

WATER CONSERVATION USING FYTOGREEN

ICP 032-2007 (91620)
Fytogreen Pacific, Inc.
c/o Verdi-Gro, Inc.

Innovative Conservation Program

Contract No. 032-2007



FINAL RESEARCH REPORT

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Narrative

Activities Performed:

The experiment was conducted on the campus of California State Polytechnic University, Pomona. Two different sites were included in the trial to address the issue of a heavy textured soil (clay loam) and a finer textured soil (sandy loam). Two different turf grasses, one warm-season (hybrid bermudagrass) and one cool-season turf (rhizomatous tall fescue) were included in the trials. These two turf types were maintained under 2 different growing conditions, one was maintained under normal golf course fairway condition (bermudagrass) and the other one (rhizomatous tall fescue) was maintained under homeowner management growing conditions in southern California.

The Fytogreen/Hydrocell was installed in the fall of 2007 in all the plots. The experiments had 3 replicates and one untreated control. The Fytogreen was incorporated with a blecovator hooked to a tractor. The soil was leveled and bermudagrass was allowed to fill in while the rhizomatous tall fescue was seeded in the fall of 2007.



Photo 1. Layout of the cool-season turf plots 4 months after incorporating Fytogreen and seeding.

Deliverables Produced:

Installation of Fytogreen amendment into the soil in the plots was accomplished in the fall of 2007. Cool-season turf (rhizomatous tall fescue) was seeded to have an established stand. The warm-season turf plots were treated with herbicides to prevent weeds from encroaching and the turf was allowed to fill in. Visual ratings along with turf quality measurements using a Greenseeker device (N Tech Instruments, Ukiah, CA) was conducted every month on a regular basis.



Photo 2. Layout of the warm-season turf 4 months after incorporating Fytogreen in the fall of 2007. The plots were just leveled and the bermudagrass was allowed to fill in. The bermudagrass established completely in the plots by the end of summer of 2008.

Establishment

Fytogreen was installed in the fall of 2007 so the bermudagrass did not fill in the plots till spring of 2008. The bermudagrass completely covered all the plots by the end of summer 2008. The rhizomatous tall fescue germinated and started to fill in the plots within 4 weeks after seeding. Complete coverage of the plots was achieved by spring 2008. The addition of Fytogreen improved establishment of both the cool and the warm season turf species (Figure 1 and 2)

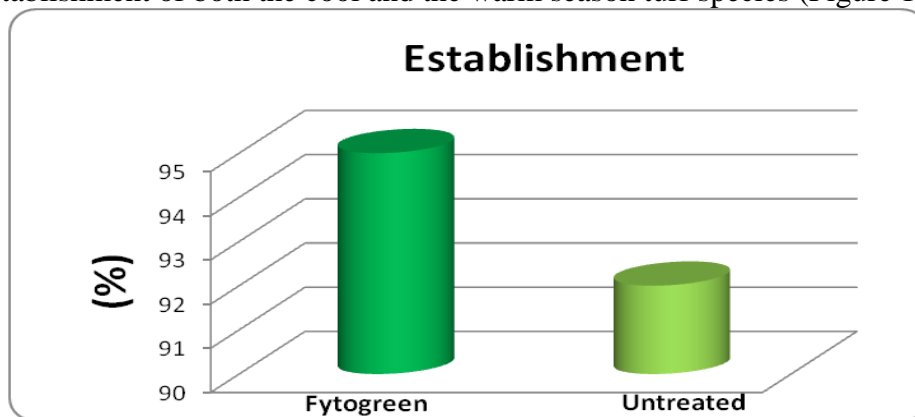


Figure 1. Establishment percentage of rhizomatous tall fescue as affected by Fytogreen amendment 6 months after seeding. The LSD (p = 0.05) was 2.15

The hybrid bermudagrass establishment was slower compared to the rhizomatous tall fescue since sprigs were not used in establishment after the Fytogreen amendment was added. The turf was allowed to fill in on its own after the installation.

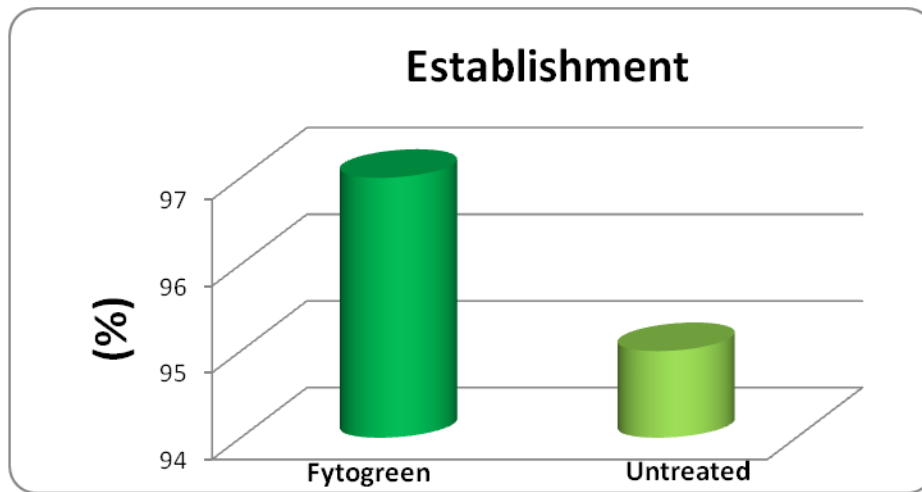


Figure 2. Establishment percentage of hybrid bermudagrass as affected by Fytogreen amendment 9 months after the Fytogreen was incorporated into the soil. The LSD ($p = 0.05$) was 1.55



Photo 3. The layout of the warm-season turf plots 6 months after incorporating Fytogreen. The bermudagrass established and covered almost 90% of the plots by the end of Spring and completely established by the end of summer 2008.

Dr. Sowmya Mitra, Associate Prof. Cal Poly Pomona & Mr. Murray Hawking, Fytogreen October 25, 2009
 Name and Title Date

WATER CONSERVATION EXPERIMENTS

During a period of 4 months the amount of irrigation water was slowly reduced to observe the effects of Fytogreen in maintaining turf quality under reduced irrigation regimes. In the month of May 2009 the irrigation system was set to deliver 100% of the ETo replacement values. In the month of June the amount of irrigation water was reduced by 25% (75% ETo) followed by 50% reduction in July (50% ETo) and finally it was reduced to 66% reduction (33% ETo) in August.

Normalized Deviation Vegetation Index (NDVI)

The health, growth, and development of turf was monitored with a Greenseeker (N Tech Instruments, Ukiah, CA). The Greenseeker sends light from a source and records the reflectance from the turf canopy. Monitoring the reflectance in the near infrared (NIR) and red (R) wavelengths allows the determination of turfgrass quality and detection of early water stress (Park et al., 2005). The characteristics of healthy, live, green vegetation is that it has a low reflectance of light from the visual spectrum (R) as a result of the leaf pigments and has a high reflectance of NIR from the scattering of light in the leaf mesophyll cells (Park et al., 2005). On the other hand, dead, brown vegetation and the soil have the reflectance that increases from the visible spectrum to NIR (Park et al., 2005). The normalized deviation vegetative index (NDVI) is strongly correlated with plant biomass, leaf area index, canopy photosynthetic capacity, and chlorophyll production (Park et al., 2005). Hence healthy dense turf stand has a higher NDVI value and the ratio of R/NIR is lower than the values observed in thin unhealthy stand of turf.

Red/NIR

A healthy dense turf stand has a higher NDVI value and the ratio of R/NIR is lower than the values observed in a thin unhealthy stand of turf.

Volumetric Moisture Content (VMC)

The volumetric moisture content (VMC) reduced as the amount of irrigation reduced from 100% ETo to 75%, 50% and finally 33% ETo. The addition of Fytogreen in both the heavy and fine textured soil resulted in higher VMC but the difference was not significant at the 100% in the heavy textured soil but was significantly higher at the 75%, 50% and 33% ETo levels. As the moisture stress increased the addition of the Fytogreen resulted in higher VMC in both soils.

Heavy Textured Soil

The bermudagrass experiments were conducted in a heavy clay loam soil. The difference in VMC between the Fytogreen with and without treatments was significant at the 75%, 50% and 33% ETo levels. Though the Fytogreen amended soil had higher VMC compared to the untreated plots during the 100% ETo irrigation regime the difference was not significant (Figure 3). It was evident that the addition of the Fytogreen amendment improved the water holding capacity of the soil under moisture stress (50% and 33% ETo irrigation regime).

Light Textured Soil

The Fytogreen amendment increased the VMC in the sandy loam soil under all the irrigation

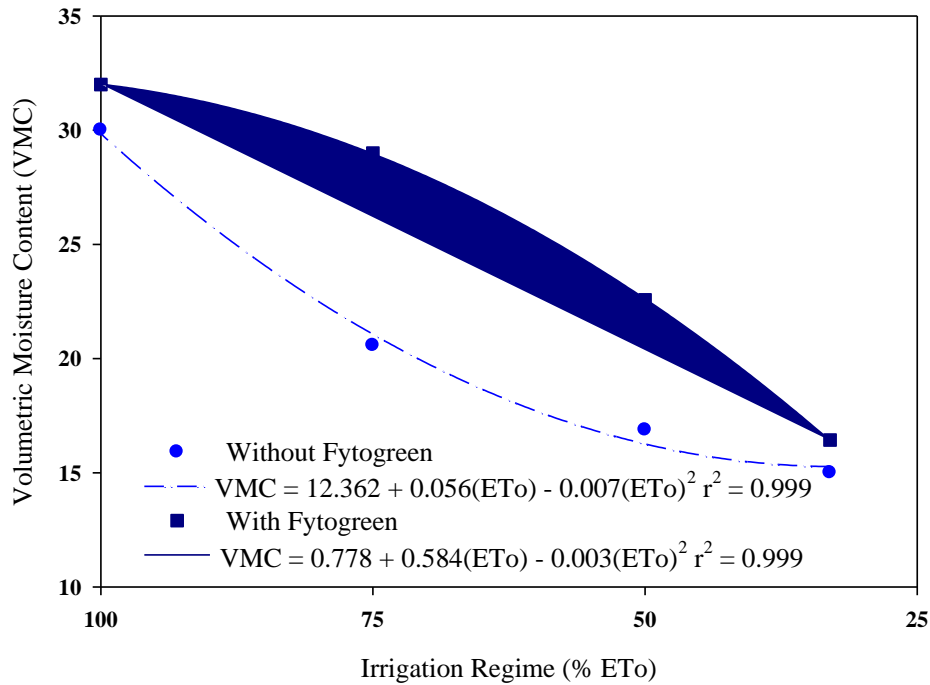


Figure 3. Overall mean volumetric moisture content (VMC) as affected by the addition of Fytogreen in a heavy textured soil under different irrigation regimes.

