MARK M. MAHADY & ASSOCIATES, INC.

Consultant To The Turfgrass Industry

Evaluation of Products and Programs for Suppression and Control of the Root Knot Nematode (*Meloidogyne sp.)* on a Creeping Bentgrass Putting Green

Final Report

Mark M. Mahady, President
Mark M. Mahady and Associates, Inc.

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Prepared By

Mark M. Mahady, M.S.
Certified Professional Agronomist
Mark M. Mahady & Associates, Inc.

P. O. Box 1290, Carmel Valley, CA 93924-1290
Phone (831) 274-2344: Cell (831) 236-2929: Fax (831) 274-6463: E-mail markmahady@aol.com

Executive Summary

In recent years an increasing number of reports have appeared in Northern and Southern California describing the detrimental effects of root knot nematodes *(Meloidogyne sp.)* on the surface quality of creeping bentgrass putting greens. Root knot nematodes are distributed world-wide and are some of the most common nematode pests of turfgrass. More than 80 species of root knot nematode have been described. Above ground symptoms of root knot nematode damage include chlorosis, wilting, and reduced growth. Symptoms are often found in a random patchy pattern. These become more apparent when the turf is stressed by high temperatures, lack of moisture, poor soil fertility, reduced root mass and very low mowing heights. Below ground symptoms include galled roots and a poor, declining, discolored root system.

The objective of this replicated field trial was to evaluate products and programs for suppression/control of root knot nematodes on a creeping bentgrass putting green when applied as properly timed, multiple treatments. On March 31, 2010, a replicated research trial was established on the Penn A4 creeping bentgrass putting green on the 13th hole of the Desert Course at The Vintage Club located in Indian Wells, California. Nematode sampling was conducted every eight weeks through the course of the trial from March to November of 2010. All samples were sent to Dr. Michael McClure at the University of Arizona for analysis of root knot nematodes and other soil nematodes.

Treatments included the following: 1) Fertilized Check #1, 2) Fertilized Check + Additions Program, 3) Grigg Brothers Program, 4) Ocean Organics Program, 5) Nema-Q (*Quillaja saponaria*) 2.5 GPA, 6) LCA0.3EC 20.8 oz/M, 7) AAA-1, April, May, June, July, 8) SciProTek Program, 9) BioFence 20 lb/M, April, May, September, November and 10) MultiGuard Protect 8 gal/A at 4 week intervals with 6 total applications.

Treatments were first deployed on April 14, 2010. The schedule consisted of treatments applied approximately every 14 days from April 14 to November 10, 2010 unless otherwise designated by the product manufacturer. Treatments were deployed with a calibrated CO_2 propelled spray system pressurized to 50 psi and equipped with 11010LP Tee-Jet nozzles to apply treatments at a spray volume of 3.0 gallons per thousand square feet (gal/1000 ft^2). Granular products were deployed with a shaker jar. Individual treatment plots measured 5’ x 10’ with two-foot aisleways. Treatments were replicated four times and randomized to balance root knot nematode pressure across all treatments.

Visual ratings for turf color (0-10 scale, 10 being darkest green), turf quality (0-10 scale, 10 being the highest quality possible) and severity of root knot induced turfgrass injury (0-1000 scale with 1000 being 100% dead turf) were conducted approximately every 14 days. Turf color was measured visually and with the Field Scout TCM 500 Meter and presented as NDVI (Normalized Difference Vegetative Index). A root knot nematode damage index was developed by multiplying the percentage of the plot injured (0-100%) by a 0-10 scale rating where zero represented no root knot damage and ten dead turf. Root depth (inches) and mass index were evaluated four times during the trial. Treatment #1, Fertilized Check #1, was used as the check plot for statistical comparison. Data were summarized and statistically analyzed. Differences between means were determined via LSD.

Nematode sampling results for total root knot nematode counts showed that the lowest root knot nematode counts were observed in March and the highest counts in August. The greatest decrease in root knot nematode counts was observed between the August and September sampling events.

The two top performing treatments for suppression of root knot nematode included Treatment #2, Fertilizer + Additions (Ocean Organics SeaPlant Extract Blend + Chipco Signature + trinexapac-ethyl) which Ranked #1 in performance with 33.9% control compared to Treatment #1, Fertilized Check #1, when comparing the total number of root knot nematodes counts from five sampling events from 3/31 to 11/22/10. Treatment #3, Grigg Brothers Program (P-K Plus + Kelplex) Ranked #2 in performance with 25.1% control compared to Fertilized Check #1, when comparing the total number of root knot nematodes counts from five sampling events from 3/31 to 11/22/10.

It is interesting to note that the two best performing treatments, Treatment #2 Fertilizer + Additions (Ocean Organics SeaPlant Extract Blend, + Chipco Signature + trinexapac-ethyl) showing 33.9% control and Treatment #3, Grigg Brothers Program (P-K Plus + Kelplex) showing 25.1% control, both contain phosphite. The Chipco Signature component in Treatment #2 provides 2.2 oz/1000 ft^2 of phosphite, while the P-K Plus component in Treatment #3 provides phosphite at the rate of 1.2 oz/1000 ft^2.

This observation is consistent with information presented in a research article presented in Phytopathology (April 2007, Volume 97, Number 4) and entitled, "Phosphite Inhibits Development of the Nematodes *Heterodera avenae* and *Meloidogyne marylandi* in Cereals": Oka, Tkachi and Mor. This research showed that the phosphite treatments did not prevent root knot nematode juveniles *(Meloidogyne marylandi)* from penetrating wheat roots or inducing giant cells. However, phosphite inhibited giant cell development: 14 days after inoculation, the giant cells in the phosphite-treated wheat were almost completely vacuolated, whereas those in untreated wheat contained dense cytoplasm.

During the first two sampling dates, Nema-Q showed good performance (41.7% and 33.1% reduction in root knot nematode counts, respectively), however, control levels dropped dramatically during the last two sampling dates. None of the remaining treatments exhibited acceptable levels of control.

None of the treatments showed dynamic suppression/control of ring and spiral nematodes. Those treatments that exhibited the greatest reduction in stubby root nematode counts included Treatment #6, LCA0.3EC 63.9% control compared to Treatment #1, Fertilized Check #1, Treatment #3, Grigg Brothers Program 29.8% control, Treatment #5, Nema-Q 27.9% control, Treatment #2, Fertilized Check + Additions 24.3% control and Treatment #4, Ocean Organics Program 20.2% control.

Turf quality across the entire surface of the creeping bentgrass plot was very good from spring (April 14) to early-summer (July 7). The most visually significant root knot nematode induced bentgrass injury was observed over a six-week period from August 30 to October 14 with subsequent recovery during cooler fall conditions. Those treatments that showed the greatest reduction in bentgrass injury from August 30 to November 22, 2010 when compared to Treatment #1, Fertilized Check #1 included Treatment #3, Grigg Brothers Program with 81.3% reduction in root knot nematode induced turfgrass injury, Treatment #4, Ocean Organics Program with 67.7% reduction in root knot nematode induced turfgrass injury, Treatment #5, Nema-Q with 43.8% reduction in root knot nematode induced turfgrass injury, and Treatment #2, Fertilized Check + Additions with 41.8% reduction in root knot nematode induced turfgrass injury.

Those treatments with the highest Total Turf Quality (TTQ) scores included: Treatment #5, Nema-Q ranked #1 with a TTQ score of 68.6, Treatment #4, Ocean Organics Program, ranked #2 with a TTQ score of 61.5, Treatment #2, Fertilized Check + Additions, ranked #3 with a TTQ score of 56.1, and Treatment #3, Grigg Brothers Program, ranked #4 with a TTQ score of 55.1.

Maximum root depth was observed in April with the greatest reduction in root depth occurring in October. Rooting depth increased between October and November, but not to levels observed in the previous spring. Treatment #1, Fertilized Check #1, lost 89.7% of rooting depth between April and October. All treatments showed similar trends of better root depth than Treatment #1, Fertilized Check #1 on August 18, October 27 and November 22.

Maximum root mass was observed in April with the greatest reduction in August and October. Root mass increased between October and November, but not to levels observed in the previous spring. Treatment #1, Fertilized Check #1, lost 73.1% of root mass between April and October. All treatments showed similar trends of better root mass than Treatment #1, Fertilized Check #1 on August 18, October 27 and November 22. Biofence, SciProTek and AAA-1 exhibited the highest root mass levels of all treatments on November 22, 2010.

While multiple applications of the best performing products evaluated in this trial did not exhibit dynamic nematode control levels (>75%), they did consistently show reduced root knot and stubby root nematode counts and reduced nematode induced bentgrass injury, while creating a positive growth environment to enhance speed of recovery and improve turfgrass quality. If these products are to be used in the scope of a root knot nematode control program, it is highly recommended that applications begin early in the season (March-April) when nematode populations are low and before the onset of summer heat stress. Continue the multiple application program through the summer months as nematode populations increase and into the fall to speed recuperative potential as conditions for turfgrass growth improve.

Although it is very encouraging to identify two treatments that reduce root knot nematode counts while reducing nematode induced injury and improving turf quality, it is essential that this important work be repeated in a year-two trial to verify the performance observed in year one, as well as continue to screen new active ingredients for suppression/control of root knot nematode.

Introduction

Plant parasitic nematodes are microscopic, worm-like animals that can greatly influence the playability and surface quality of putting greens. In recent years more reports have appeared in Northern and Southern California describing the detrimental effects of root knot nematodes *(Meloidogyne sp.)* on the surface quality of creeping bentgrass putting greens. Root knot nematodes are distributed world-wide and are some of the most common nematode pests of turfgrass. More than 80 species of root knot nematode have been described. Above ground symptoms of root knot nematode damage include chlorosis, wilting, and reduced growth. Symptoms are often found in a random patchy pattern. These become more apparent when the turf is stressed by high temperatures, lack of moisture, poor soil fertility, reduced root mass and very low mowing heights. Below ground symptoms include galled roots and a poor, declining, discolored root system.

To further complicate matters, root knot nematode feeding sites are ideal locations for entry of fungal plant pathogens and diseases. These organisms are often found in conjunction with high nematode populations. Fungi and bacteria which cause root rot, wilt, and other plant diseases often infect nematode-damaged roots earlier and more severely than uninjured roots. Some viruses can also be transmitted by nematodes.

The objective of this replicated field trial was to evaluate products and programs for suppression/control of root knot nematodes on a creeping bentgrass putting green when applied as properly timed, multiple treatments.

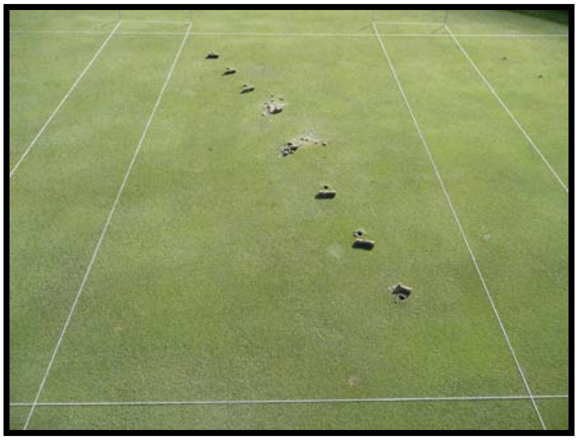
Materials & Methods

On March 31, 2010, a replicated research trial was established on the Penn A4 creeping bentgrass putting green on the 13th hole of the Desert Course at The Vintage Club located in Indian Wells, California. On this date all check and treatment plots were sampled for nematode activity and the turf/soil cores sent to Dr. Michael McClure at the University of Arizona for analysis. The nematode count data generated from this sampling were used to establish a balanced treatment randomization across the field plot. Eight ¾" diameter turf and soil profile core samples were collected to a depth of approximately four inches from each plot (Photographs 1 and 2). Each core sample consisted of grass, roots and soil. The eight core samples from each treatment plot were placed in a one-quart Ziplock bag. A total of 48 plot samples (12 treatments x 4 replications) were generated for each sampling date. Nematode sampling was conducted every eight weeks through the course of the trial from March to November of 2010. All samples were sent to Dr. Michael McClure at the University of Arizona for analysis of root knot nematodes and other soil nematodes.

