Use of Silver Nanoparticles for Nematode Control on the Bermudagrass Putting Green

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Objectives:

1. *Develop silver nanoparticle compounds with nematicidal activity.*
2. *Evaluate the efficacy of silver nanoparticles for control of nematode and improvement of turf quality in the bermudagrass putting green.*

Plant-parasitic nematodes can be a critical limiting factor for maintaining warm-season turfgrasses in golf courses. Nematode problems on intensively managed bermudagrass putting greens are reported frequently in Texas. The sole effective nematicide, Nemacur (fenamiphos), was banned from turfgrass use in 2008, and no comparable alternative is currently available. This lack of options for controlling nematodes poses serious problems in turfgrass management, particularly for intensively managed golf course fairways and putting greens

To meet the aesthetic and recreational demands, golf course superintendents are heavily dependent on conventional synthetic pesticides. However, the use of pesticides poses substantial human health and environmental risks. Particularly, conventional synthetic nematicides including Nemacur are more toxic to humans and animals compared to other pesticides. Silver nanoparticle compounds that we have developed will help to alleviate these safety concerns by producing a universal and environmentally friendly nematicide at a comparable cost to conventional pesticides. The silver nanoparticles have multi-site modes of action to kill nematodes and will provide a great alternative to the conventional nematicides.

Nematicide efficacy was evaluated in the turfgrass research field at Texas A&M University in 2013. The field trial was conducted on the bermudagrass cultivar 'TifEagle' putting green infested with the root-knot nematode *Meloidogyne graminis*, starting on April 23. Individual plots measured 4 by 6 feet and were arranged in a randomized complete block design with four replications. Treatments included Nortica (*Bacillus firmus*, a biological nematicide labeled for turfgrass, Bayer; 70 lbs per acre; monthly application), silver nanoparticles (AgNP; 150 ppm; biweekly application), and the non-treated control. Individual treatments were applied at a pressure of 40 psi using a CO_2-pressurized boom sprayer equipped with two TeeJet 8002 nozzles. Silver nanoparticles were chemically synthesized in the lab. Both Nortica and AgNP were agitated by hand and applied at an equivalent of 2 gal

Figure 1. Galls formed in the bermudagrass

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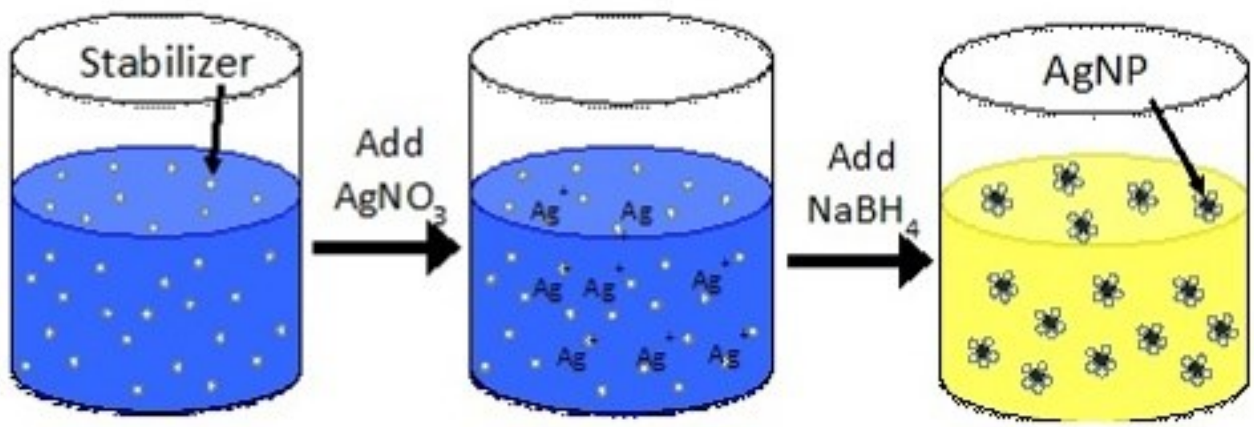
dilute nematicide spray per 1000 ft2. Immediately after treatment, additional water was applied until the soil was saturated.

Turf quality was measured monthly at a 1–9 scale: 6 = acceptable and 9 = best. To determine the change in nematode populations in turfgrass, composite soil and root samples were collected from each test plot using a standard 2.5 cm diameter soil probe. Soil cores (5 cores per plot) were collected and mixed to form a composite sample. Nematodes will be extracted from a 100 cm3 aliquots of each soil sample using the modified Baermann funnel system, identified to genus, and counted using an inverted compound microscope. In addition, turfgrass roots were examined for presence of abnormal gall formations (Figure 1). Five roots of length 1.5 inches were randomly selected and the number of root galls was recorded.