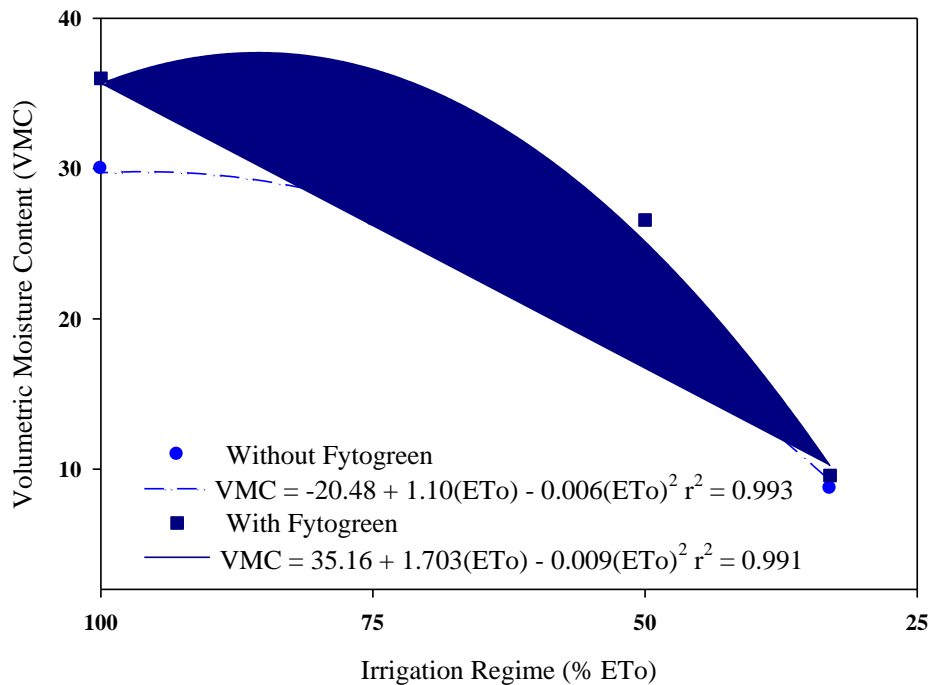


Figure 4. Overall mean volumetric moisture content (VMC) as affected by the addition of Fytogreen in a light textured soil under different irrigation regimes.

regimes but the difference was not significant under the 33% ETo irrigation regime. The decrease in VMC as the irrigation water was reduced for both the with and without Fytogreen amendment treatments could be explained with a quadratic regression models. The addition of the Fytogreen amendment resulted in a significant increase in VMC under reduced irrigation regimes compared to the non amended soil and hence the results suggested that Fytogreen can be used as a tool in water conservation on landscapes in a heavy or light textured soil or with cool season or warm season turf under arid warm growing conditions like southern California.

Warm-season Turf

The normalized deviation vegetative index (NDVI) value of the bermudagrass plots was higher in the Fytogreen amended plots compared to the non amended plots throughout the experiment under all irrigation regimes except the 100% ETo irrigation regime. The difference in NDVI increased as the moisture stress increased. Hence the turf in the Fytogreen amended plots was more healthy and dense compared to the non amended plots as observed by higher NDVI values in the Fytogreen amended plots (Figure 5).

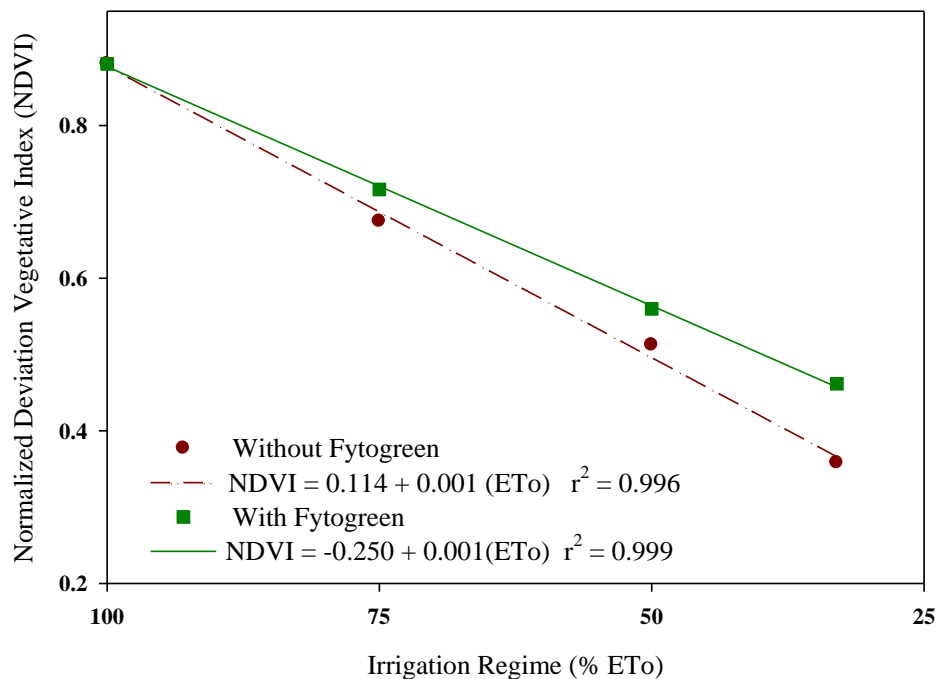


Figure 5. Overall mean normalized deviation vegetation index (NDVI) of the bermudagrass as affected by the addition of Fytogreen under different irrigation regimes. A healthy dense turf stand had a higher NDVI value.

The ratio of Red/NIR values increased as the irrigation water was reduced. The Fytogreen amended plots had lower Red/NIR compared to the non amended plots which indicated that the Fytogreen amended plots experienced less stress during the reduced irrigation regime. The difference in the ratios of Red/NIR between the with and without Fytogreen treatments was higher under the 50% and 33% ETo irrigation regime compared to the 100 and 75% ETo irrigation regime (Figure 6).

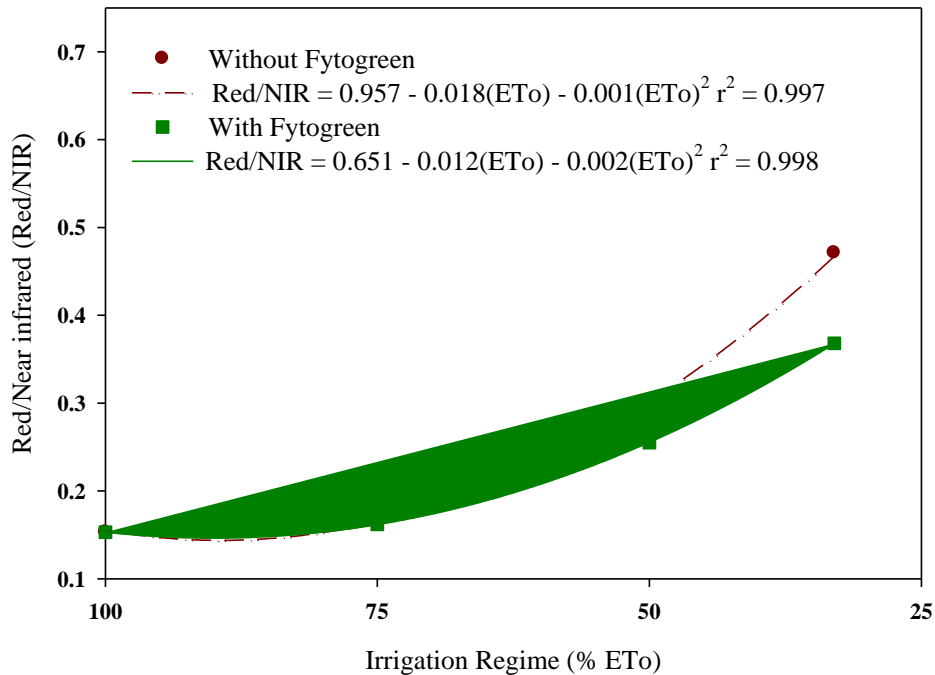


Figure 6. Overall mean ratio of red/ near infrared (Red/NIR) of the bermudagrass as affected by the addition of Fytogreen under different irrigation regimes. A healthy dense turf stand has a lower ratio of Red/NIR.

Cool-season Turf

The NDVI values of the rhizomatous tall fescue reduced as the amount of irrigation water was reduced for both the with and without the Fytogreen treatments. The reduction in NDVI for both the treatments could be explained with quadratic regression models (Figure 7). The turf had higher NDVI values in the Fytogreen amended plots compared to the non amended plots under moisture stress. There was no significant difference in NDVI values between the treatments under 100% ETo irrigation regime. As the irrigation water was reduced the NDVI values reduced and the difference between the treatments became significant at the 50% and 33% ETo irrigation regime.

The ratio of Red/NIR of the rhizomatous tall fescue increased as the amount of irrigation water was reduced for both the with and without the Fytogreen treatments. The increase in Red/NIR for both the treatments could be explained with quadratic regression models (Figure 8). The turf had lower ratio of Red/NIR in the Fytogreen amended plots compared to the non amended plots under moisture stress. There was no significant difference in the ratios of Red/NIR between the treatments under 100% ETo irrigation regime. As the irrigation water was reduced the ratio of Red/NIR values increased and the difference between the treatments became significant at the 50% and 33% ETo irrigation regime. The rhizomatous tall fescue in the Fytogreen amended plots had higher NDVI and lower Red/NIR ratio compared to the non amended plots which indicated that the turf in the Fytogreen amended plots were healthy and dense with better turf color, quality, growth, development and had experienced less stress compared to the non amended plots.

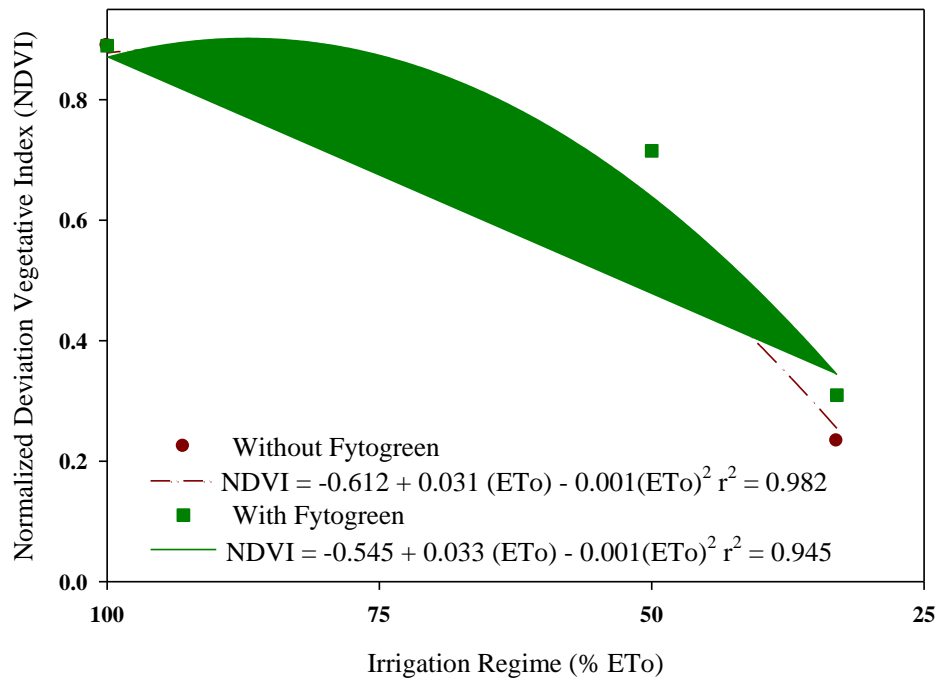


Figure 7. Overall mean normalized deviation vegetation index (NDVI) of the rhizomatous tall fescue as affected by the addition of Fytogreen under different irrigation regimes. A healthy dense turf stand had a higher NDVI value.