Treatments as presented in Table 1 were first deployed on April 14, 2010. The schedule consisted of treatments applied approximately every 14 days from April 14 to November 10, 2010. Treatments were deployed with a calibrated CO_2 propelled spray system pressurized to 50 psi and equipped with 11010LP Tee-Jet nozzles to apply treatments at a spray volume of 3.0 gallons per thousand square feet (gal/1000 ft^2). Granular products were deployed with a shaker jar.

Treatment #4, #5, #6, #7, #8, #9 and #10 applications were followed by a 30 minute irrigation to move products into the root zone. The remaining treatments (#2, #3 and #4a component) were then applied for foliar absorption. A pacing watch was used for liquid applications to maintain proper walking speed and ensure accurate applications. Individual treatment plots measured 5' x 10' with two-foot aisleways (title page photograph). Treatments were replicated four times and randomized to balance root knot nematode pressure across all treatments.

Photographs 1 & 2. Sampling of a treatment plot on the 13th green at the Desert Course at The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.



Visual ratings for turf color (0-10 scale, 10 being darkest green), turf quality (0-10 scale, 10 being the highest quality possible) and severity of root knot induced turfgrass injury (0-1000 scale with 1000 being 100% dead turf) were conducted approximately every 14 days. Turf color was measured visually and with the Field Scout TCM 500 Meter presented as NDVI (Normalized Difference Vegetative Index). A root knot nematode damage index was developed by multiplying the percentage of the plot injured (0-100%) by a 0-10 scale rating where zero represented no root knot nematode damage and ten dead turf. Root depth (inches) and root mass index were evaluated four times during the trial. Treatment #1, Fertilized Check #1, was used as the check plot for statistical comparison. Two additional treatments, Treatment #11 (Fertilized Check #2) and Treatment #12 (Fertilized Check #3) were included to monitor changes in nematode populations in additional fertilized only plots. Data were summarized and statistically analyzed. Differences between means were determined via LSD.

Table 1. Treatment schedule. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

	Treatments	Rate	Company	Application Interval
1)	Fertilized Check #1[1]	*	*	Per Maintenance Program
2)	Fert Check + Additions[2]	Program	Ocean Organic, Bayer	2 Week Interval: 16 Appl. Total
3)	Grigg Brothers	Program	Grigg Bros.	2 Week Interval: 16 Appl. Total
4)	Ocean Organics	Program	Ocean Organics	2 Week Interval: 16 Appl. Total
5)	Nema-Q (*Quillaja saponaria*)	2.5 GPA	Mry AgRes	2 Week Interval: 16 Appl. Total
6)	LCA0.3EC (azadirachtin)	20.8 oz/M	*	2 Week Interval: 16 Appl. Total
7)	AAA-1	*	*	April, May, June, July
8)	Sci ProTek	Program	BiAgro	2 Week Interval: 16 Appl. Total
9)	BioFence	20 lb/M	Gies Organics	April, May, September, November
10)	MultiGuard Protect	8 gal/A	AgriGuard	4 Week Interval: 6 Appl. Total
11)	Fertilized Check #2[1]	*	*	Per Maintenance Program
12)	Fertilized Check #3[1]	*	*	Per Maintenance Program

[1] All treatments (1-12) received the same general N-P-K fertility program, as Treatment #1, Fertilized Check #1.
[2] Treatment #2 received the general fertility program plus additions such as seaweed extract, phosphite and T-Nex.

Treatments Described

- Treatment #1, Fertilized Check #1
  - Standard N, P, K program was applied by The Vintage Club maintenance staff to the entire green every 7 days (0.03 lb. of N per 1000 ft^2, 0.0033 lb. of P per 1000 ft^2, and 0.0075 lb. of K per 1000 ft^2)

- Treatment #2, Fertilized Check + Additions
  - Ocean Organics: SeaPlant Extract Blend — 2 oz/1000 ft^2 every 14 days
  - Chipco Signature (Bayer) — 4 oz/1000 ft^2 every 14 days
  - T-Nex (trinexapac-ethyl) — 0.1 oz/1000 ft^2 every 14 days

- Treatment #3, Grigg Brothers Program
  - P-K Plus (3-7-18) — 6 oz/1000 ft^2 every 14 days
  - Kelplex (1-2-2) — 4 oz/1000 ft^2 every 14 days

- Treatment #4, Ocean Organics Program
  - Pre Mix Plus — 5 oz/1000 ft^2 every 14 days
  - Nu Release — 0.4 oz/1000 ft^2 every 14 days
  - SeaBlend — 5 lb/1000 ft^2 every 28 days
  - The Ocean Organics program presented above was applied from 4/14/10 to 8/30/10. From 9/14/10 (application #12) to 11/10/10 (application #16) phosphite (2 oz/1000 ft^2) was added to the program described above.

- Treatment #5, Nema-Q: Monterey Ag Resources
  - Nema-Q (saponins of *Quillaja saponaria*) — 2.5 gal/every 14 days

- Treatment #6, PA
  - LCA0.3EC — 20.8 oz/1000 ft^2 every 14 days
  - LCA0.3EC was not received until 5/26/10. LCA0.3EC was applied at 26 oz/1000 ft^2 for applications #4, #5, #6, and #7, and then at 20.8 oz/1000 ft^2 for applications #8 through #16.

- Treatment #7, Confidential Entry
  - AAA-1 — April, May, June, July

- Treatment #8, SciProTek, BiAgro Program
  - Nematek — 5 oz/1000 ft^2 every 14 days
  - Nutrphite Ultra — 5 oz/1000 ft^2 every 14 days
  - Dispense — 18 oz/1000 ft^2 every 14 days

- Treatment #9, Gies Organic Products, Inc.
  - Biofence — 20 lb/1000 ft^2 on 4/14, 5/26, 9/14 and 11/9/10

- Treatment #10, Agriguard Company, LLC
  - Multiguard Protect — 8 gal/A (5% solution) on 4/14, 5/12, 6/7, 7/7, 8/3 and 8/30/10

- Treatment #11, Fertilized Check #2
  - Standard N, P, K program applied by The Vintage Club maintenance staff to the entire green every 7 days

- Treatment #12, Fertilized Check #3
  - Standard N, P, K program applied by The Vintage Club maintenance staff to the entire green every 7 days

Results and Discussion

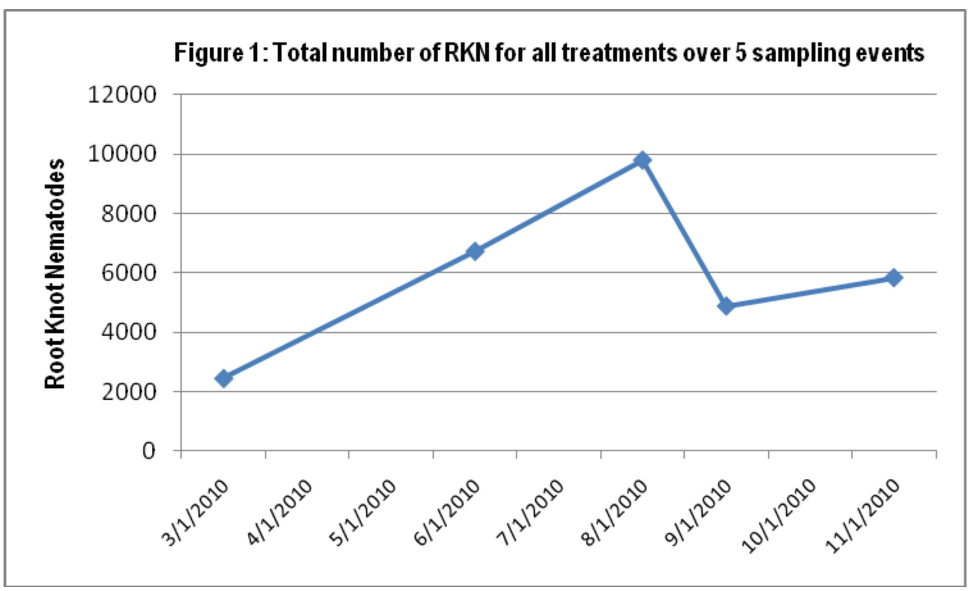
◆ ***Root Knot Nematode Counts (Figure 1)***

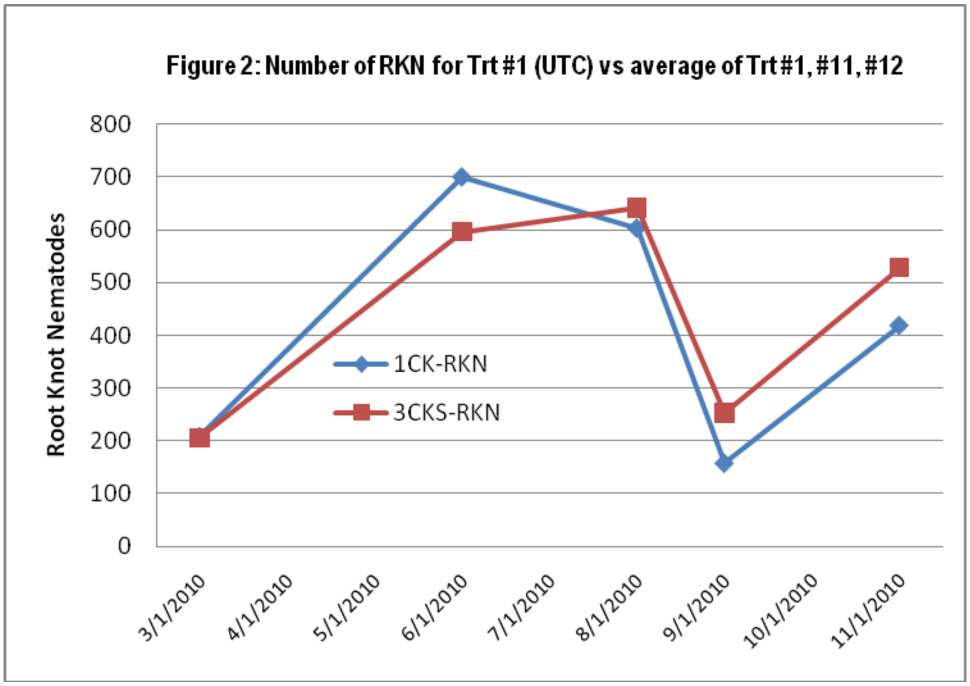
The specific species of root knot nematode infesting the putting greens at The Vintage Club has not yet been identified. However, Dr. McClure is conducting DNA sequencing on the samples received and is hoping to be able to properly identify the exact species this year.

Documenting root knot nematode population counts in untreated check plots during spring, summer and fall can help tremendously in better understanding normal changes in population trends and dynamics, and, in turn, greatly assist in the accurate interpretation of treatment effects. Figure 1 shows the combined total of root knot nematodes for all treatments over five sampling events conducted on March 31, June 7, August 4, September 29 and November 22, 2010. The lowest root knot nematode counts were observed in March and the highest counts in August. The greatest decrease in root knot nematode counts was observed between the August and September sampling events.

In this trial, Treatment #1 represents the fertilized check treatment used to generate statistical calculations. However, because of the population count variation that can very often exist in nematode trials, two additional treatments, Treatment #11 and Treatment #12, were also maintained as fertilized check plots. Treatments #11 and 12 were included in order to provide further root knot nematode count trend information and to ensure that nematode counts in Treatment #1 fell within realistic ranges.

Figure 2 shows a comparison of the root knot nematode counts for Treatment #1 and the combine root knot nematode counts of Treatments #1, #11 and #12. Population count trends are similar over the five sampling dates.





◆ ***Treatments Effects and Root Knot Nematode Counts (Table 2)***

Table 2 shows the results of root knot nematode sampling as conducted by Dr. Michael McClure and his staff at the University of Arizona.