Turfgrass quality was not statistically different among treatments in August and September. Silver nanoparticles did not cause any phytotoxicity on turfgrass. However, turf quality of the non–treated control tended to decrease dramatically compared with AgNP and Nortica treatments in September (Figure 2A) after the hot summer. Neither AgNP nor Nortica treatment significantly decreased nematode population (Figure 2B) or root gall formation (Figure 2C) compared with the non–treated control in August and September. Natural populations of root–knot nematode were highly variable throughout the season. Juveniles of root –knot nematode were found at very low frequency during the summer (June and August) and their number in the soil started to increase in September.

Summary Points

- Continuous applications of silver nanoparticle beginning in the spring did not decrease nematode populations or root gall formation compared with the non–treated control in the summer.
- Continuous applications of silver nanoparticle for more than 6 months may be required to affect nematode populations and root gall formations, and to improve turfgrass quality.
- Silver nanoparticles did not cause any phytotoxicity on bermudagrass.
- Juveniles of root knot nematode were changed by month, and did not reach the high number to cause damage on turfgrass quality in 2013.



Synthesis of silver nanoparticles for controlling nematodes in golf course turfgrasses.

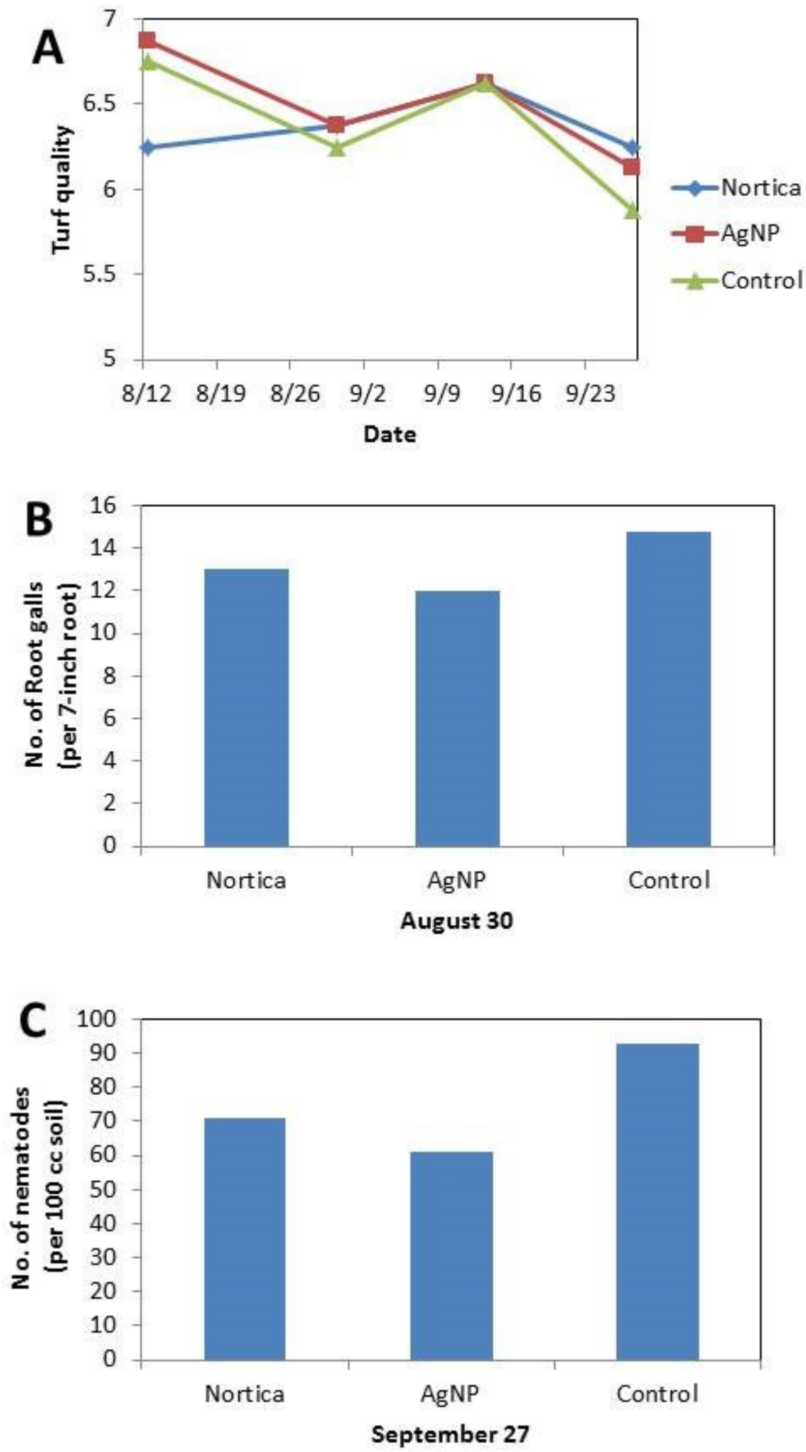


Figure 2. Nematicide efficacy on turf quality (A), nematode population (B), and gall formation (C) evaluated in the bermudagrass putting green at Texas A&M University in 2013.

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