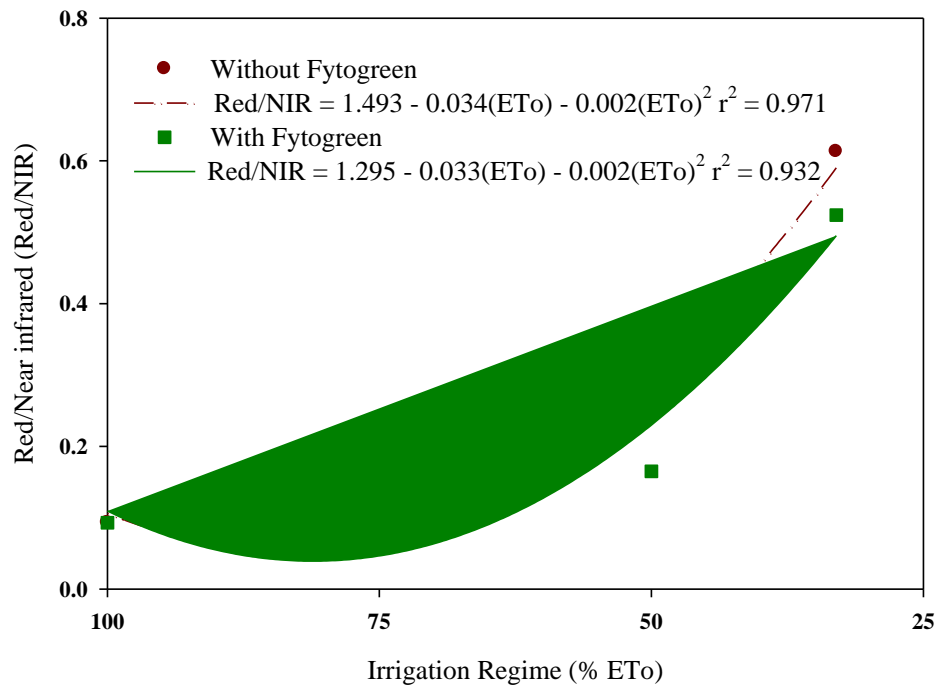


Figure 8. Overall mean ratios of Red/NIR of the rhizomatous tall fescue as affected by the addition of Fytogreen under different irrigation regimes. A healthy dense turf stand had a lower ratio of Red/NIR.

100% ETo

During the month of May 2009 the irrigation system was set to deliver 100% of the ETo replacement. Taking the crop coefficient of bermudagrass as 0.75 and 0.85 for the rhizomatous tall fescue under southern California growing conditions this irrigation regime was actually more than optimum irrigation for both the turf types maintained under golf course fairways or home owner growing conditions so the turf did not experience any moisture stress.

Volumetric Moisture Content (VMC)

Overall the addition of Fytogreen increased the VMC content in the heavy and light textured soil. The difference between the with and without Fytogreen treatments was more under reduced irrigation regimes.

Heavy Textured Soil

In the clay loam soil the difference between the Fytogreen amended soil and the non amended soil was highly significant. The Fytogreen amended soil held significantly higher amount of water which was evident from higher VMC at the 6 inches from the soil surface compared to the non amended soil (Figure 9).

Light Textured Soil

In the sandy loam soil the difference between the Fytogreen amended soil and the non amended soil was highly significant. The Fytogreen amended soil held significantly higher amount of water which was evident from higher VMC at the 6 inches from the soil surface compared to the non amended soil (Figure 10).

Normalized Deviation Vegetative Index (NDVI) and Red/NIR

A healthy dense turf stand has a higher NDVI value and the ratio of R/NIR is lower than the values observed in thin unhealthy stand of turf.

Warm-season Turf

The NDVI value for bermudagrass was higher and the ratio of Red/NIR was lower in the Fytogreen amended plots compared to the non amended plots when the plots received 100% of the ETo replacement (Figures 11 and 12). Hence even when there was adequate moisture in the soil the turf in the Fytogreen amended soil was healthier and the turf color and quality was higher compared to the non amended soil.

Cool -season Turf

The NDVI value for rhizomatous tall fescue was higher and the ratio of Red/NIR was lower in the Fytogreen amended plots compared to the non amended plots when the plots received 100% of the ETo replacement (Figure 13 and 14). Hence even when there was adequate moisture in the soil the turf in the Fytogreen amended soil was healthier and the turf color and quality was higher compared to the non amended soil.

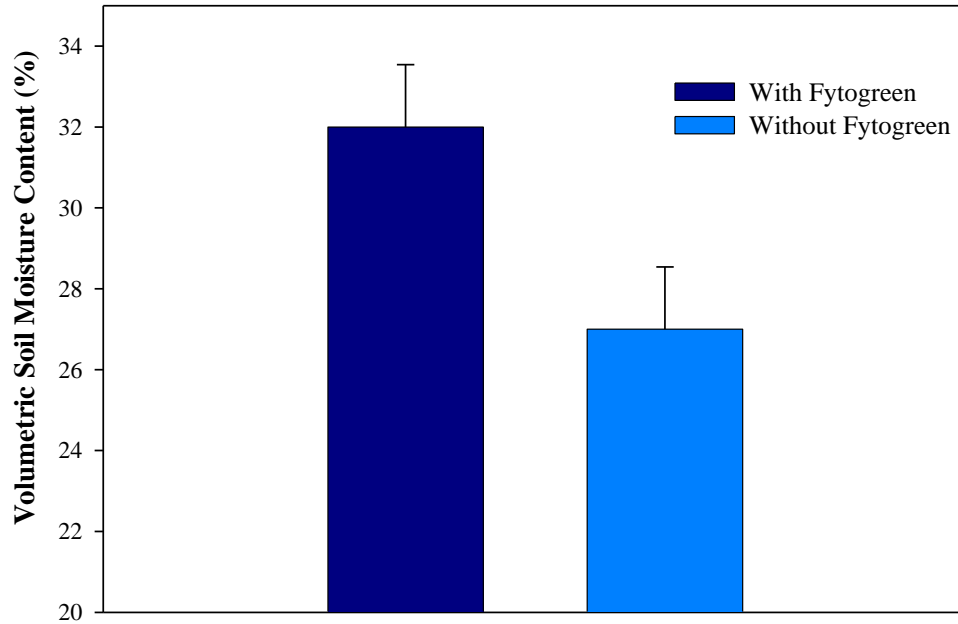


Figure 9. Mean VMC as affected by the incorporation of Fytogreen into the heavy textured soil when the plots were irrigated with 100% ETo replacement.

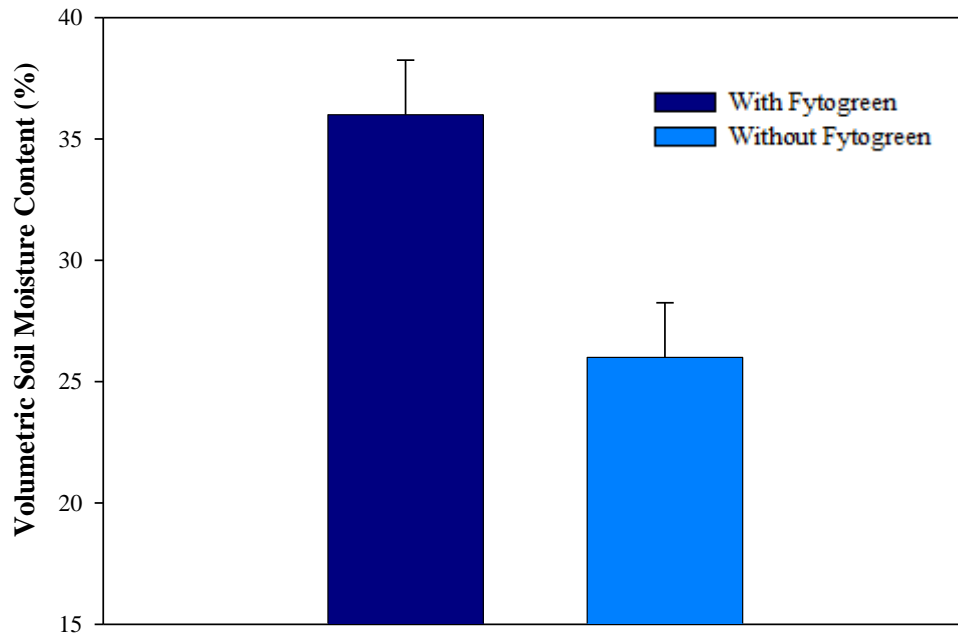


Figure 10. Mean VMC as affected by the incorporation of Fytogreen into the light textured soil when the plots were irrigated with 100% ETo replacement.

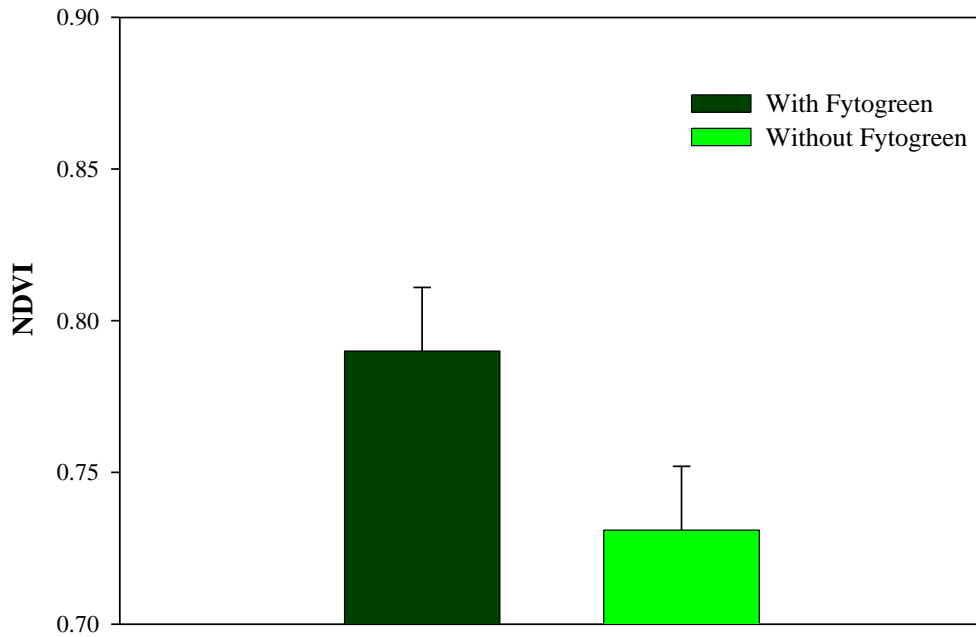


Figure 11. Mean NDVI for the bermudagrass as affected by the Fytogreen amendment irrigated with 100% ETo replacement.

