later than at the other study areas. Additional rainfall at the Oconee and Madison sites may have had a leaching effect on the applied Milorganite®, thus decreasing the repellent's effectiveness. Further research is needed to determine the effects of rainfall on Milorganite®.

CONCLUSION

Results of this study suggest that Milorganite® has potential for reducing browsing damage, but effectiveness may be associated with other factors. The degree of effectiveness of a repellent may be influenced by size of area to be protected, density of animal population, availability of alternative forages, and conditioning (Mason 1998). Weather, particularly rainfall likely influences the duration of effectiveness. The encouraging results of this study suggest that further research related to application rates and frequency of reapplication of Milorganite® is warranted.

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