Dr. McClure used a mist-extraction of 250 cubic centimeters (cc) of soil (or specific volumes indicated in his report) for 72 hours. Nematodes recovered were collected on a 500-mesh sieve and resuspended in 20 cc of water for observation and counting. One cc of the suspension was counted at magnifications of 60-80X. Nematode threshold levels are normally presented per 100 cc of suspension in agronomic discussions, so for this reason all of the submitted counts and data presented in this report have been multiplied by 100 to more easily correlate results.

Column A represents root knot nematode counts for the first nematode sampling event on March 31, 2010. The treatment randomization in this trial was established after the root knot nematode sampling data were generated on March 31, 2010 in order to balance root knot nematode counts across treatments. Potential treatment effects are more easily interpreted if all treatments across the plot exhibit approximately equal nematode counts prior to the first application.

Column B represents root knot nematode counts for the June 7, 2010 sampling event. Column C represents root knot nematode counts for the August 4, 2010 sampling event. Column D represents root knot nematode counts for the September 29, 2010 sampling event. Column E represents root knot nematode counts for the November 22, 2010 sampling event.

Column F represents total root knot nematode counts for all five sampling events from March 31 to November 22, 2010. Percent control (% Control) is presented in parentheses and is statistically calculated by comparing the total number of nematode counts over the five sampling events for individual treatments to that of Treatment #1, Fertilized Check #1.

Table 2. Treatment effects on root knot nematode counts. The Vintage Club, Indian Wells, CA. 2010.
Dr. Michael McClure, University of Arizona and Mark M. Mahady & Associates, Inc.

Treatments	Column A Root Knot Nematodes 1st Sample 3/31/10	Column B Root Knot Nematodes (% Control) [1] 6/7/10	Column C Root Knot Nematodes (% Control) 8/4/10	Column D Root Knot Nematodes (% Control) 9/29/10	Column E Root Knot Nematodes (% Control) 11/22/10	Column F Total Root Knot Nematodes (% Control) 3/31 to 11/22/10
1) Fertilized Check #1	208.0 a	700.5 a[6] (0.0%)	603.3 a (0.0%)	157.3 a (0.0%)	418.8 a (0.0%)	2087.9 (0.0%)
2) Fert Check + Additions	204.0 a	287.3 a **(59.0%)**[2]	320.0 a **(47.0%)**[3]	262.0 a (-66.6%)	307.8 a **(26.5%)**[4]	**1381.1** **(33.9%)**[5]
3) Grigg Bros.	202.0 a	367.3 a **(47.6%)**	485.0 a **(19.6%)**	322.0 a (-104.8%)	187.5 a **(55.2%)**	**1563.8** **(25.1%)**
4) Ocean Organics	202.0 a	387.8 a **(44.6%)**	1101.0 a (-82.5%)	427.0 a (-171.5%)	308.0 a **(26.4%)**	2425.8 (-16.2%)
5) Nema-Q (*Quillaja saponaria*)	200.0 a	408.5 a **(41.7%)**	403.8 a **(33.1%)**	504.3 a (-220.7%)	936.0 a (-123.5%)	2452.6 (-17.5%)
6) LCA0.3EC (azadirachtin)	208.0 a	376.5 a **(46.3%)**	975.0 a (-61.6%)	803.8 a (-411.1%)	423.3 a (-1.1%)	2786.6 (-33.5%)
7) AAA-1	192.0 a	652.8 a (6.8%)	1023.3 a (-69.6%)	528.5 a (-236.1%)	634.5 a (-51.5%)	3031.1 (-45.2%)
8) Sci ProTek	208.0 a	715.5 a (-2.1%)	959.8 a (-59.1%)	414.8 a (-163.8%)	680.8 a (-62.6%)	2978.9 (-42.7%)
9) BioFence	208.0 a	410.0 a **(41.5%)**	1570.0 a (-160.3%)	630.0 a (-300.6%)	356.8 a (14.8%)	3174.8 (-52.1%)
10) MultiGuard Protect	200.0 a	1320.0 a (-88.4%)	1019.0 a (-68.9%)	225.0 a (-43.1%)	411.5 a (1.7%)	3175.5 (-52.1%)
11) Fertilized Check #2	200.0 a	500.0 a (28.6%)	519.0 a (14.0%)	246.0 a (-56.4%)	503.5 a (-20.2%)	1968.5 (5.7%)
12) Fertilized Check #3	210.0 a	588.8 a (16.0%)	800.5 a (-32.7%)	357.0 a (-127.0%)	662.0 a (-58.1%)	2618.3 (-25.4%)
LSD (P=.05)	315.29	674.06	835.27	389.80	500.98	
Standard Deviation	218.36	466.83	578.47	269.96	346.96	
CV	107.30	88.43	70.98	66.42	71.41	

[1] Percent control as calculated versus Treatment #1, Fertilized Check #1.
[2] Green highlights in Column B present the highest levels of control among treatments on June 7, 2010.
[3] Red highlights in Column C present the highest levels of control among treatments on August 4, 2010.
[4] Purple highlights in Column E present the highest levels of control among treatments on November 22, 2010.
[5] Blue highlights in Column F denote those treatments with the highest level of overall control when comparing the total number of root knot nematodes collected over five sampling events to the number of root knot nematode counts of Fertilized Check #1.
[6] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

Although it is often difficult to correlate the influence of specific treatments on population counts of root knot nematodes, there would appear to be some statistically non-significant, but positive treatment trends. The top two performing treatments include the following:

1. **Treatment #2, Fertilized Check + Additions (Ocean Organics SeaPlant Extract Blend + Chipco Signature + trinexapac-ethyl) Ranked #1 in performance with 33.9% control** compared to Treatment #1, Fertilized Check #1, when comparing the total number of root knot nematodes counts from five sampling events from 3/31 to 11/22/10. Treatment #2 showed lower root knot nematode counts on 3 of 4 sampling dates when compared to Treatment #1, Fertilized Check #1.

2. **Treatment #3, Grigg Brothers Program (P-K Plus + Kelplex) Ranked #2 in performance with 25.1% control** compared to Fertilized Check #1, when comparing the total number of root knot nematodes counts from five sampling events from 3/31 to 11/22/10. Treatment #3 showed lower root knot nematode counts on 3 of 4 sampling dates when compared to Treatment #1, Fertilized Check #1.

If utilizing the average root knot nematode counts of all untreated treatments (Treatments #1, #11 and #12 combined) instead of **Treatment #1**, Fertilized Check #1 alone, the percent control increases slightly for the two top performing treatments with Treatment #2 Fertilizer + Additions (Ocean Organics Seaweed Extract, + Chipco Signature + trinexapac-ethyl) showing **37.9% control** and **Treatment #3**, Grigg Brothers Program (P-K Plus + Kelplex) showing **29.7% control.**

It is interesting to note that the two best performing treatments, Treatment #2, Fertilized Check + Additions (Ocean Organics SeaPlant Extract Blend + Chipco Signature + trinexapac-ethyl) showing 37.9% control and Treatment #3, Grigg Brothers Program (P-K Plus + Kelplex) showing 29.7% control, both contain phosphite. The Chipco Signature component in Treatment #2 provides 2.2 oz/1000 ft^2 of phosphite, while the P-K Plus component in Treatment #3 provides phosphite at the rate of 1.2 oz/1000 ft^2. In addition, Treatment #4, the Ocean Organics Program, added phosphite (2 oz/1000 ft^2) on September 14 and after five applications showed a 26.4% reduction in root knot nematode counts during the last nematode sampling event on November 22, 2010. Also, those three treatments with the highest level of root knot nematode control on November 22, 2010 all contained phosphite.

This observation is consistent with information presented in a research article in the scientific journal Phytopathology (April 2007, Volume 97, Number 4) and entitled, “Phosphite Inhibits Development of the Nematodes *Heterodera avenae* and *Meloidogyne marylandi* in Cereals”: Oka, Tkachi and Mor. This research showed that the phosphite treatments did not prevent root knot nematode juveniles *(Meloidogyne marylandi)* from penetrating wheat roots or inducing giant cells. However, phosphite inhibited giant cell development: 14 days after inoculation, the giant cells in the phosphite-treated wheat were almost completely vacuolated, whereas those in untreated wheat contained dense cytoplasm.

During the first two sampling dates, Nema-Q showed good performance (41.7% and 33.1% reduction in root knot nematode counts, respectively), however, control levels dropped dramatically during the last two sampling dates. None of the remaining treatments exhibited acceptable levels of control.

◆ ***Treatments Effects and Ring Nematode Counts (Table 3)***

Table 3 shows ring nematode (*Criconemella*) count data as generated by Dr. Michael McClure and his staff at the University of Arizona.

Ring nematode counts in Fertilized Check treatments exhibited variable population count trends since the first sampling event on March 31, 2010. Treatment #1, Fertilized Check #1, showed decreasing ring nematode counts, while Treatment #11, Fertilized Check #2 and Treatment #12, Fertilized Check #3, showed increases in ring nematode counts.

It is difficult to correlate the influence of specific treatments on population counts of ring nematodes, particularly when population count trends are variable in Fertilized Check treatments.

Column F in Table 3 presents the total number of ring nematodes collected per treatment over the five sampling dates. Data from the first sampling date (3/31/10) is presented to better define trends in ring nematode count dynamics from sampling date to sampling date. However, the data from the 3/31/10 sampling date is not included in the total counts for Column F because the 3/31/10 ring nematode count sampling data was highly variable. If this data is included it is not representative of true treatment effects on that date (3/31/10), and greatly increases the possibility of skewing treatment product performance perspectives. For this reason only data from the 6/7/10, 8/4/10, 9/29/10 and 11/22/10 sampling events are included in this Column F total so that the true influence of treatments on ring nematode populations could more easily be identified. This same format is used for spiral nematodes (Table 4) and stubby root nematode (Table 5).

None of the treatments exhibited a dynamic reduction in ring nematode counts. A contributing factor was the very low ring nematode counts recorded in Treatment #1, Fertilizer Check #1 during the five sampling dates. The two treatments that did show potential to reduce ring nematode counts during certain sampling events included Treatment #9 Biofence and Treatment #8 SciProTek. If utilizing the average root knot nematode counts of all untreated treatments (Treatments #1, #11 and #12 combined) instead of Treatment #1, Fertilized Check #1 alone, the percent control improves greatly for the two top performing treatments with **Treatment #9 Biofence increasing from -11.6% to 37.4% control, and Treatment #8 SciProTek increasing from -14.4% to 35.9% control** over the five sampling dates. None of the remaining treatments exhibited acceptable levels of control.

Table 3. Treatment effects on ring nematode counts. The Vintage Club, Indian Wells, CA. 2010.
Dr. Michael McClure, University of Arizona and Mark M. Mahady & Associates, Inc.