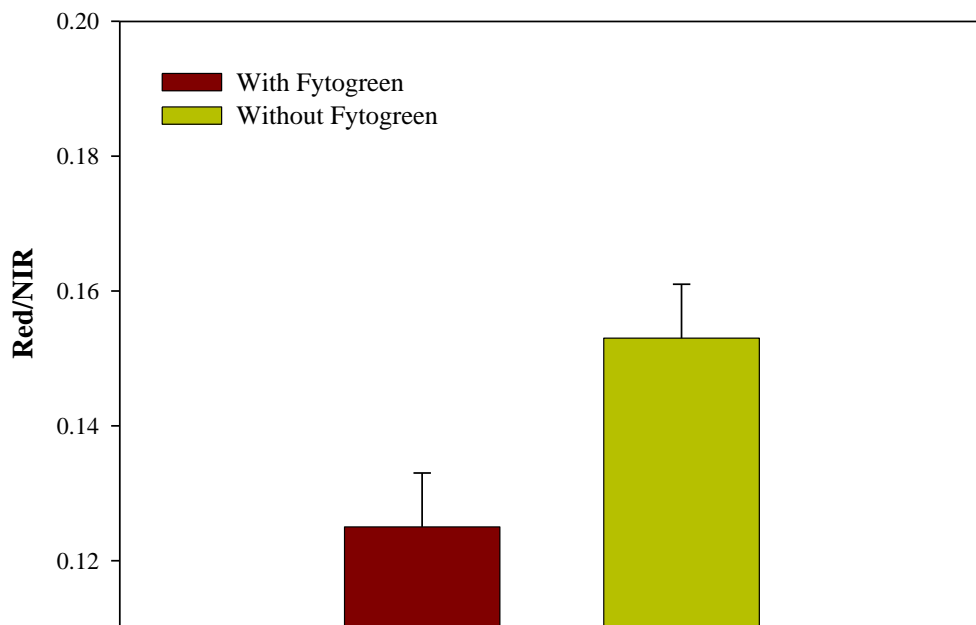


Figure 12. Mean ratio of Red/NIR for the bermudagrass as affected by the Fytogreen amendment irrigated with 100% ETo replacement.

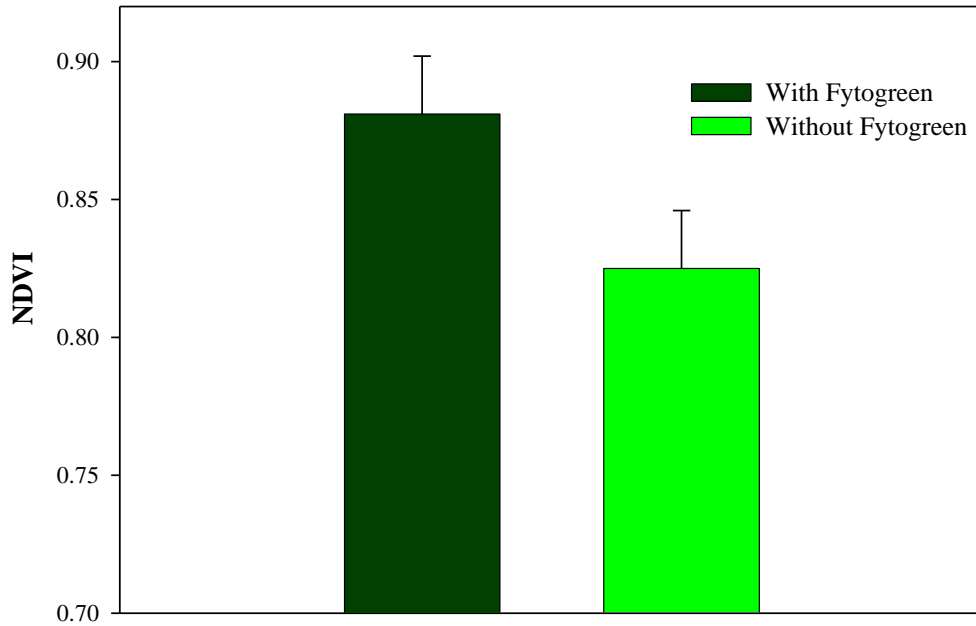


Figure 13. Mean NDVI for the rhizomatous tall fescue as affected by the Fytogreen amendment irrigated with 100% ETo replacement.

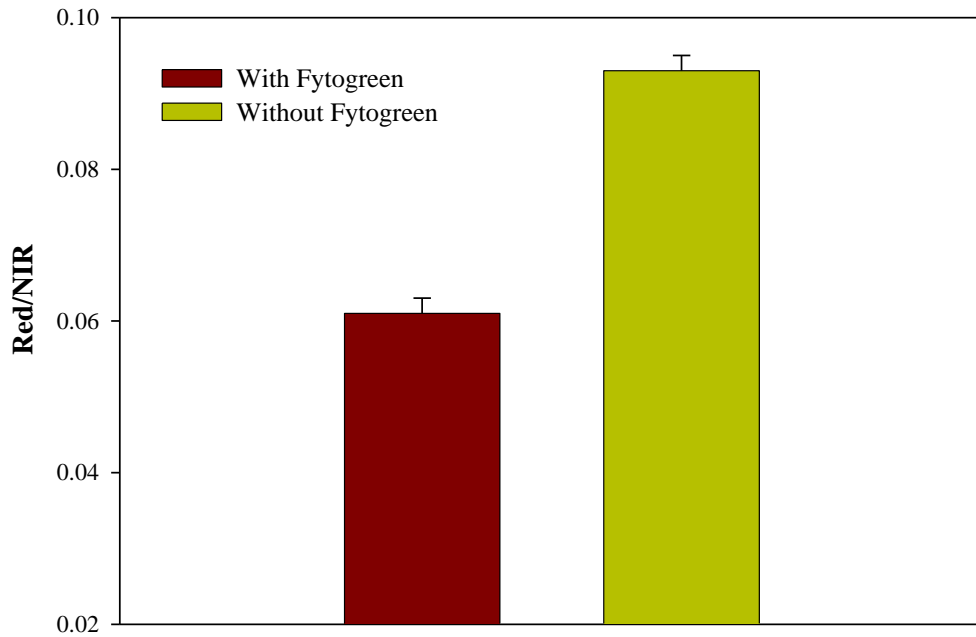


Figure 14. Mean ratio of Red/NIR for the rhizomatous tall fescue as affected by the Fytogreen amendment irrigated with 100% ETo replacement.

75% ETo

During the month of June 2009 the irrigation system was set to deliver 75% of the ETo replacement values. Hence these treatments were actually saving 25% of the irrigation water in respect to the ETo replacement values. Taking the crop coefficient of bermudagrass as 0.75 and 0.85 for the rhizomatous tall fescue under southern California growing conditions this irrigation regime was actually optimum irrigation for bermudagrass and 10% reduction in the amount of irrigation water for the rhizomatous tall fescue maintained under golf course fairways or home owner growing conditions respectively under southern California growing conditions

$$ET_c = \text{Crop coefficient} \times ET_o$$

$$ET_{\text{bermudagrass}} = 0.75 \times ET_o$$

$$ET_{\text{rhizomatous tall fescue}} = 0.85 \times ET_o$$

Volumetric Moisture Content (VMC)

Heavy Textured Soil

In the clay loam soil the difference between the Fytogreen amended soil and the non amended soil was highly significant. The Fytogreen amended soil held significantly higher amount of water which was evident from higher VMC at the 6 inches from the soil surface compared to the non amended soil (Figure 15).

Light Textured Soil

In the sandy loam soil the difference between the Fytogreen amended soil and the non amended soil was highly significant. The Fytogreen amended soil held significantly higher amount of water which was evident from higher VMC at the 6 inches from the soil surface compared to the non amended soil (Figure 16).

Normalized Deviation Vegetative Index (NDVI) and Red/NIR

Warm-season Turf

The NDVI value for bermudagrass was higher and the ratio of Red/NIR was lower in the Fytogreen amended plots compared to the non amended plots when the plots received 75% of the ETo replacement (Figures 17 and 18). Hence even when there was optimum moisture in the soil the turf in the Fytogreen amended soil was healthier and the turf color and quality was higher compared to the non amended soil.

Cool -season Turf

The NDVI value for rhizomatous tall fescue was higher and the ratio of Red/NIR was lower in the Fytogreen amended plots compared to the non amended plots when the plots received 75% of the ETo replacement (Figure 19 and 20). Hence as the turf experienced slight moisture stress (10% reduction compared to the optimum) the turf in the Fytogreen amended soil was experiencing less stress and was healthier with better turf color and quality compared to the non amended soil under slight moistures stress.

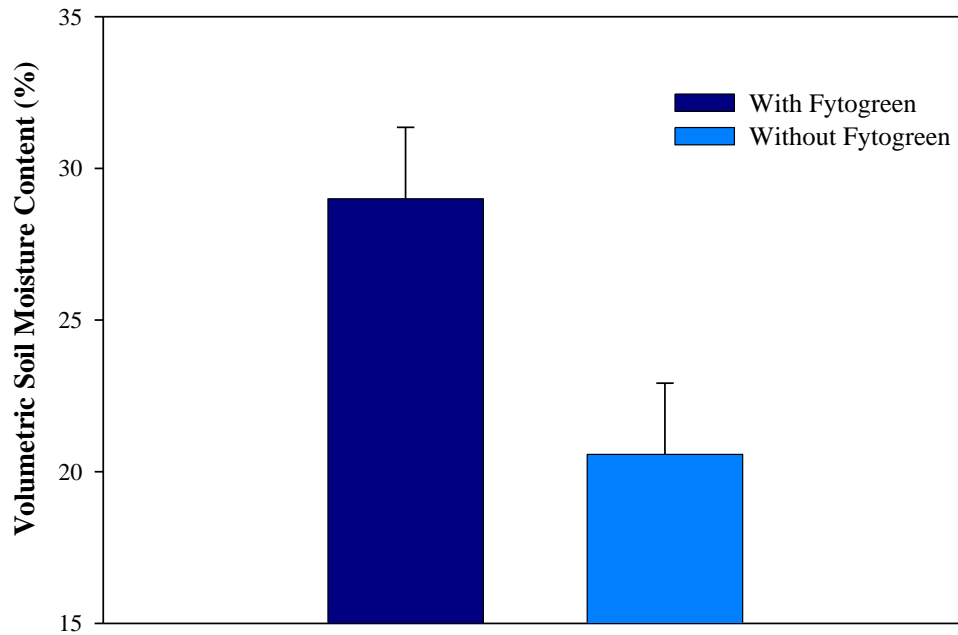


Figure 15. Mean VMC as affected by the incorporation of Fytogreen into the heavy textured soil when the plots were irrigated with 75% ETo replacement.

