Comparison of a 2-Layer Electric Fence and a Single Strand Electric Fence in Mitigating Browsing of Impatiens by White-tailed Deer

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ABSTRACT: The objective of this study was to evaluate two electric fence configurations in minimizing damage to impatiens (*Impatiens walleriana*) by white-tailed deer (*Odocoileus virginianus*). Each of 3 sites consisted of 3 plots (3mx3m), containing 16, evenly spaced impatiens planted on the perimeter of each plot. Plots within each site had a control, single strand and 2-layered electric fence. Control plots had no fencing. Single strand plots had one electrified wire attached to posts at 40cm height, surrounding the plot. Two-layered electric fence had energized wire attached to posts at 25cm and 60cm height, on the perimeter of the plot. A second, single electrified wire was attached to posts at 25cm height, 1m to the exterior of the two strand fence. Eight plants within each plot was photographed weekly for 3-weeks. The percentage of total pixels containing plant material in each photo was used to determine changes in plant growth. The percentage of pixels containing impatiens plants was lower ($p<0.001$) in control plots (5.0% ± 0.3), compared to the single strand (42.8% ± 3.3) or the 2-layered (45.8% ± 1.1) electric fences at the end of the 21-day trial. In this study, both electric fence configurations were effective in reducing damage to impatiens by white-tailed deer.

KEY WORDS: electric fence, impatiens, white-tailed deer

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INTRODUCTION

White-tailed deer (*Odocoileus virginianis*) have often been reported to be the single species causing the most economic damage to crops in the United States (VerCauteren et al. 2006). Reports of damage to crops, orchards, landscapes and gardens is extensive (Conover et al. 2018, Hildreth et al. 2012, VerCauteren et al. 2006). On a national basis, deer were reported as causing as much as 50-70% of the total damage inflicted by a wildlife species over several decades (Conover et al. 2018). Population of white-tailed deer has proliferated in suburban areas of the United States in part, due to habitat quality, lack of predation and limited hunting pressure (Hildreth et al. 2012, Hubbard and Nielsen 2009). Habituation of wildlife including deer, to humans can create additional challenges often causing greater economic damage (Sutton and Heske 2017, Geist 2016, Hubbard and Nielsen 2009).

Fences have been utilized throughout history as a means to regulate animal movement (VerCauteren et al. 2006). Electric fences are generally considered less expensive compared to woven wire (Webb et al. 2009) and have the potential to act as both a physical, and a psychological barrier due to the electric shock (Webb et al. 2009, VerCauteren et al. 2006, Curtis et al. 1994).

Numerous electric fence designs have been tested as a means to mitigate damage inflicted by deer. Webb and coworkers (2009) examined a 15-strand, 2.5m height, fence and reported animal penetration occurred at weak points in the system such as water crossing and similar low points. Electrified 5-strand high-tensile wire (Palmer et al. 1985), electric polybraid (Seamans and VerCauteren 2006) as well as a 4-strand electric fence (McAninch 1986) have been reported to be effective in controlling deer movement and damage to various crops.

More simplistic electric fence designs containing three electrified wires has been called an offset or New Hampshire electric fence (Palmer et al. 1985), and a Gallagher® - 2-Layered Deer-Exclusion Fence (Parris et al. 2008). In essence an interior fence supports two strands of electric wire. A second fence, approximately 1m to the exterior of the first fence, contains a single electric wire attached at an intermediate height compared to the interior fence. In a captive animal study, deer penetrated the fence design (Palmer et al. 1985), while a similar configuration resulted in a significant reduction in deer browsing damage compared to controls (Parris et al. 2008). Single strand electrified fences were reported to be successful in limiting damage to a newly planted area (Steger 1988), as well as decreasing damage to corn by 90% (Hygstrom and Cravens 1988).

For the protection of small gardens and horticultural crops, utilization of the more simplistic 2-layered or single-strand of electrified fence offers advantages due to simplicity and cost. Therefore, the objective of this study was to compare the effectiveness of the single-strand electric fence and 2-layered electric fence configurations at reducing damage caused by deer.

MATERIALS and METHODS

Three sites, approximately 10m apart, each contained 3 test plots. Each plot consisted of a 3m x 3m square containing 16 evenly-spaced impatiens (*Impatiens walleriana*) plants, planted on the perimeter of the square. Plants were provided water as needed. Plots within each site contained a control, single-strand and a 2-layered electric fence. Control plots had no fencing. Single-strand plots consisted of an electrified 17-guage wire (FarmGard, Glencoe, MN) suspended by plastic fence posts (Fi Shock, ZarebaSystems, Lititz, PA) at a height of 40cm, erected 30cm outside of the perimeter of the plants. Two-layered electric fence had strands of energized wire attached to plastic posts at 25cm and 60cm height, erected 30cm outside of the perimeter of the plot. A second, single electrified wire was attached to plastic fence posts at a height of 25cm, 1m to the exterior of the two-strand fence. A low-impedance solar powered charger (EESP5M-Z, ZarebaSystems, Lititz, PA) was used to energize all electric fences across all plots.