Treatments		Column A Ring Nematodes 1st Sample 3/31/10	Column B Ring Nematodes (% Control) [1] 6/7/10	Column C Ring Nematodes (% Control) 8/4/10	Column D Ring Nematodes (% Control) 9/29/10	Column E Ring Nematodes (% Control) 11/22/10	Column F Total Ring Nematodes (% Control) 6/7 to 11/22/10
1)	Fertilized Check #1	76.0 a[5]	131.5 a (0.0%)	36.8 a (0.0%)	10.0 a (0.0%)	52.5 a (0.0%)	230.8 (0.0%)
2)	Fert Check + Additions	90.0 a	129.5 a (1.5%)	127.5 a (-246.9%)	53.3 a (-432.5%)	42.5 a (19.0%)	352.8 (-52.9%)
3)	Grigg Bros.	158.0 a	271.8 a (-106.7%)	335.0 a (-811.6%)	72.0 a (-620.0%)	95.8 a (-82.4%)	774.6 (-235.6%)
4)	Ocean Organics	132.0 a	156.5 a (-19.0%)	195.8 a (-432.7%)	58.5 a (-485.0%)	66.0 a (-25.7%)	476.8 (-106.6%)
5)	Nema-Q (*Quillaja saponaria*)	50.0 a	102.3 a (22.2%)	135.0 a (-267.3%)	27.3 a (-172.5%)	41.5 a (21.0%)	306.1 (-32.6%)
6)	LCA0.3EC (azadirachtin)	80.0 a	100.8 a (23.4%)	125.0 a (-281.0%)	87.5 a (-775.0%)	52.8 a (-0.5%)	366.1 (-58.6%)
7)	AAA-1	132.0 a	124.3 a (5.5%)	140.0 a (-281.0%)	75.3 a (-652.5%)	68.8 a (-31.0%)	408.4 (-76.9%)
8)	Sci ProTek	56.0 a	55.8 a **(57.6%)**[2]	102.8 a (-179.6%)	70.0 a (-600.0%)	35.5 a **(32.4%)**[3]	264.1 **(-14.4%)**
9)	BioFence	98.0 a	85.0 a **(35.4%)**	100.0 a (-172.1%)	52.3 a (-422.5%)	20.5 a **(61.0%)**	257.8 **(-11.6%)**[4]
10)	MultiGuard Protect	56.0 a	289.0 a (-119.8%)	102.0 a (-177.6%)	47.0 a (-370.0%)	75.5 a (-43.8%)	513.5 (-122.5%)
11)	Fertilized Check #2	144.0 a	160.0 a (-21.7%)	236.0 a (-542.2%)	138.3 a (-1282.5%)	104.5 a (-99.0%)	638.8 (-176.8%)
12)	Fertilized Check #3	148.0 a	91.3 a (30.6%)	162.0 a (-340.8%)	72.3 a (-622.5%)	41.0 a (21.9%)	366.6 (-58.8%)
LSD (P=.05)			147.45	224.54	117.61	69.26	
Standard Deviation			102.12	155.51	81.45	47.97	
CV			100.45	109.93	128.02	82.62	

1 Percent control as calculated versus Treatment #1, Fertilized Check #1.
2 Green highlights in Column B present the highest levels of control among treatments on June 7, 2010.
3 Red highlights in Column E present the highest levels of control among treatments on November 22, 2010.
4 Blue highlights in Column F denote those treatments with the highest level of overall control when comparing the total number of ring nematodes collected during five sampling events to the number of ring nematode counts of Fertilized Check #1.
5 Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

◆ ***Treatments Effects and Spiral Nematode Counts (Table 4)***

Table 4 shows spiral nematode (*Helicotylenchus*) count data. Treatments exhibited minimal impact on spiral nematode counts. Column F in Table 4 presents the total number of spiral nematodes collected per treatment on the five sampling dates. Data from the first sampling date (3/31/10) was not included in this total so that the true influence of treatments on spiral nematode populations could more easily be determined.

None of the treatments exhibited a dynamic reduction in spiral nematode counts. A contributing factor was the low spiral nematode counts recorded in Treatment #1, Fertilized Check #1 during the five sampling dates. The two treatments that did show potential to reduce ring nematode counts during certain sampling events included Treatment #7 AAA-1 and Treatment #6 LCA0.3EC. If utilizing the average root knot nematode counts of all untreated treatments (Treatments #1, #11 and #12 combined) instead of Treatment #1, Fertilized Check #1 alone, the percent control improves greatly for the two top performing treatments with **Treatment #7 AAA-1 increasing from -3.6% to 18.0% control, and Treatment #6 LCA0.3EC increasing from -3.9% to 17.8% control** over the five sampling dates.

Table 4. Treatment effects on spiral nematode counts. The Vintage Club, Indian Wells, CA. 2010.
Dr. Michael McClure, University of Arizona and Mark M. Mahady & Associates, Inc.

Treatments	Column A Spiral Nematodes 1st Sample 3/31/10	Column B Spiral Nematodes (% Control) [1] 6/7/10	Column C Spiral Nematodes (% Control) 8/4/10	Column D Spiral Nematodes (% Control) 9/29/10	Column E Spiral Nematodes (% Control) 11/22/10	Column F Total Spiral Nematodes (% Control) 6/7 to 11/22/10
1) Fertilized Check #1	908.0 a[5]	830.5 a (0.0%)	874.3 a (0.0%)	472.3 a (0.0%)	687.8 a (0.0%)	2864.9 (0.0%)
2) Fert Check + Additions	1272.0 a	1094.3 a (-31.8%)	1250.0 a (-43.0%)	624.8 a (-32.3%)	962.5 a (-39.9%)	3831.6 (-33.7%)
3) Grigg Bros.	1018.0 a	1088.8 a (-31.1%)	1580.0 a (-80.7%)	976.8 a (-106.8%)	882.3 a (-28.3%)	4527.9 (-58.0%)
4) Ocean Organics	920.0 a	1601.0 a (-92.8%)	1398.5 a (-60.0%)	1204.0 a (-154.9%)	1146.0 a (-66.6%)	5349.5 (-86.7%)
5) Nema-Q (*Quillaja saponaria*)	1224.0 a	1070.8 a (-28.9%)	1873.0 a (-114.2%)	836.0 a (-77.0%)	1006.0 a (-46.3%)	4785.8 (-67.0%)
6) LCA0.3EC (azadirachtin)	800.0 a	686.5 a **(17.3%)**[2]	710.0 a **(18.8%)**[3]	777.3 a (-64.6%)	803.8 a (-16.9%)	2977.6 **(-3.9%)**[4]
7) AAA-1	1024.0 a	701.0 a **(15.6%)**	946.5 a (-8.3%)	513.3 a (-8.7%)	807.0 a (-17.3%)	2967.8 **(-3.6%)**
8) Sci ProTek	1024.0 a	1893.0 a (-127.9%)	1819.8 a (-108.1%)	1050.0 a (-122.3%)	792.8 a (-15.3%)	5655.6 (-97.4%)
9) BioFence	1216.0 a	1360.0 a (-63.8%)	990.0 a (-13.2%)	764.3 a (-61.8%)	554.5 a (19.4%)	3668.8 (-28.1%)
10) MultiGuard Protect	1552.0 a	1470.0 a (-77.0%)	1000.0 a (-14.4%)	634.0 a (-34.3%)	887.0 a (-29.0%)	3991.0 (-39.3%)
11) Fertilized Check #2	1139.0 a	996.0 a (-19.9%)	1434.0 a (-64.0%)	892.3 a (-88.9%)	1170.0 a (-70.1%)	4492.3 (-56.8%)
12) Fertilized Check #3	1016.0 a	934.3 a (-12.5%)	1105.5 a (-26.5%)	689.3 a (-46.0%)	777.0 a (-13.0%)	3506.1 (-22.4%)
LSD (P=.05)	723.01	873.18	685.92	595.11	698.73	
Standard Deviation	500.73	604.73	475.04	412.15	483.92	
CV	45.82	52.87	38.05	52.43	55.43	

[1] Percent control as calculated versus Treatment #1, Fertilized Check #1.
[2] Green highlights in Column B present the highest levels of control among treatments on June 7, 2010.
[3] Red highlights in Column C present the highest levels of control among treatments on August 4, 2010.
[4] Blue highlights in Column F denote those treatments with the highest level of overall control when comparing the total number of spiral nematodes collected during five sampling events to the number of spiral nematode counts of Fertilized Check #1.
[5] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

◆ *Treatments Effects and Stubby Root Nematode Counts (Table 5)*

Table 5 shows the results of sampling for stubby root nematodes (*Trichodorus*) over five sampling dates. All three Fertilized Check treatments, Treatment #1, Fertilized Check #1, Treatment #11, Fertilized Check #2 and, Treatment #12, Fertilized Check #3, showed very similar stubby root nematode count trends and totals over the five sampling dates.

Table 5. Treatment effects on stubby root nematode counts. The Vintage Club, Indian Wells, CA. 2010. Dr. Michael McClure, University of Arizona and Mark M. Mahady & Associates, Inc.

Treatments	Column A Stubby Nematodes 1st Sample 3/31/10	Column B Stubby Nematodes (% Control)[1] 6/7/10	Column C Stubby Nematodes (% Control) 8/4/10	Column D Stubby Nematodes (% Control) 9/29/10	Column E Stubby Nematodes (% Control) 11/22/10	Column F Total Stubby Nematodes (% Control) 6/7 to 11/22/10
1) Fertilized Check #1	16.0 a[7]	39.0 a (0.0%)	22.8 a (0.0%)	14.3 a (0.0%)	40.8 a (0.0%)	116.9 (0.0%)
2) Fert Check + Additions	136.0 a	28.3 a **(27.6%)**[2]	25.0 a (-9.9%)	8.8 a (38.6%)	26.3 a (35.6%)	88.4 **(24.3%)**[6]
3) Grigg Bros.	120.0 a	34.8 a **(10.9%)**	32.5 a (-42.9%)	4.0 a (71.9%)	10.8 a (73.6%)	82.1 **(29.8%)**
4) Ocean Organics	60.0 a	66.3 a (-69.9%)	12.0 a **(47.3%)**[3]	5.0 a (64.9%)	10.0 a (75.5%)[5]	93.3 **(20.2%)**
5) Nema Q (*Quillaja saponaria*)	96.0 a	41.8 a (-7.1%)	18.0 a **(20.9%)**	2.5 a **(82.5%)**	22.0 a (46.0%)	84.3 **(27.9%)**
6) LCA0.3EC (azadirachtin)	80.0 a	18.3 a **(53.2%)**	10.0 a **(56.0%)**	0.0 a **(100.0%)**[4]	14.0 a (65.6%)	42.4 **(63.9%)**
7) AAA-1	64.0 a	74.5 a (-91.0%)	9.8 a **(57.1%)**	24.0 a (-68.4%)	45.8 a (-12.3%)	154.1 (-31.8%)
8) Sci ProTek	48.0 a	68.3 a (-75.0%)	16.3 a **(28.6%)**	2.0 a **(86.0%)**	14.8 a (63.8%)	101.4 (13.3%)
9) BioFence	120.0 a	115.0 a (-194.9%)	45.0 a (-97.8%)	6.5 a (54.4%)	27.8 a (31.9%)	194.3 (-66.2%)
10) MultiGuard Protect	84.0 a	42.0 a (-7.7%)	30.0 a (-31.9%)	4.0 a (71.9%)	39.8 a (2.5%)	115.8 (1.0%)
11) Fertilized Check #2	64.0 a	68.0 a (-74.4%)	20.5 a (9.9%)	32.5 a (-128.1%)	21.3 a (47.9%)	142.3 (-21.7%)
12) Fertilized Check #3	372.0 a	43.8 a (-12.2%)	28.0 a (-23.1%)	9.0 a (36.8%)	14.8 a (63.8%)	95.6 (18.2%)
LSD (P=.05)	222.05	58.48	36.08	22.55	34.27	
Standard Deviation	153.79	40.50	24.99	15.62	23.73	
CV	146.46	75.97	111.16	166.6	98.98	

1 Percent control as calculated versus Treatment #1, Fertilized Check #1.
2 Green highlights in Column B present the highest levels of control among treatments on June 7, 2010.
3 Red highlights in Column C present the highest levels of control among treatments on August 4, 2010.
4 Purple highlights in Column D present the highest levels of control among treatments on September 29, 2010.
5 Orange highlights in Column D present the highest levels of control among treatments on November 22, 2010.
6 Blue highlights in Column F denote those treatments with the highest level of overall control when comparing the total number of stubby root nematodes collected during five sampling events to the number of stubby root nematode counts of Fertilized Check #1.
7 Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

Column F in Table 5 presents the total number of stubby root nematodes collected per treatment during the five sampling dates. Data from the first sampling date (3/31/10) was not included in this total so that the true influence of treatments on stubby root populations could more easily be identified.

Those treatments that exhibited the greatest reduction in stubby root nematode counts when comparing the total number of stubby root nematodes collected during five sampling events to the number of stubby root nematode counts of Fertilized Check #1 include the following:

1. **Treatment #6, LCA0.3EC: showed 63.9% control** compared to Treatment #1, Fertilized Check #1.