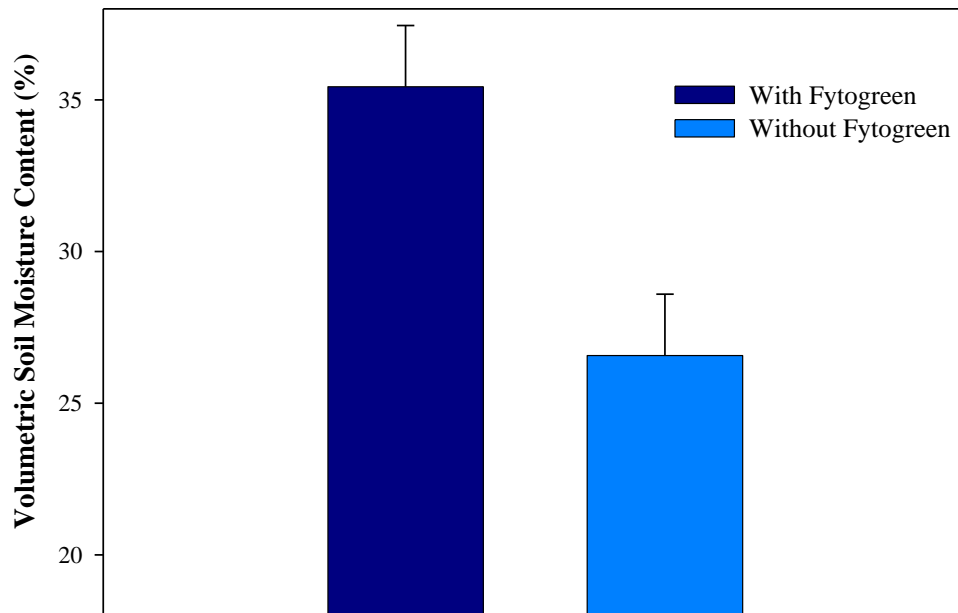


Figure 16. Mean VMC as affected by the incorporation of Fytogreen into the light textured soil when the plots were irrigated with 75% ETo replacement.

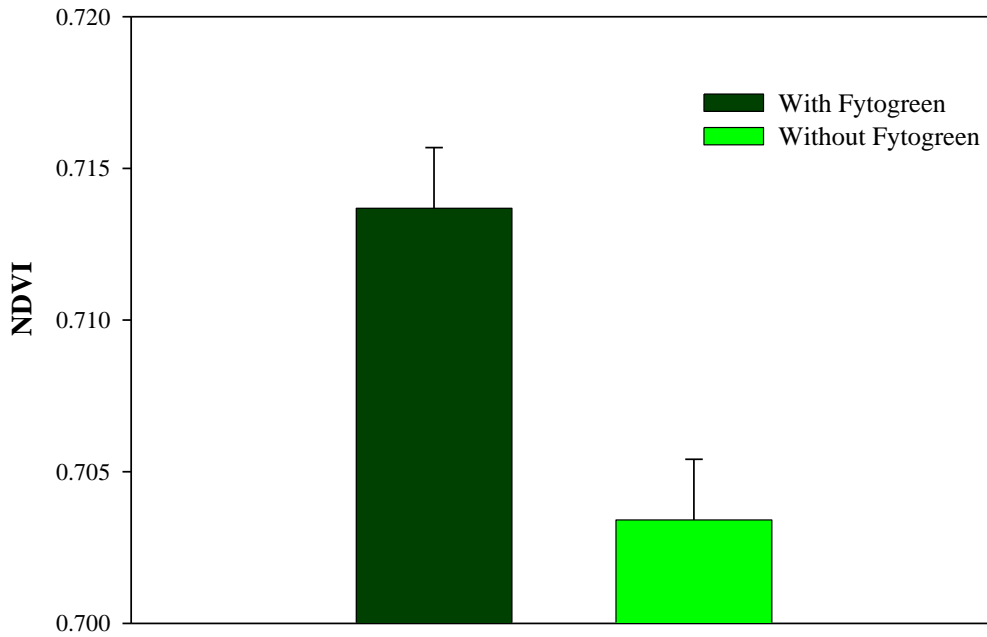


Figure 17. Mean NDVI for the bermudagrass as affected by the Fytogreen amendment irrigated with 75% ETo replacement.

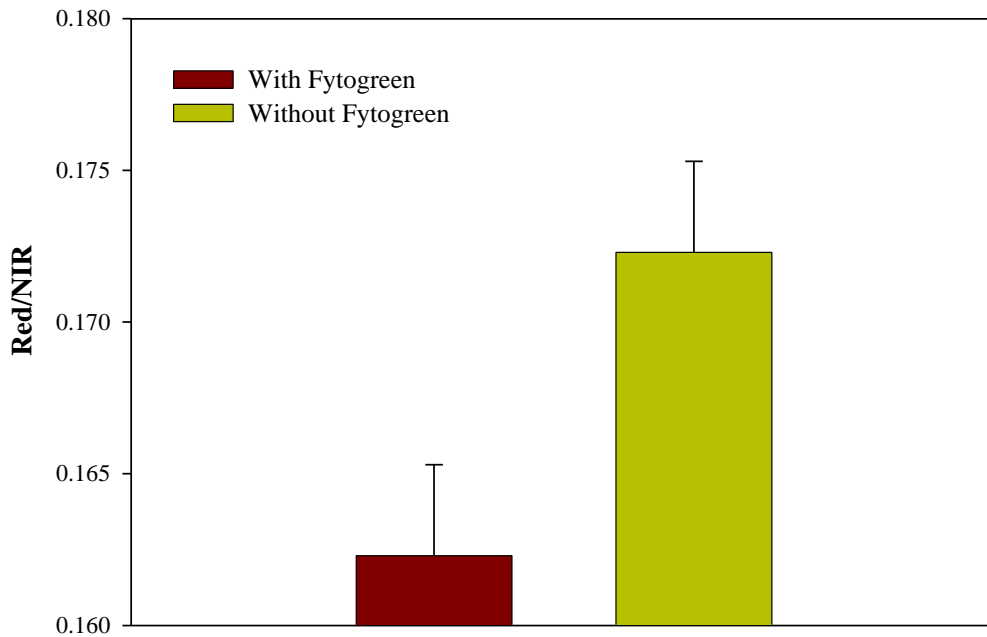


Figure 18. Mean ratio of Red/NIR for the bermudagrass as affected by the Fytogreen amendment irrigated with 75% ETo replacement.

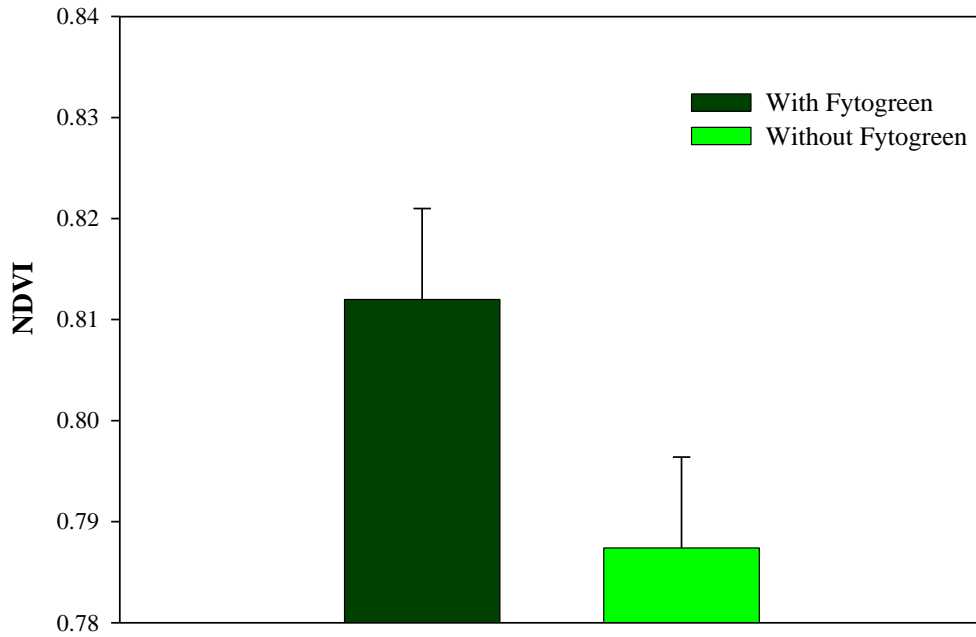


Figure 19. Mean NDVI for the rhizomatous tall fescue as affected by the Fytogreen amendment irrigated with 75% ETo replacement.

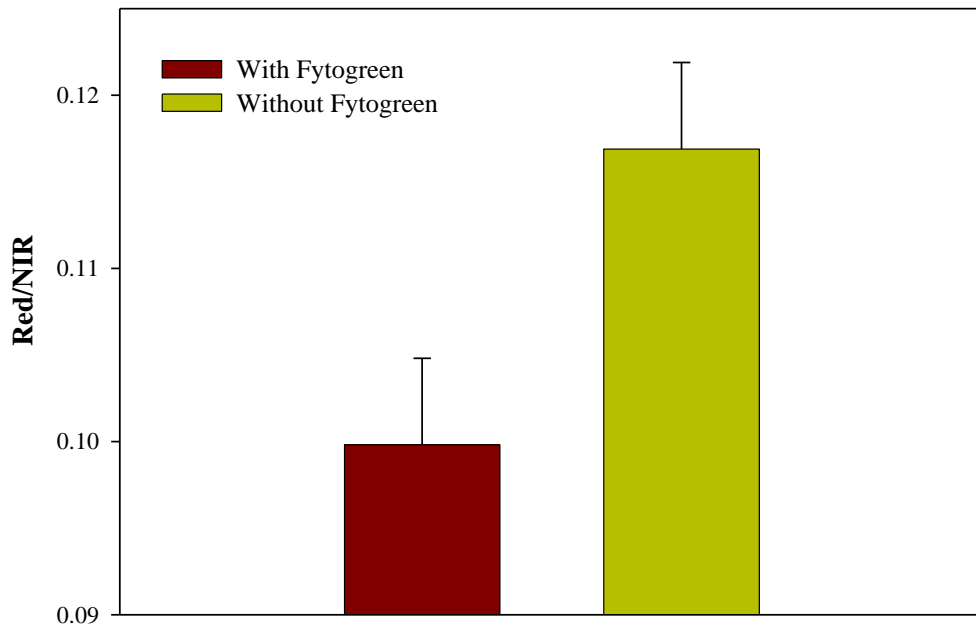


Figure 20. Mean ratio of Red/NIR for the rhizomatous tall fescue as affected by the Fytogreen amendment irrigated with 75% ETo replacement.