Eight of the 16 plants, every other plant, within each of the 9 plots had a plant identification stake placed 15cm away from the plant on the perimeter of each square. Photographs (Canon EOS Rebel T6, Canon, Ōta, Tokyo, Japan) of each marked plant were collected weekly, over a 3-week period, using a cameral stand to ensure images were collected at a consistent height (30cm) and distance (60cm) from each plant. Damage due to browsing was determined by comparing the change in proportion of pixels containing plant material compared to the total pixels in each photograph through the use of a software imaging program (Image J, NIH, US Government, Bethesda, MD).

Univariate analysis of variance procedures of SPSS (SPSS 25.0 2017) were utilized to determine differences in the proportion of pixels containing the plant material within each photograph, by treatment, plot, week and technician. Duncan's Multiple Range Test was utilized to determine differences between parameters ($p<0.05$).

RESULTS and DISCUSSION

Among the parameters evaluated, no differences ($p>0.08$) were noted for technician, suggesting consistency among the observers when estimating the percentage of total pixels containing plant material in each photo to determine changes in plant growth. Differences ($p<0.05$) in week post-planting, fence treatment, and site containing each of three plots were observed. A site x treatment interaction ($p<0.05$) was likely due to one or the three sites having greater exposure to sunlight, resulting in less overall growth due to stress on shade-thriving impatiens. No other two or three-way interactions were significant.

While plants were randomly planted within all plots, analysis of photographs taken immediately post-planting indicated control plants had the lowest ($p<0.05$) proportion of pixels containing the impatient plants (28.4% ± 1.1) across all plots, compared to the plots receiving the single electric wire treatment ($p<0.05$; 31.2% ± 1.2) or having the 2-layered fence ($p<0.05$; 34.9% ± 1.3). At 7-days post-treatment, damage by consumption of impatiens was observed as a decrease ($p<0.05$) in pixel plant area in the control plots (5.2% ± 0.9), while increases in plant area of the single-wire fence (35.5% ±1.1) plots and 2-layered fence (41.3% ± 1.2) plots, indicated plant growth. This trend remained consistent for plant analysis on 14-day and 21-day post-planting (Figure 1). Across the 21-day trial, the percentage of pixels containing impatiens plants was lower ($p<0.001$) in control plots (5.0% ± 0.5), compared to the single-strand (42.8% ± 1.1) or the 2-layered (45.8% ± 1.8) electric fences. In this study, both electric fence configurations were effective in reducing damage to impatiens by white-tailed deer.

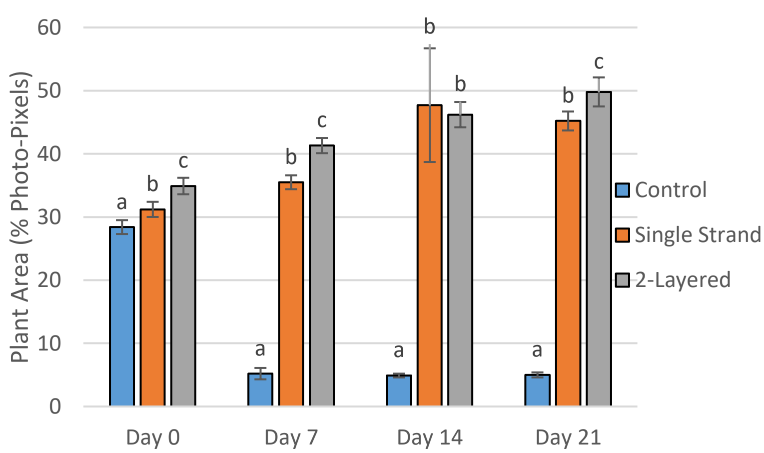

Figure 1: Estimated Plant Area of Impatiens (Impatiens walleriana) Subjected to Deer Browsing When Incorporating a Single-Strand or 2-Layered Electric Fence and Controls

The results of this study supports previous work indicating a single-strand of electrified fence can be effective in decreasing damage due to deer browsing (Hygstrom and Cravens 1988, Steger 1988). The 2-layered fence has also been reported to significantly reduce damage to crops (Parris et al. 2008).

It is important to note that these simplistic fence designs primarily function as a psychological barrier due to the electric shock as opposed to a physical barrier (Webb et al. 2009, VerCauteren et al. 2006, Curtis et al. 1994). Size of area intended to be protected, deer density and forage availability all can influence degree of motivation to transverse a barrier (Seamans and VerCauteren 2010, Curtis et al. 1994). During the current study, it was noted that availability of forage and climatic conditions were extremely favorable compared to most years and likely decreased level of motivation of deer to penetrate each fence design. Regardless, for small gardens, these two fence designs offer a relatively inexpensive, effective and easy to construct means to mitigate deer damage.

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