2. **Treatment #3, Grigg Brothers Program: showed 29.8% control**.

3. **Treatment #5, Nema-Q: showed 27.9% control.**

4. **Treatment #2, Fertilized Check + Additions: showed 24.3% control**.

5. **Treatment #4, Ocean Organics Program: showed 20.2% control**.

◆ ***Treatment Effects and Root Knot Nematode Induced Turfgrass Injury (Table 6)***

Historically it has been very difficult to correlate nematode populations and corresponding turfgrass injury. This effect was also observed in this replicated trial.

Photograph 3. The root knot nematode field plot located on #13 green of the Desert Course at The Vintage Club on July 7, 2010. Mark M. Mahady & Associates, Inc.

Turf quality across the entire surface of the creeping bentgrass plot was very good from spring (April 14) to early-summer (July 7). During the summer no blanket applications of insecticide were applied to the test green in order to avoid any potential influence on root knot nematode activity. During mid-July sod webworm activity began to influence surface quality across the entire plot so a Telstar treatment was applied to control the sod webworm. Telstar is a pyrethroid and binds to the soil quickly and tightly. Control was highly effective.

Table 6. **Time Frame: August 30 to November 22, 2010**. Treatment effects on root knot nematode induced injury to creeping bentgrass. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Bent Injury[1] (%Contl) 8/30 DOA11[2]	Bent Injury (%Contl) 9/14 DOA12[3]	Bent Injury (%Contl) 9/29 DOA13	Bent Injury (%Contl) 10/14 DOA14	Bent Injury (%Contl) 10/27 DOA15	Bent Injury (%Contl) 11/9 DOA16	Bent Injury (%Contl) 11/22/10 13DAA16	Total Bentgrass Injury (%Control) 8/30-11/22/10
1) Fert CK #1	*	238.8 a[4] (0.0%)	58.00 a (0.0%)	18.8 a (0.0%)	30.0 ab (0.0%)	11.3 a (0.0%)	3.750 a (0.0%)	0.0 a	360.7 (0.0%)
2) Fert CK+Additions	Program	167.0 a **(30.1%)**	17.00 a **(70.7%)**	9.5 a (49.3%)	16.3 ab (45.8%)	0.0 b (100.0%)	0.000 a (100.0%)	0.0 a	209.8 **(41.8%)**
3) Grigg Bros.	Program	33.3 a **(86.1%)**	15.75 a **(72.8%)**	9.5 a (49.3%)	7.5 ab (75.0%)	0.5 b (95.6%)	0.938 a (75.0%)	0.0 a	67.5 **(81.3%)**
4) Ocean Organics	Program	90.3 a **(62.2%)**	18.25 a **(68.5%)**	5.3 a (72.0%)	2.3 b (92.5%)	0.0 b (100.0%)	0.188 a (95.0%)	0.0 a	116.3 **(67.7%)**
5) Nema-Q	2.5 gal/A	168.0 a **(29.6%)**	25.75 a **(55.6%)**	5.5 a (70.7%)	3.0 b (90.0%)	0.5 b (95.6%)	0.000 a (100.0%)	0.0 a	202.8 **(43.8%)**
6) LCA0.3EC	20.8 oz/M	223.8 a (6.3%)	18.63 a **(67.9%)**	7.5 a (60.0%)	38.3 a (-27.5%)	3.5 b (68.9%)	2.000 a (46.7%)	0.0 a	293.7 (18.6%)
7) AAA-1	Program	182.5 a (23.6%)	37.50 a (35.3%)	13.0 a (30.7%)	19.3 ab (35.8%)	1.3 b (88.9%)	0.500 a (86.7%)	0.0 a	254.1 (29.5%)
8) SciProTek	Program	229.0 a (4.1%)	55.25 a (4.7%)	17.0 a (9.3%)	6.8 ab (77.5%)	2.3 b (80.0%)	0.625 a (83.3%)	0.0 a	311.0 (13.8%)
9) BioFence	20 lb/M	188.8 a (20.9%)	30.25 a (47.8%)	12.5 a (33.3%)	28.3 ab (5.8%)	3.0 b (73.3%)	0.000 a (100.0%)	0.0 a	262.9 (27.1%)
10) MultGd Protect	8 gal/A	193.8 a (18.8%)	33.50 a (42.2%)	4.5 a (76.0%)	11.5 ab (61.7%)	0.0 b (100.0%)	0.125 a (96.7%)	0.0 a	243.4 (32.5%)
11) Fert CK #2	*	235.0 a (1.6%)	38.75 a (33.2%)	7.3 a (61.3%)	3.0 b (90.0%)	0.3 b (97.8%)	0.000 a (100.0%)	0.0 a	284.4 (21.2%)
12) Fert CK #3	*	201.5 a (15.6%)	28.25 a (51.3%)	14.0 a (25.3%)	21.0 ab (30.0%)	5.0 b (55.6%)	2.250 a (40.0%)	0.0 a	272.0 (24.6%)
LSD (P=0.05)		147.63	39.534	15.09	20.45	5.55	2.6803	0.0	

[1] Bentgrass injury rated on a 0-1000 scale by multiplying the percentage of the plot injured (0-100%) times a 0-10 scale rating where 0 represents no damage and 10 dead turf.
[2] DOA11: Day of application eleven.
[3] DOA12: Day of application twelve.
[4] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

The most visually significant root knot nematode induced bentgrass injury was observed over a six-week period from August 30 to October 14 (Table 6) with subsequent recovery during cooler fall conditions. Those treatments that showed the greatest reduction in bentgrass injury from August 30 to November 22, 2010 when compared to Treatment #1, Fertilized Check #1 included the following:

1. **Treatment #3, Grigg Brothers Program: showed 81.3% reduction in root knot nematode induced turfgrass injury compared to Treatment #1, Fertilized Check #1.**

2. **Treatment #4, Ocean Organics Program: showed 67.7% reduction in root knot nematode induced turfgrass injury.**

3. **Treatment #5, Nema Q: showed 43.8% reduction in root knot nematode induced turfgrass injury.**

4. **Treatment #2, Fertilized Check + Additions: showed 41.8% reduction in root knot nematode induced turfgrass injury.**

◆ ***Treatment Effects and Turfgrass Quality (Table 7)***

As previously mentioned, many turfgrass researchers, agronomists and nematologists have found it very difficult to correlate nematode population levels with corresponding levels of turfgrass quality.

Turfgrass quality ratings for all treatments and evaluation dates are presented in Tables 7 and 8.

Table 7. **Time Frame: April 14 to August 4, 2010**. Treatment effects on creeping bentgrass quality. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Bent Quality[1] 4/14 DOA1[2]	Bent Quality 4/23 DOA2[3]	Bent Quality 5/11 DOA3	Bent Quality 5/26 DOA4	Bent Quality 6/7 DOA5	Bent Quality 6/23 DOA6	Bent Quality 7/7 DOA7	Bent Quality 7/21 DOA8	Bent Quality 8/4/10 DOA9
1) Fert CK #1	*	9.0 a[4]	9.0 a	9.0 a	9.0 a	7.0 a	7.0 a	8.0 a	3.8 a	3.0 a
2) Fert CK+Additions	Program	9.0 a	9.0 a	9.0 a	9.0 a	8.3 a	7.8 a	8.0 a	3.0 a	2.8 a
3) Grigg Bros.	Program	9.0 a	9.0 a	9.0 a	9.0 a	8.0 a	8.0 a	8.0 a	3.3 a	3.0 a
4) Ocean Organics	Program	9.0 a	8.8 a	9.0 a	9.0 a	7.8 a	7.5 a	7.8 a	3.0 a	3.0 a
5) Nema-Q	2.5 gal/A	9.0 a	9.0 a	9.0 a	9.0 a	8.0 a	7.8 a	8.0 a	3.5 a	2.8 a
6) LCA0.3EC	20.8 oz/M	9.0 a	9.0 a	9.0 a	9.0 a	7.5 a	7.5 a	7.8 a	4.5 a	4.0 a
7) AAA-1	Program	9.0 a	9.0 a	9.0 a	9.0 a	8.0 a	7.3 a	8.0 a	3.3 a	2.5 a
8)SciProTek	Program	9.0 a	9.0 a	9.0 a	9.0 a	7.8 a	7.8 a	8.0 a	2.8 a	2.8 a
9) BioFence	20 lb/M	9.0 a	9.0 a	9.0 a	9.0 a	8.0 a	8.0 a	7.5 a	3.3 a	3.5 a
10) MultGd Protect	8 gal/A	9.0 a	9.0 a	9.0 a	9.0 a	8.0 a	7.5 a	8.0 a	3.5 a	3.3 a
11) Fert CK #2	*	9.0 a	9.0 a	9.0 a	9.0 a	8.0 a	7.5 a	8.0 a	3.0 a	2.5 a
12) Fert CK #3	*	9.0 a	9.0 a	9.0 a	9.0 a	7.8 a	7.8 a	8.0 a	3.0 a	2.5 a
LSD (P=0.05)		0.0	0.21	0.0	0.0	0.83	0.98	0.50	1.01	0.94

[1] Bentgrass quality: rated on a 0-10 scale with zero representing no quality, 6 minimally acceptable quality and 10 the best turf possible.
[2] DOA1: Day of application one.
[3] DOA2: Day of application two.
[4] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

As described in the previous section on bentgrass injury, turf quality across the entire surface of the creeping bentgrass plot was very good from spring to early-summer. Sod webworm activity reduced quality during July, and then injury due to root nematodes appeared in mid-August.

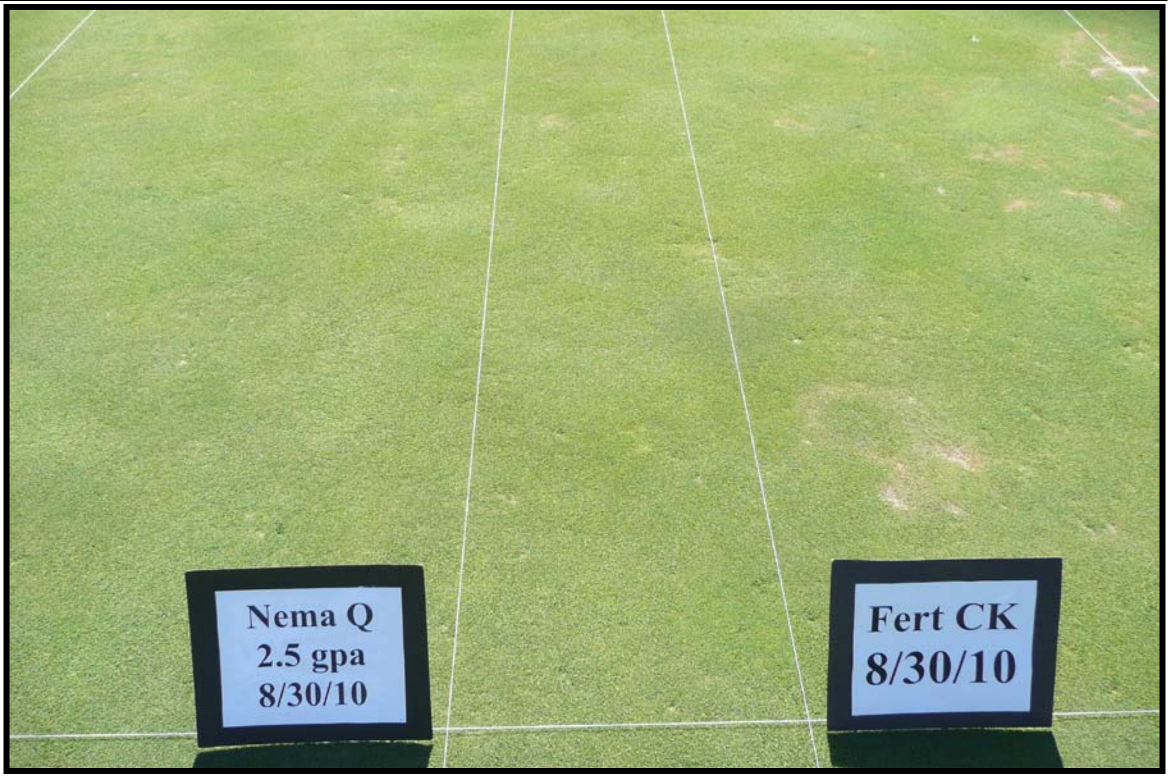
Photograph 4. The root knot nematode field plot located on #13 green of the Desert Course at The Vintage Club on August 30, 2010. Note turfgrass injury. Mark M. Mahady & Associates, Inc.