50% ETo

During the month of July 2009 the irrigation system was set to deliver 50% of the ETo replacement values. Hence these treatments were actually saving 50% of the irrigation water in respect to the ETo replacement values. Taking the crop coefficient of bermudagrass as 0.75 and 0.85 for the rhizomatous tall fescue under southern California growing conditions this irrigation regime was actually a reduction of 25% in the amount of irrigation water for bermudagrass and 35% for the rhizomatous tall fescue maintained under golf course fairways or home owner growing conditions respectively under southern California growing conditions

$ET_{\text{bermudagrass}} = 0.75 \times ET_O$ Hence, for 50% ET_O it was 25% reduction in the amount of irrigation
 $ET_{\text{rhizomatous tall fescue}} = 0.85 \times ET_O$ Hence, for 50% ET_O it was 35% reduction in the amount of irrigation

Volumetric Moisture Content (VMC)

Heavy Textured Soil

In the clay loam soil the difference between the Fytogreen amended soil and the non amended soil was highly significant. The Fytogreen amended soil held significantly higher amount of water which was evident from higher VMC at the 6 inches from the soil surface compared to the non amended soil (Figure 21). The mean VMC was 23% in the Fytogreen amended soil compared to 17% in the non amended soil under the 50% ETo irrigation regime.

Light Textured Soil

In the sandy loam soil the difference between the Fytogreen amended soil and the non amended soil was highly significant. The Fytogreen amended soil held significantly higher amount of water which was evident from higher VMC at the 6 inches from the soil surface compared to the non amended soil (Figure 22). The mean VMC was 27% in the Fytogreen amended soil compared to 20% in the non amended soil under the 50% ETo irrigation regime.

Normalized Deviation Vegetative Index (NDVI) and Red/NIR

Warm-season Turf

The NDVI value for bermudagrass was higher and the ratio of Red/NIR was lower in the Fytogreen amended plots compared to the non amended plots when the plots received 50% of the ETo replacement (Figures 23 and 24). Hence under moisture stress the turf in the Fytogreen amended soil was healthier and the turf color and quality was higher compared to the non amended soil.

Cool -season Turf

The NDVI value for rhizomatous tall fescue was higher and the ratio of Red/NIR was lower in the Fytogreen amended plots compared to the non amended plots when the plots received 50% of the ETo replacement (Figure 25 and 26). Hence as the turf experienced slight moisture stress (25% reduction compared to the optimum for bermudagrass and 35% reduction compared to the

optimum for rhizomatous tall fescue) the turf in the Fytogreen amended soil was healthier and experienced less stress compared to the non amended soil.

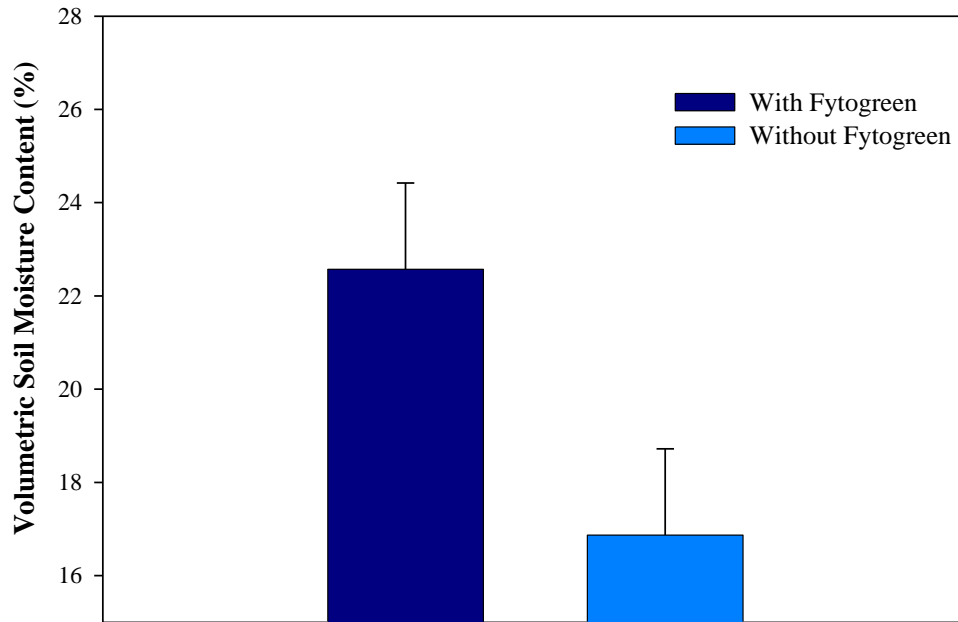


Figure 21. Mean VMC as affected by the incorporation of Fytogreen into the heavy textured soil when the plots were irrigated with 50% ETo replacement.

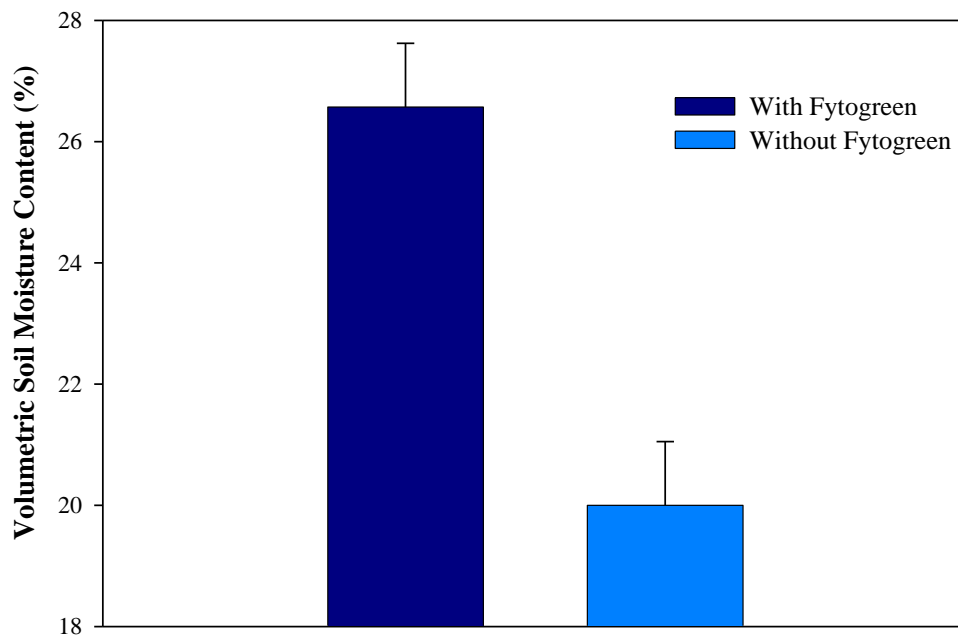


Figure 22. Mean VMC as affected by the incorporation of Fytogreen into the light textured soil when the plots were irrigated with 50% ETo replacement.

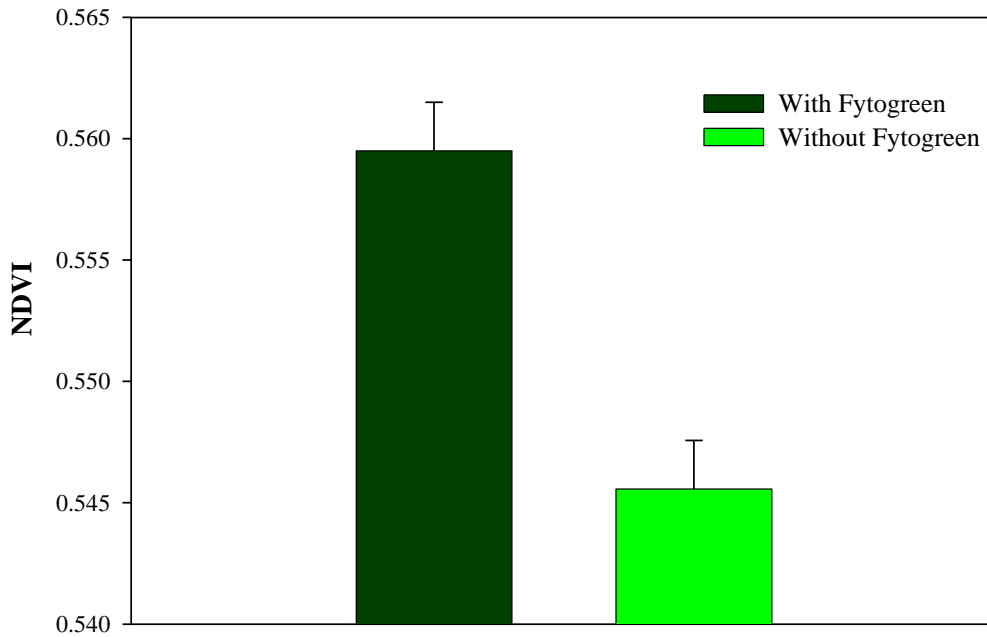


Figure 23. Mean NDVI for the bermudagrass as affected by the Fytogreen amendment irrigated with 50% ETo replacement.

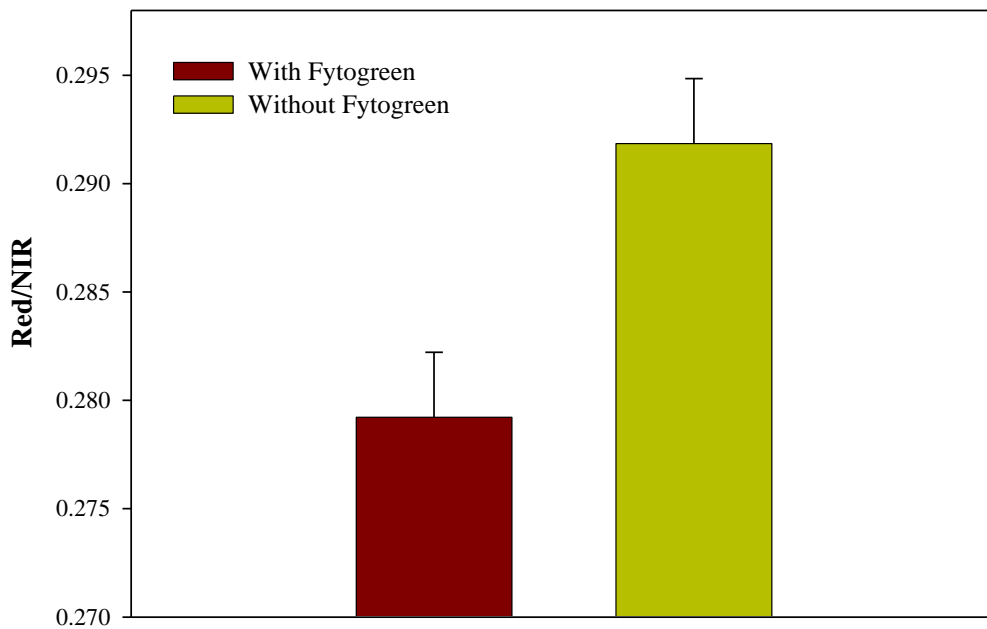


Figure 24. Mean ratio of Red/NIR for the bermudagrass as affected by the Fytogreen amendment irrigated with 50% ETo replacement.

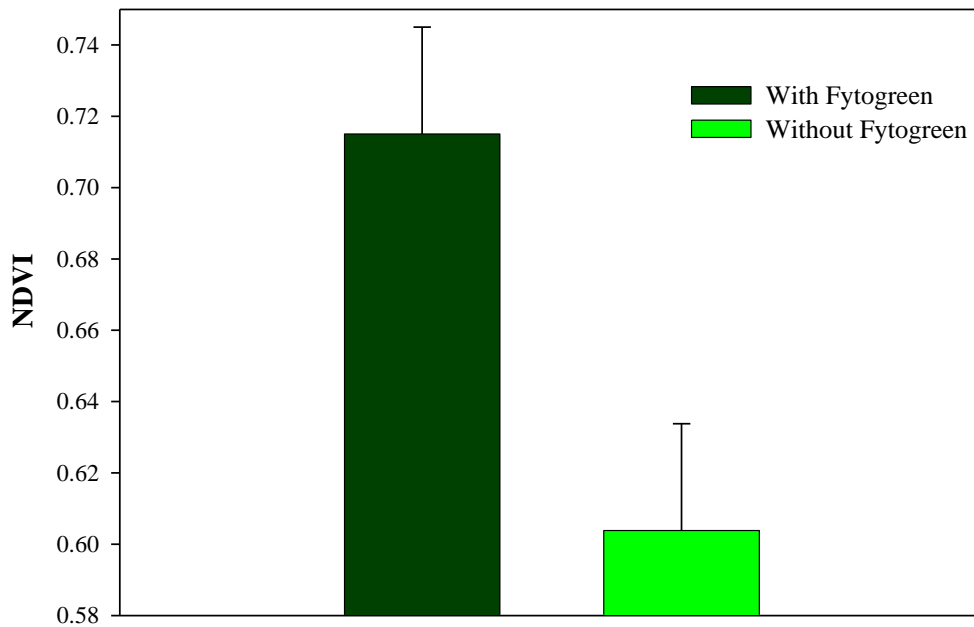


Figure 25. Mean NDVI for the rhizomatous tall fescue as affected by the Fytogreen amendment irrigated with 50% ETo replacement.

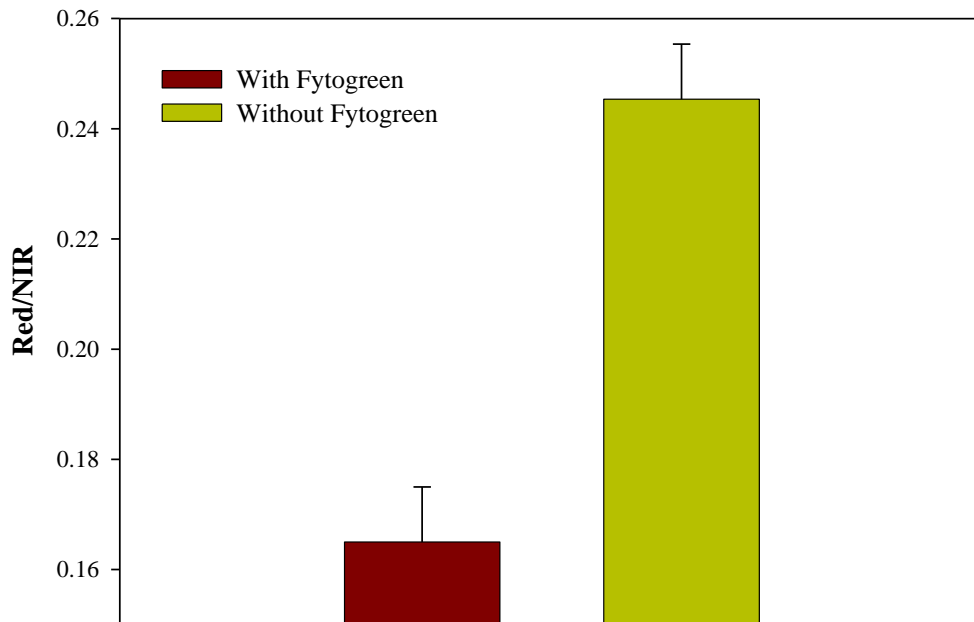


Figure 26. Mean ratio of Red/NIR for the rhizomatous tall fescue as affected by the Fytogreen amendment irrigated with 50% ETo replacement.

33% ETo

During the month of August 2009 the irrigation system was set to deliver 33% of the ETo replacement values. Hence these treatments were actually saving 67% of the irrigation water in respect to the ETo replacement values. Taking the crop coefficient of bermudagrass as 0.75 and 0.85 for the rhizomatous tall fescue under southern California growing conditions this irrigation regime was actually a reduction of 42% in the amount of irrigation water for bermudagrass and 52% reduction for the rhizomatous tall fescue maintained under golf course fairways or home owner growing conditions respectively under southern California growing conditions

$ET_{\text{bermudagrass}} = 0.75 \times ET_O$ Hence, for 33% ET_O it was 42% reduction in the amount of irrigation
 $ET_{\text{rhizomatous tall fescue}} = 0.85 \times ET_O$ Hence, for 33% ET_O it was 52% reduction in the amount of irrigation

Volumetric Moisture Content (VMC)***Heavy Textured Soil***

In the clay loam soil the difference between the Fytogreen amended soil and the non amended soil was highly significant. The Fytogreen amended soil held significantly higher amount of water which was evident from higher VMC at the 6 inches from the soil surface compared to the non amended soil (Figure 27). Hence under limited irrigation the Fytogreen amendment helped in improving water holding capacity of the clay loam soil.

Light Textured Soil

In the sandy loam soil the difference between the Fytogreen amended soil and the non amended soil was highly significant. The Fytogreen amended soil held significantly higher amount of water which was evident from higher VMC at the 6 inches from the soil surface compared to the non amended soil (Figure 28). Hence under limited irrigation the Fytogreen amendment helped in improving water holding capacity of the sandy loam soil.

Normalized Deviation Vegetative Index (NDVI) and Red/NIR**Warm-season Turf**

The NDVI value for bermudagrass was higher and the ratio of Red/NIR was lower in the Fytogreen amended plots compared to the non amended plots when the plots received 33% of the ETo replacement by irrigation (Figures 29 and 30). Hence under moisture stress the turf in the Fytogreen amended soil was healthier and the turf color and quality was higher compared to the non amended soil.

Cool -season Turf

The NDVI value for rhizomatous tall fescue was higher and the ratio of Red/NIR was lower in the Fytogreen amended plots compared to the non amended plots when the plots received 33% of the ETo replacement (Figure 31 and 32). Hence as the turf experienced moisture stress (42% reduction compared to the optimum for bermudagrass and 52% reduction compared to the

optimum irrigation for rhizomatous tall fescue) the turf in the Fytogreen amended soil was healthier, experienced less stress and had higher turf color and quality compared to the non amended soil.

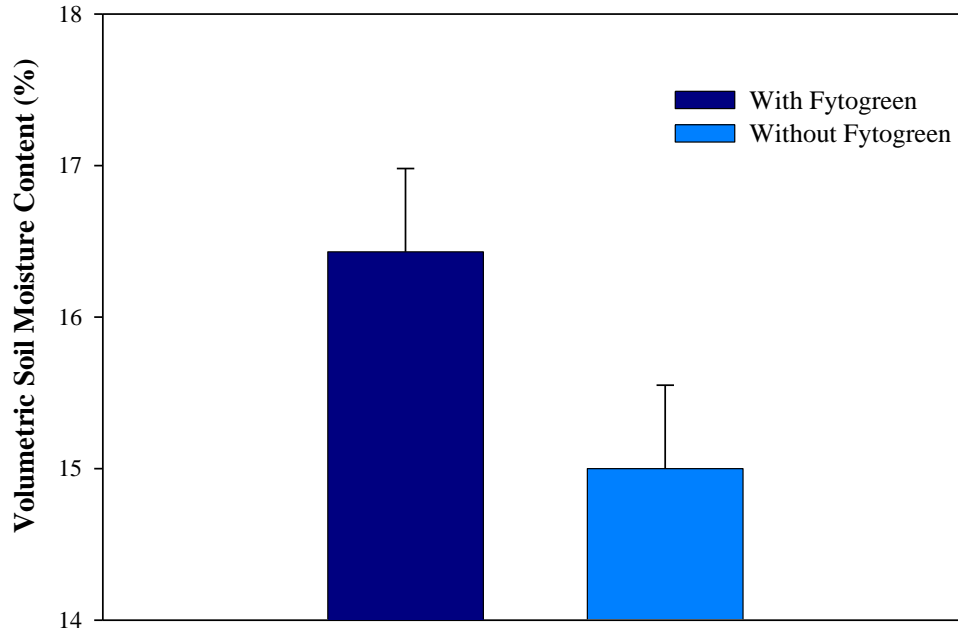


Figure 27. Mean VMC as affected by the incorporation of Fytogreen into the heavy textured soil when the plots were irrigated with 33% ETo replacement.

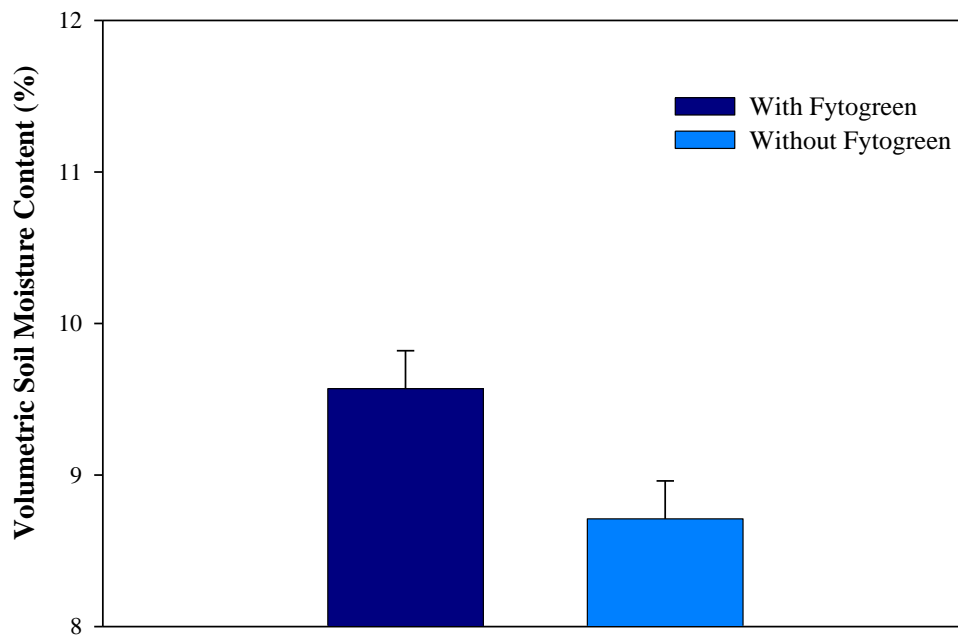


Figure 28. Mean VMC as affected by the incorporation of Fytogreen into the light textured soil when the plots were irrigated with 33% ETo replacement.