Photograph 5. Treatment #4, Ocean Organics Program (left) versus Treatment #6, LCA0.3EC (right) on August 30, 2010. Note turfgrass injury in LCA0.3EC plot. Mark M. Mahady & Associates, Inc.

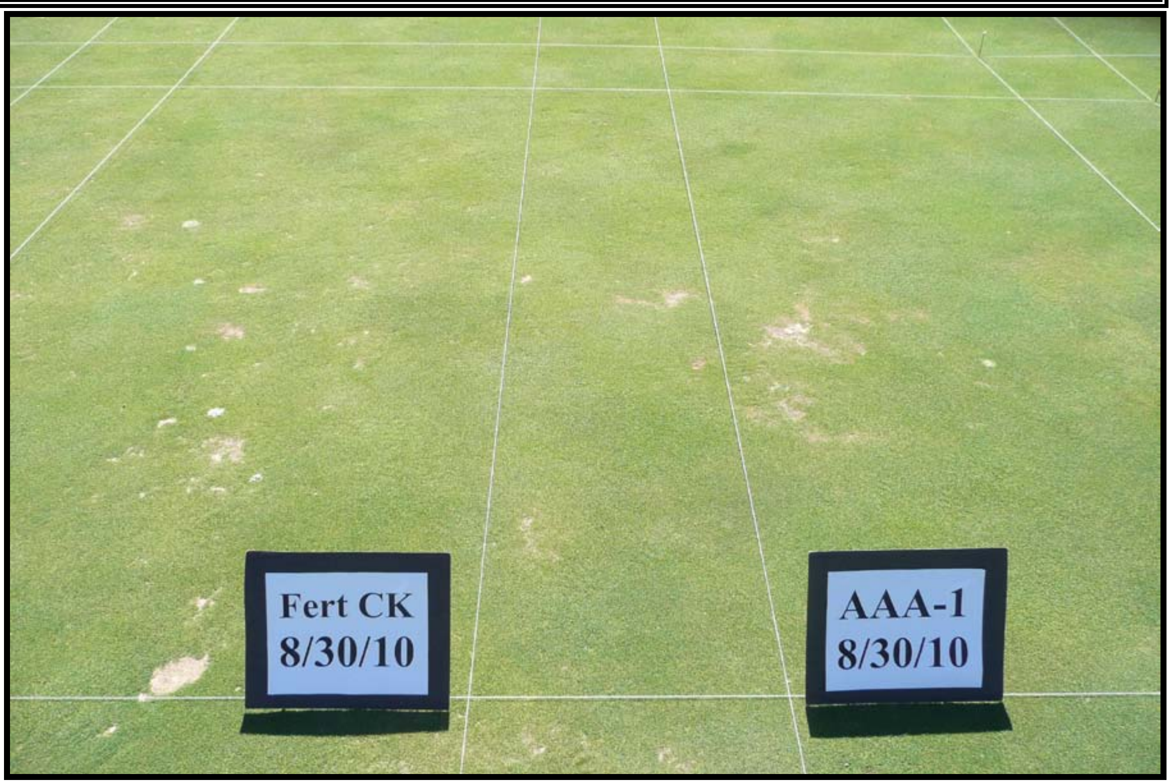
Photograph 6. Treatment #2, Fertilized Check + Additions (left) versus Treatment #10, MultiGuard Protect (right) on August 30, 2010. Note turfgrass injury in MultiGuard Protect plot. Mark M. Mahady & Associates, Inc.

Photograph 7. Treatment #4, Ocean Organics Program (left) versus Treatment #3, Grigg Brothers Program (right) on August 30, 2010. Mark M. Mahady & Associates, Inc.

Photograph 8. Treatment #5, Nema-Q (left) versus Treatment #1, Fertilized Check #1 (right) on August 30, 2010. Note turfgrass injury in Fertilized Check #1 plot. Mark M. Mahady & Associates, Inc.



Photograph 9. Treatment #1, Fertilized Check #1 (left) versus Treatment #7, AAA-1 (right) on August 30, 2010. Note turf injury in both treatment plots. Mark M. Mahady & Associates, Inc.



Photograph 10. Treatment #8, SciProTek Program (left) versus Treatment #5, Nema-Q (right) on August 30, 2010. Note extensive turfgrass injury in SciProTek plot. Mark M. Mahady & Associates, Inc.

Table 8. **Time Frame: August 17 to November 22, 2010**. Treatment effects on creeping bentgrass quality. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Bent Quality 8/17 DOA10[2]	Bent Quality[1] 8/30 DOA11	Bent Quality 9/14 DOA12	Bent Quality 9/29 DOA13	Bent Quality 10/14 DOA14	Bent Quality 10/27 DOA15	Bent Quality 11/9 DOA16	Bent Quality 11/22/10 13DAA16
1) Fert CK #1	*	3.0 a[3]	3.8 a	5.0 a	6.0 a	4.5 b	5.5 a	7.8 a	8.8 a
2) Fert CK+Additions	Program	3.0 a	4.3 a	5.3 a	6.0 a	5.3 ab	8.0 a	9.0 a	9.0 a
3) Grigg Bros.	Program	3.5 a	5.5 a	5.3 a	6.0 a	5.5 ab	7.8 a	8.3 a	9.0 a
4) Ocean Organics	Program	3.5 a	4.5 a	5.5 a	6.3 a	6.3 ab	8.0 a	8.8 a	9.0 a
5) Nema-Q	2.5 gal/A	3.3 a	3.8 a	6.0 a	6.5 a	6.8 a	7.5 a	9.0 a	9.0 a
6) LCA0.3EC	20.8 oz/M	4.0 a	3.5 a	6.0 a	5.8 a	4.5 b	7.3 a	8.5 a	9.0 a
7) AAA-1	Program	2.8 a	3.3 a	4.8 a	5.8 a	5.3 ab	7.8 a	8.8 a	9.0 a
8)SciProTek	Program	3.3 a	3.5 a	4.3 a	5.0 a	5.3 ab	7.3 a	8.5 a	9.0 a
9) BioFence	20 lb/M	3.5 a	3.5 a	5.0 a	4.8 a	4.8 ab	7.0 a	9.0 a	9.0 a
10) MultGd Protect	8 gal/A	3.0 a	3.5 a	5.5 a	6.5 a	5.8 ab	8.0 a	8.8 a	9.0 a
11) Fert CK #2	*	2.5 a	3.5 a	5.0 a	6.0 a	6.8 a	7.8 a	8.8 a	9.0 a
12) Fert CK #3	*	3.0 a	3.5 a	5.8 a	5.8 a	4.8 ab	7.3 a	7.5 a	8.8 a
LSD (P=0.05)		1.28	1.67	1.94	1.69	1.27	1.42	1.05	0.28

[1] Bentgrass quality: rated on a 0-10 scale with zero representing no quality, 6 minimally acceptable quality and 10 the best turf possible.
[2] DOA10: Day of application ten.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

Table 9 shows a Total Turf Quality Summary for all treatments for the trial period from June 7 to November 22, 2010. There were 13 turf quality rating events over this five-month period.

Column A presents the average turf quality per treatment generated over 13 rating events at approximately two week intervals from June 7 to November 22, 2010. While the average quality rating over time can provide a general indicator of performance, an average rating concept can often times be a false indicator of performance depending on the high and low quality extremes observed.

Column D represents "Total Turf Quality". Total Turf Quality represents acceptable quality over time. Total Turf Quality is determined by multiplying Column B, the number of rating events when the average quality score was equal to or greater than 6, by Column C, the average for all those events in which turf quality was equal to or greater than 6.

Treatment #5, Nema-Q exhibited a Total Turf Quality score of 68.6 and ranked #1 of all treatments. Treatment #4, Ocean Organics Program, showed a Total Turf Quality Score of 61.5 and ranked #2. Treatment #2, Fertilized Check + Additions, exhibited a Total Turf Quality score of 56.1 and ranked #3, and Treatment #3, Grigg Brothers Program, showed a Total Turf Quality score of 55.1 and ranked #4.

Table 9. **Total Turf Quality Summary.** **Time Frame: June 3, 2009 to December 15, 2009**. The influence of treatment on *Poa annua* quality. The Links at Spanish Bay. Pebble Beach, CA. 2009. Mahady & Assoc., Inc.

Treatments	Rate	A Average of 13 Quality Ratings 6/7/10 to 11/22/10	B Number of Quality Ratings ≥ 6 (13 Ratings Possible)		C Average of Ratings ≥ 6		D Total Turf Quality	E Total Turf Quality Ranking (1-4)
5) Nema-Q	2.5 gal/A	6.38	9	x	7.62	=	68.6	1
4)Ocean Organics	Program	6.23	8	x	7.69	=	61.5	2
2) Fert CK + Additions	Program	6.14	7	x	8.01	=	56.1	3
3) Grigg Bros.	Program	6.25	7	x	7.87	=	55.1	4

◆ ***Treatment Effects and Turfgrass Color (Tables 10-13)***

Visual color ratings for all treatments and evaluation dates are presented in Tables 10 and 11. NDIV (Normalized Difference Vegetative Index) readings as generated by the Spectrum Technologies Field Scout 500 Meter are presented in Tables 12 and 13.

Color is just one component of overall turfgrass quality. Subtle differences in bentgrass color were observed among treatments over the 17 rating dates. Visual ratings correlated well with meter generated NDVI readings.

While the Spectrum Technologies Field Scout 500 Meter is a quality unit and provides very accurate readings, proper use in field plots showing great variation in turf quality can present a challenge. In many of the treatment plots there were patches of healthy green grass adjacent to patches of brown turf injured from nematode activity. Because conditions across the plot were not uniform in nature, the placement of the meter and the condition of the turf in the placement area greatly influenced the NDVI reading. A system was devised in which the meter was placed at three points measuring 1.5 feet, 5 feet and 8.5 feet from the end of each 5' x 10' treatment plot, and the average of these three ratings entered as the reading for that plot.