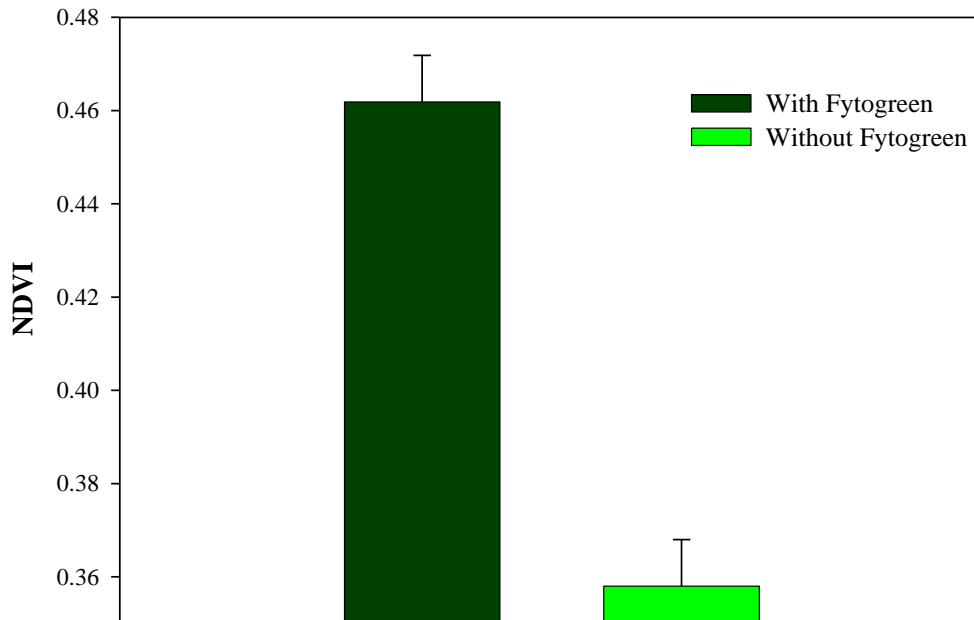


Figure 29. Mean NDVI for the bermudagrass as affected by the Fytogreen amendment irrigated with 33% ETo replacement.

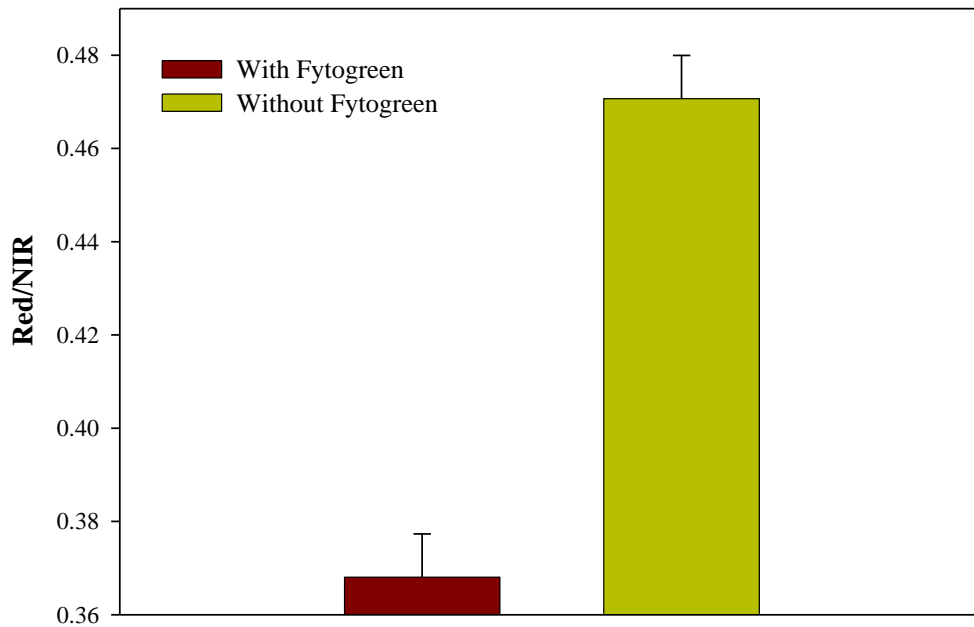


Figure 30. Mean ratio of Red/NIR for the bermudagrass as affected by the Fytogreen amendment irrigated with 33% ETo replacement.

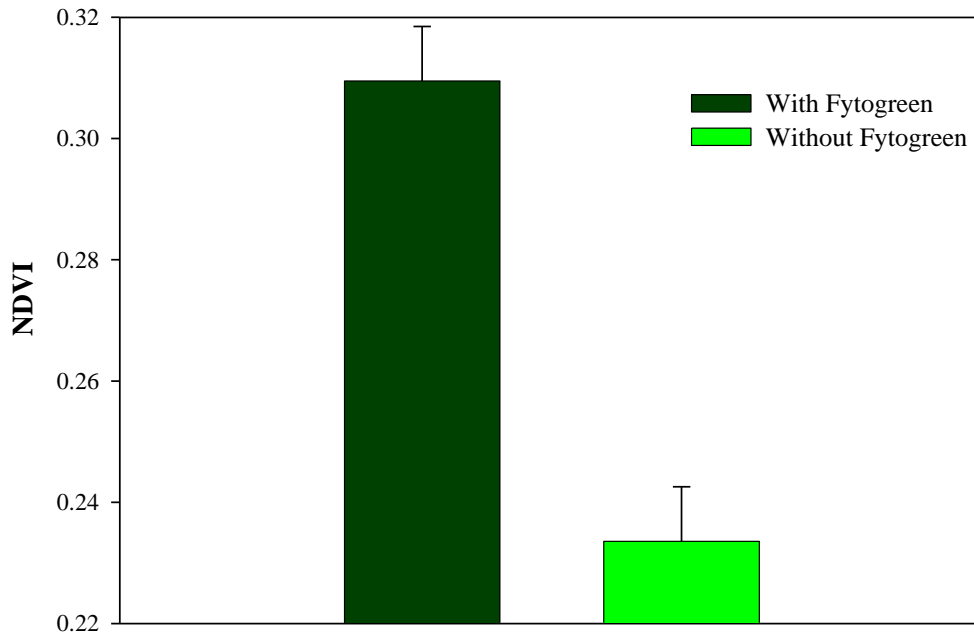


Figure 31. Mean NDVI for the rhizomatous tall fescue as affected by the Fytogreen amendment irrigated with 33% ETo replacement.

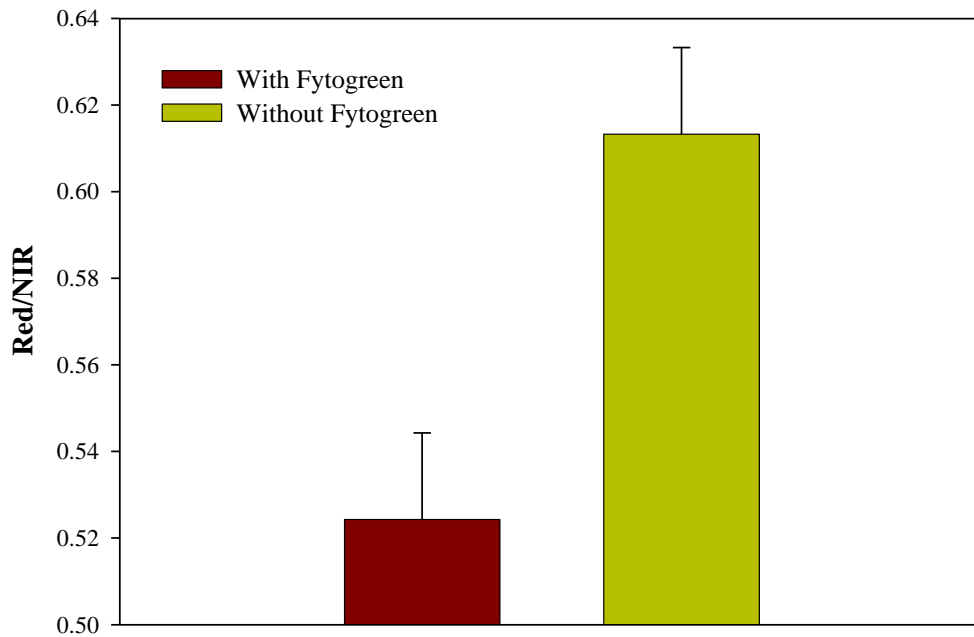


Figure 32. Mean ratio of Red/NIR for the rhizomatous tall fescue as affected by the Fytogreen amendment irrigated with 33% ETo replacement.

CONCLUSION

Overall the addition of Fytogreen as a soil amendment improved the water holding capacity of the heavy and light textured soil as indicated by the higher VMC in the Fytogreen amended soil compared to the non amended soil. The Fytogreen amendment resulted in improved turf color, quality and reduced stress on hybrid bermudagrass maintained under golf course fairway management practices on a clay loam soil and rhizomatous tall fescue maintained home owner growing conditions on a sandy loam soil in southern California when the amount of irrigation was limited. The bermudagrass and rhizomatous tall fescue in the Fytogreen amended plots had higher NDVI and lower Red/NIR ratio compared to the non amended plots which indicated that the turf in the Fytogreen amended plots were healthy and dense with better turf color and quality compared to the non amended plots. Even under optimum irrigation practices (75% ETo) or over irrigation (100% ETo) the addition of Fytogreen significantly improved VMC, turf growth and development which was indicated by higher NDVI values and lower ratios of Red/NIR compared to non amended soil . Under reduced irrigation practices (50% and 33% ETo) Fytogreen amendment helped in increasing the water holding capacity which was indicated by higher VMC in the Fytogreen amended soil compared to non amended soils. Under reduced irrigation regime the addition of Fytogreen improved turf color, quality, reduced stress on the turf and improved turf growth and development which was indicated by the higher NDVI values and lower red/NIR ratios compared to the non amended soil. Irrespective of the texture of soil either heavy or light textured soil the Fytogreen amendment would help conserve irrigation water. The water conservation potential was 25% to 40% (50 % ETo to 33% ETo) on a heavy textured soil compared to the optimum irrigation regime for bermudagrass maintained under golf course fairways management conditions or 35% to 50% on a fine textured soil for rhizomatous tall fescue in southern California without adversely effecting growth and development of either cool or warm-season turf species. The crop coefficient of other turf species like perennial ryegrass or Kentucky bluegrass are different than bermudagrass or rhizomatous tall fescue so the amount of water than can be conserved can be calculated from the ETo replacement values by multiplying the crop coefficient values for the turf type. In conclusion Fytogreen can be used as tool to conserve irrigation water without adversely affecting turf physiology. In order to achieve optimum results the Fytogreen amendments should be incorporated into the soil before seeding or can also be incorporated into an established turf stand.

REFEENCES

- Park, D. M., J. L Cisar, D. K. McDermitt, K. E. Williams, J. J. Haydu, and W. P. Miller. 2005. Using red and infrared reflectance and visual observations to monitor turf quality and water stress in surfactant-treated bermudagrass under reduced irrigation. *International Turfgrass Society Research Journal* 10:115-120.