Table 10. **Time Frame: April 14 to August 4, 2010**. Treatment effects on creeping bentgrass color. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Bent Color[1] 4/14 DOA1[2]	Bent Color 4/23 DOA2	Bent Color 5/11 DOA3	Bent Color 5/26 DOA4	Bent Color 6/7 DOA5	Bent Color 6/23 DOA6	Bent Color 7/7 DOA7	Bent Color 7/21 DOA8	Bent Color 8/4/10 DOA9
1) Fert CK #1	*	7.0 a[3]	7.0 a	6.0 a	6.0 a	5.8 a	6.3 a	6.0 a	4.8 a	5.0 a
2) Fert CK+Additions	Program	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	7.0 a	6.3 a	5.5 a	5.0 a
3) Grigg Bros.	Program	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	7.0 a	6.0 a	5.3 a	5.0 a
4) Ocean Organics	Program	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	7.0 a	6.0 a	5.0 a	5.0 a
5) Nema-Q	2.5 gal/A	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	6.8 a	6.0 a	5.0 a	5.0 a
6) LCA0.3EC	20.8 oz/M	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	7.0 a	6.0 a	5.5 a	5.0 a
7) AAA-1	Program	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	6.8 a	6.0 a	5.0 a	5.0 a
8) SciProTek	Program	7.0 a	7.0 a	6.0 a	6.0 a	6.3 a	7.0 a	6.0 a	5.0 a	5.0 a
9) BioFence	20 lb/M	7.0 a	7.0 a	6.3 a	6.0 a	6.5 a	6.8 a	5.8 a	5.3 a	5.0 a
10) MultGd Protect	8 gal/A	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	6.8 a	6.0 a	5.0 a	5.0 a
11) Fert CK #2	*	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	6.5 a	6.0 a	5.0 a	5.0 a
12) Fert CK #3	*	7.0 a	7.0 a	6.0 a	6.0 a	6.0 a	6.8 a	6.0 a	5.0 a	5.0 a
LSD (P=0.05)		0.0	0.0	0.21	0.0	0.38	0.58	0.29	0.59	0.0

[1] Bentgrass color: rated on a 0-10 scale with zero representing no color, 6 minimally acceptable color and 10 the best turf color.
[2] DOA1: Day of application one.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

Table 11. **Time Frame: August 17 to November 22, 2010**. Treatment effects on creeping bentgrass color. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Bent Color[1] 8/17 DOA10[2]	Bent Color 8/30 DOA11	Bent Color 9/14 DOA12	Bent Color 9/29 DOA13	Bent Color 10/14 DOA14	Bent Color 10/27 DOA15	Bent Color 11/9 DOA16	Bent Color 11/22/10 13DAA16
1) Fert CK #1	*	4.8 a[3]	4.8 b	6.8 a	5.8 a	5.8 a	7.0 a	6.8 b	6.8 a
2) Fert CK+Additions	Program	5.3 a	5.3 ab	7.3 a	5.8 a	6.0 a	7.0 a	7.8 a	7.0 a
3) Grigg Bros.	Program	5.0 a	6.0 a	7.0 a	6.0 a	6.0 a	7.0 a	7.0 b	7.0 a
4) Ocean Organics	Program	5.0 a	5.5 ab	7.0 a	6.0 a	6.0 a	7.0 a	7.0 b	7.0 a
5) Nema-Q	2.5 gal/A	5.0 a	5.0 ab	7.0 a	6.0 a	6.0 a	7.0 a	7.0 b	7.0 a
6) LCA0.3EC	20.8 oz/M	5.0 a	4.5 b	6.8 a	5.8 a	5.8 a	7.0 a	7.0 b	7.0 a
7) AAA-1	Program	5.0 a	5.0 ab	7.0 a	6.0 a	6.0 a	7.0 a	7.0 b	7.0 a
8) SciProTek	Program	5.0 a	4.5 b	6.8 a	6.0 a	6.0 a	7.0 a	7.0 b	7.0 a
9) BioFence	20 lb/M	5.0 a	5.5 ab	7.0 a	6.2 a	5.8 a	7.0 a	7.0 b	7.2 a
10) MultGd Protect	8 gal/A	4.8 a	5.3 ab	6.8 a	6.0 a	6.0 a	7.0 a	7.0 b	7.0 a
11) Fert CK #2	*	5.0 a	5.3 ab	7.0 a	6.0 a	6.0 a	7.0 a	7.0 b	7.0 a
12) Fert CK #3	*	5.0 a	5.3 ab	7.0 a	6.0 a	6.0 a	7.0 a	7.0 b	7.0 a
LSD (P=0.05)		0.34	0.65	0.40	0.44	0.37	0.0	0.30	0.38

[1] Bentgrass color: rated on a 0-10 scale with zero representing no color, 6 minimally acceptable color and 10 the best turf color.
[2] DOA10: Day of application ten.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

Table 12. **Time Frame: June 23 to August 30, 2010**. Treatment effects on creeping bentgrass color as measured by NDVI. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Bent Color[1] NDVI 6/23 DOA6[2]	Bent Color NDVI 7/7 DOA7[3]	Bent Color NDVI 7/21 DOA8	Bent Color NDVI 8/4 DOA9	Bent Color NDVI 8/17 DOA10	Bent Color NDVI 8/30/10 DOA11
1) Fert CK #1	*	0.8140 a[3]	0.8125 a	0.7923 ab	0.7458 a	0.7438 a	0.6453 a
2) Fert CK+Additions	Program	0.8173 a	0.8120 a	0.7475 b	0.7328 a	0.7768 a	0.7708 a
3) Grigg Bros.	Program	0.8215 a	0.8255 a	0.8013 a	0.7690 a	0.8180 a	0.8093 a
4) Ocean Organics	Program	0.8200 a	0.8235 a	0.7945 ab	0.7730 a	0.7810 a	0.7773 a
5) Nema-Q	2.5 gal/A	0.8150 a	0.8195 a	0.7845 ab	0.7488 a	0.7605 a	0.7543 a
6) LCA0.3EC	20.8 oz/M	0.8198 a	0.8163 a	0.7978 ab	0.7638 a	0.7970 a	0.7428 a
7) AAA-1	Program	0.8153 a	0.8128 a	0.7888 ab	0.7248 a	0.7683 a	0.7268 a
8) SciProTek	Program	0.8223 a	0.8188 a	0.7805 ab	0.7198 a	0.7385 a	0.6955 a
9) BioFence	20 lb/M	0.8050 a	0.8138 a	0.7880 ab	0.7565 a	0.6883 a	0.7078 a
10) MultGd Protect	8 gal/A	0.8088 a	0.8203 a	0.7638 ab	0.7488 a	0.7333 a	0.7175 a
11) Fert CK #2	*	0.8110 a	0.8163 a	0.7715 ab	0.7198 a	0.8038 a	0.7048 a
12) Fert CK #3	*	0.8148 a	0.8163 a	0.7565 ab	0.7418 a	0.7455 a	0.6963 a
LSD (P=0.05)		0.01502	0.01290	0.03098	0.04249	0.08476	0.10259

[1] Bentgrass color was measured with the Field Scout TCM 500 Meter and presented as NDVI (Normalized Difference Vegetative Index).
[2] DOA6: Day of application six.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

Table 13. **Time Frame: September 14 to November 22, 2010**. Treatment effects on creeping bentgrass color as measured by NDVI. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Bent Color[1] NDVI 9/14 DOA12[2]	Bent Color NDVI 9/29 DOA13[3]	Bent Color NDVI 10/14 DOA14	Bent Color NDVI 10/27 DOA15	Bent Color NDVI 11/9 DOA16	Bent Color NDVI 11/22/10 13DAA16
1) Fert CK #1	*	0.7593 a[3]	0.7893 a	0.7595 b	0.7650 b	0.7705 a	0.7160 a
2) Fert CK+Additions	Program	0.8348 a	0.7920 a	0.8095 a	0.7955 a	0.7940 a	0.7283 a
3) Grigg Bros.	Program	0.8335 a	0.8085 a	0.8208 a	0.7970 a	0.7913 a	0.7263 a
4) Ocean Organics	Program	0.8245 a	0.8045 a	0.8150 a	0.7945 a	0.7855 a	0.7260 a
5) Nema-Q	2.5 gal/A	0.8198 a	0.8053 a	0.8120 a	0.7950 a	0.7860 a	0.7220 a
6) LCA0.3EC	20.8 oz/M	0.7898 a	0.7985 a	0.8063 a	0.7838 ab	0.7715 a	0.7255 a
7) AAA-1	Program	0.7933 a	0.8080 a	0.8105 a	0.7913 a	0.7835 a	0.7205 a
8) SciProTek	Program	0.7143 a	0.8040 a	0.8173 a	0.7798 ab	0.7865 a	0.7253 a
9) BioFence	20 lb/M	0.7488 a	0.7780 a	0.7960 a	0.7798 ab	0.7833 a	0.7143 a
10) MultGd Protect	8 gal/A	0.7645 a	0.8003 a	0.7970 a	0.7880 ab	0.7908 a	0.7255 a
11) Fert CK #2	*	0.8138 a	0.8005 a	0.8153 a	0.7998 a	0.7865 a	0.7200 a
12) Fert CK #3	*	0.8003 a	0.7728 a	0.7988 a	0.7850 ab	0.7723 a	0.7215 a
LSD (P=0.05)		0.09865	0.02749	0.02688	0.01604	0.01835	0.01618

[1] Bentgrass color was measured with the Field Scout TCM 500 Meter and presented as NDVI (Normalized Difference Vegetative Index).
[2] DOA12: Day of application twelve.
[3] Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).

◆ ***Treatment Effects and Creeping Bentgrass Rooting (Tables 14 and 15)***

Creeping bentgrass rooting data is presented in Tables 14 and 15. Table 14 shows the maximum root depth (inches) observed for all treatments (average of three ¾" cores sampled to a depth of 12 inches) on April 14, August 18, October 27 and November 22, 2010.

The following trends appear in the generated data:

- Maximum root depth was observed in April with the greatest reduction in root depth observed in October.
- Rooting depth increased between October and November, but not to levels observed in the previous spring.
- Treatment #1, Fertilized Check #1, lost 89.7% of rooting depth between April and October.
- All treatments showed similar trends of better root depth than Treatment #1, Fertilized Check #1 on August 18, October 27 and November 22.

Table 14. Treatment effects on creeping bentgrass maximum root depth. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Max Root Depth[1] 4/14/10 DOA1[2]	Max Root Depth 8/18/10 DOA13[3]	Max Root Depth 10/27/10 DOA15	Max Root Depth 11/22/10 13DAA16
1) Fert CK #1	*	7.25"	2.0"	0.75"	1.5"
2) Fert CK+Additions	Program	6.75"	3.5"	2.75"	3.5"
3) Grigg Bros.	Program	7.25"	3.5"	2.0"	4.3"
4) Ocean Organics	Program	3.5"	3.5"	2.25"	3.0"
5) Nema-Q	2.5 gal/A	5.0"	3.0"	3.25"	2.0"
6) LCA0.3EC	20.8 oz/M	3.75"	3.0"	2.0"	2.125"
7) AAA-1	Program	5.0"	3.5"	2.125"	3.5"
8) SciProTek	Program	5.0"	5.5"	2.5"	3.5"
9) BioFence	20 lb/M	7.0"	4.0"	2.5"	3.5"
10) MultGd Protect	8 gal/A	3.5"	3.5"	1.75"	3.5"
11) Fert CK #2	*	6.5"	3.5"	1.75"	2.5"
12) Fert CK #3	*	7.0"	3.5"	2.25"	2.25"
Average		5.6"	3.5"	2.2"	3.1"

[1] Maximum root depth: an average of three ¾" cores sampled to a depth of 12 inches.
[2] DOA1: Day of application one.
[3] DOA13: Day of application thirteen.

Table 15 shows the maximum root mass index generated for all treatments (average of three ¾" cores sampled to a depth of 12 inches) on April 14, August 18, October 27 and November 22, 2010.

The root mass index was generated by collecting a ¾" core to a depth of 12 inches, finding the depth of the primary root mass, and multiplying the depth of the root mass by the percentage of the total roots found in the primary root mass.

The following trends appear in the generated data:

- Maximum root mass was observed in April with the greatest reduction in August and October.
- Root mass increased between October and November, but not to levels observed in the previous spring.
- Treatment #1, Fertilized Check #1, lost 73.1% of root mass between April and October.
- All treatments showed similar trends of better root mass than Treatment #1, Fertilized Check #1 on August 18, October 27 and November 22.
- Biofence, SciProTek and AAA-1 exhibited the highest root mass levels of all treatments on November 22, 2010.

Table 15. Treatment effects on creeping bentgrass root mass index. The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	Rate	Max Root Mass[1] 4/14/10 DOA1[2]	Max Root Mass 8/18/10 DOA13[3]	Max Root Mass 10/27/10 DOA15	Max Root Mass 11/22/10 13DAA16
1) Fert CK #1	*	2.6	0.8	0.7	1.0
2) Fert CK+Additions	Program	3.5	2.0	1.4	1.6
3) Grigg Bros.	Program	3.2	1.4	1.4	1.2
4) Ocean Organics	Program	2.4	1.3	1.4	1.4
5) Nema-Q	2.5 gal/A	3.4	0.9	1.4	1.4
6) LCA0.3EC	20.8 oz/M	2.4	1.8	1.5	1.4
7) AAA-1	Program	2.8	1.2	1.5	1.8
8) SciProTek	Program	2.8	0.9	1.7	1.8
9) BioFence	20 lb/M	2.8	1.1	1.5	2.0
10) MultGd Protect	8 gal/A	2.6	1.6	1.2	1.5
11) Fert CK #2	*	2.8	1.0	0.9	1.5
12) Fert CK #3	*	2.4	1.2	1.1	1.4
Average		2.8	1.3	1.3	1.5

[1] Root mass index: multiply the maximum depth of the primary root mass by the percentage of total roots in the primary root mass.
[2] DOA1: Day of application one.
[3] DOA13: Day of application thirteen.

◆ ***Data Overview (Tables 16 and 17)***

It is difficult to understand the potential interaction of soil nematodes such as root knot, ring, spiral and stubby root, as well as how their combined presence may influence overall creeping bentgrass stress. It is hypothesized that combining high counts of soil nematodes with the extreme summer heat of this low desert microclimate would increase the potential to reduce creeping bentgrass quality. Table 16 presents the percent change in total counts for specific nematodes for all treatments compared to the Treatment #1, Fertilized Check #1.

The two best performing treatments for suppression/control of root knot nematodes were:

1.	Fertilized Check + Additions	33.9%
2.	Grigg Brothers Program	25.1%

Although none of the treatments provided acceptable control of ring nematodes, the best performing treatments were:

1.	Biofence	-11.6%
2.	SciProTek	-14.4%

Although none of the treatments provided acceptable control of spiral nematodes, the best performing treatments were:

1.	AAA-1	-3.6%
2.	LCA0.3EC	-3.9%

The three best performing treatments for suppression/control of stubby root nematodes were:

1.	LCA0.3EC	63.9%
2.	Grigg Brothers Program	29.8%
3.	Nema-Q	27.9%

Table 16. Percent change in specific nematode counts per treatment when compared to the Fertilized Check #1. Total counts generated over five sampling dates from March 31 to November 22, 2010. **Blue highlights are positive** and represent a percent reduction in nematode counts when compared to Fertilized Check #1. **Red highlights are negative** and represent negative control (-) or a percent increase in nematode counts when compared to the Fertilized Check #1. The Vintage Club, Indian Wells, CA. 2010. Dr. Michael McClure, University of Arizona. Mark M. Mahady & Associates, Inc.

Treatments	R. Knot	Ring	Spiral	Stubby
2) Fert CK + Additions	**33.9%**[1]	**-52.9%**	**-33.7%**	**24.3%**
3) Grigg Bros.	**25.1%**[2]	**-235.6%**	**-58.0%**	**29.8%**[2]
4) Ocean Organics	**-16.2%**	**-106.6%**	**-86.7%**	**20.2%**
5) Nema-Q	**-17.5%**	**-32.6%**	**-67.0%**	**27.9%**
6) LCA0.3EC	**-33.5%**	**-58.6%**	**-3.9%**[2]	**63.9%**[1]
7) AAA-1	**-45.2%**	**-76.9%**	**-3.6%**[1]	**-31.8%**
8) SciProTek	**-42.7%**	**-14.4%**[2]	**-97.4%**	**13.3%**[2]
9) BioFence	**-52.1%**[3]	**-11.6%**[1]	**-28.1%**	**-66.2%**
10) MultGd Protect	**-52.1%**	**-122.5%**	**-39.3%**	**1.0%**

[1] Ranked #1.
[2] Ranked #2.

Table 17 follows a similar format to Table 16 and helps identify and rank the best products for a specific nematode problem. Multiple product treatment programs utilizing certain products for specific nematode problems during peak seasonal timing may prove to be valuable in driving nematode counts below critical threshold levels and dynamically reducing turf injury.

Table 17. Correlating treatment performance with control of specific nematodes and influence on turfgrass quality factors. Each product is classified by performance as very effective (+++), effective (++), marginally effective (+), neutral (*) or negative (-). Effective treatments are ranked 1-5 with 1 being the best. **Blue highlights indicate positive control**. **Red highlights are negative and indicate very poor or no control.** The Vintage Club, Indian Wells, CA. 2010. Mark M. Mahady & Associates, Inc.

Treatments	R. Knot	Ring	Spiral	Stubby	Turf Quality	Red. Turf Injury[3]
2) Fert CK + Additions	++/1[1]	-	-	++/4	3	4
3) Grigg Bros.	++/2[2]	-	-	++/2[2]	4	1[1]
4) Ocean Organics	*	-	-	++/5	2[2]	2[2]
5) Nema-Q	*	-	-	++/3	1[1]	3
6) LCA0.3EC	-	-	*2	+++/1[1]	5	*
7) AAA-1	-	-	*1	-	*	5
8) SciProTek	-	*2	-	+	*	*
9) BioFence	-	*1	-	-	*	+
10) MultGd Protect	-	-	-	*	*	+

[1] Ranked #1.
[2] Ranked #2.
[3] Reduction in nematode induced turfgrass injury.

◆ ***Detailed Product Performance of the Top Five Performing Treatments***

Treatment #2: Fertilized Check + Additions Program

- This program consisted of Ocean Organics SeaPlant Extract Blend, Turf Signature (Bayer) and T-Nex (trinexapac-ethyl) applied every 14 days
- Ranked #1 (33.9% control) for reduction of root knot nematodes
- Ranked #4 (24.3% control) for reduction of stubby root nematodes
- Ranked #3 in Total Turf Quality (56.1)
- Ranked #4 (41.8%) for reduction of root knot nematode induced turfgrass injury

Treatment #3: Grigg Brothers Program

- This program consisted of P-K Plus and Kelplex applied every 14 days
- Ranked #2 (25.1% control) for reduction of root knot nematodes
- Ranked #2 (29.8% control) for reduction of stubby root nematodes
- Ranked #4 in Total Turf Quality (55.1)
- Ranked #1 (81.3%) for reduction of root knot nematode induced turfgrass injury

Treatment #4: Ocean Organics Program

- This program consisted of PreMix Plus and Nu-Release applied every 14 days, plus SeaBlend applied every 28 days
- Showed reduction in root knot nematode counts on two of four sampling dates, but overall control was not acceptable (-16.2%)
- Ranked #5 (20.2% control) for reduction of stubby root nematodes
- Ranked #2 in Total Turf Quality (61.5)
- Ranked #2 (67.7%) for reduction of root knot nematode induced turfgrass injury

Treatment #5: Nema-Q Program

- This program consisted of Nema-Q applied every 14 days
- Showed reduction in root knot nematode counts on two of four sampling dates, but overall control was not acceptable (-17.5%)
- Ranked #3 (27.9% control) for reduction of stubby root nematodes
- Ranked #1 in Total Turf Quality (68.6)
- Ranked #3 (43.8%) for reduction of root knot nematode induced turfgrass injury

Treatment #6: LCA0.3EC

- This program consisted of LCA0.3EC applied every 14 days
- Overall root knot nematode control was not acceptable (-45.5%)
- Ranked #1 (63.9% control) for reduction of stubby root nematodes
- Ranked #5 in Total Turf Quality (68.6)
- Ranked #10 (18.6%) for reduction of root knot nematode induced turfgrass injury

Summary and Practical Perspectives

On March 31, 2010, a replicated research trial was established on the Penn A4 creeping bentgrass putting green on the 13th hole of the Desert Course at The Vintage Club located in Indian Wells, California. The objective of this replicated field trial was to evaluate products and programs for suppression/control of root knot nematodes on a creeping bentgrass putting green when applied as properly timed, multiple treatments.

Based on the scope of the treatment protocol, a two-week application and evaluation schedule, and five nematode sampling events, the following conclusions are presented:

- The two best performing treatments for suppression of root knot nematodes, Treatment #2, Fertilize Check + Additions (Ocean Organics SeaPlant Extract Blend, + Chipco Signature + trinexapac-ethyl) showing 37.9% control and Treatment #3, Grigg Brothers Program (P-K Plus + Kelplex) showing 29.7% control, both contain phosphite. The Chipco Signature component in Treatment #2 provides 2.2 oz/1000 ft^2 of phosphite, while the P-K Plus component in Treatment #3 provides phosphite at the rate of 1.2 oz/1000 ft^2. In addition, Treatment #4, the Ocean Organics Program, added phosphite (2 oz/1000 ft^2) on September 14 and after five applications showed a 26.4% reduction in root knot nematode counts during the last nematode sampling event on November 22, 2010. During the first two sampling dates, Nema-Q showed good performance (41.7% and 33.1% reduction in root knot nematode counts, respectively), however, control levels dropped dramatically during the last two sampling dates. None of the remaining treatments exhibited acceptable levels of control.

- None of the treatments exhibited acceptable suppression of ring and spiral nematodes.

- Those treatments that exhibited the greatest reduction in stubby root nematode counts included Treatment #6, LCA0.3EC (63.9% control), Treatment #3, Grigg Brothers Program (29.8% control), Treatment #5, Nema-Q (27.9% control), Treatment #2, Fertilized Check + Additions (24.3% control), and Treatment #4, Ocean Organics Program (20.2% control).

- It is very difficult to correlate nematode population counts with corresponding turfgrass injury. The most visually significant root knot nematode induced bentgrass injury was observed over a six-week period from August 30 to October 14 with subsequent bentgrass recovery during cooler fall conditions. Those treatments that showed the greatest reduction in root knot nematode induced bentgrass injury from August 30 to November 22, 2010 when compared to Treatment #1, Fertilized Check #1 included Treatment #3, Grigg Brothers Program (81.3% reduction in bentgrass injury), Treatment #4, Ocean Organics Program (67.7% reduction in bentgrass injury), Treatment #5, Nema-Q (43.8% reduction in bentgrass injury), and Treatment #2, Fertilized Check + Additions (41.8% reduction in bentgrass injury).

- Those treatments that exhibited the highest Total Turf Quality scores over 13 evaluation dates included Treatment #5, Nema-Q (68.6 and ranked #1 of all treatments), Treatment #4, Ocean Organics Program (61.5 and ranked #2), Treatment #2, Fertilized Check + Additions (56.1 and ranked #3), and Treatment #3, Grigg Brothers Program (55.1 and ranked #4).

- Maximum root depth was observed in April with the greatest reduction in root depth occurring in October. Rooting depth increased between October and November, but not to levels observed in the previous spring. Treatment #1, Fertilized Check #1, lost 89.7% of rooting depth between April and October. All treatments showed similar trends of better root depth than Treatment #1, Fertilized Check #1 on August 18, October 27 and November 22.

- Maximum root mass was observed in April with the greatest reduction in August and October. Root mass increased between October and November, but not to levels observed in the previous spring. Treatment #1, Fertilized Check #1, lost 73.1% of root mass between April and October. All treatments showed similar trends of better root mass than Treatment #1, Fertilized Check #1 on August 18, October 27 and November 22. Biofence, SciProTek and AAA-1 exhibited the highest root mass levels of all treatments on November 22, 2010.

<u>Take Home Message</u>

While multiple applications of the best performing products evaluated in this trial did not exhibit dynamic nematode control levels (>75%), they did consistently show reduced root knot and stubby root nematode counts and reduced nematode induced bentgrass injury, while creating a positive growth environment to enhance speed of recovery and improve turfgrass quality.

If these products are to be used in the scope of a root knot nematode control program, it is highly recommended that applications begin early in the season (March-April) when nematode populations are low and before the onset of summer heat stress. Continue the multiple application program through the summer months as nematode populations increase and into the fall to speed recuperative potential as conditions for turfgrass growth improve.

Additional Future Field Research Needs

Although it is very encouraging to identify two treatments that reduce root knot nematode counts while reducing nematode induced injury and improving turf quality, it is essential that this important work be repeated in a year-two trial to verify the performance observed in year one, as well as continue to screen new active ingredients for suppression/control of root knot nematode.

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