**1999 ANNUAL RESEARCH
PROGRESS REPORT**

of

Performance and Management of New Dwarf Bermudagrasses

Submitted by:

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Executive Summary

Principle Investigator: Dr. Richard H. White
Research Associate: Mr. Mark Hall
Graduate Research Assistants: Mr. Jason Gray and Mr. Jason Gaudreau
Research Period: 1 January 1999 through 8 November 1999

In general, Champion produced acceptable quality, which increased with increasing N for winter, spring, and summer of 1998. When excessive thatch accumulated in the 683 and 878 kg N $ha^{-1}year^{-1}$ treatments in late summer 1998, scalping damage began to reduce the quality of Champion at those rates of N. This trend continued in Champion during spring 1999 and scalping occurred at all rates of N in summer 1999. This decline in quality trend is further evident in bermudagrass shoot density determinations for fall 1999. Quality of MiniVerde and overseeded MiniVerde tended to increase with N over much of the experiment, and acceptable quality was achieved at the 292 kg N $ha^{-1}year^{-1}$ for most dates. Floradwarf tended to have a significant response to N throughout the experiment, but acceptable quality was rarely reached in this cultivar regardless of N applied. Turf quality in TifEagle and overseeded TifEagle generally did not deviate far from a rating near minimum acceptable and demonstrated little response to increasing N. Tifdwarf tended to have a strong response to N during the summer seasons, and thatch did not become a problem in this cultivar. Acceptable quality was generally obtained at 488 kg N $ha^{-1}year^{-1}$, but there was added benefit to increasing N up to the highest rate.

Judicious nitrogen management will be important in the management of all of these cultivars, but may be more crucial in Champion, MiniVerde, and TifEagle. Thatch accumulation was highly responsive to N in all three cultivars. Thatch became a severe problem in Champion during the first summer of the experiment and showed the potential to affect MiniVerde and TifEagle similarly in the future if there is continued use of high N rates. Severe, infrequent compared with light, frequent vertical mowing reduced thatch in Floradwarf, MiniVerde, TifEagle and Tifdwarf, but the subsequent reduction in turfgrass quality with the severe vertical mowing treatment may be too detrimental for golf course greens. In MiniVerde, data suggest that the combination of frequent topdressing and frequent light vertical mowing reduced thatch while not decreasing quality. There were no significant topdressing main effects in any cultivar in relation to thatch depth. Both treatments did equally well in controlling the rate of thatch accumulation.

A rate of 488 kg N $ha^{-1}year^{-1}$ was adequate for maintaining acceptable quality in TifEagle and MiniVerde during the summer of 1998 and 1999 and quality increased with N in MiniVerde. In Champion, exceeding a rate of 488 kg N $ha^{-1}year^{-1}$ had deleterious effects due to excessive thatch accumulation and subsequent scalping damage. Acceptable quality was maintained in Tifdwarf at a low rate of N and quality tended to increase with N during the summer months. Since there was not excessive thatch accumulation across a wide range of vertical mowing or topdressing regimes, a high rate of N could be used in Tifdwarf. No rate of N or set of other cultural practices produced even a minimum acceptable level of quality in Floradwarf. Floradwarf's poor quality may be due to sensitivity of Floradwarf to bermudagrass decline or poor growth response due to high pH (soil test data revealed a pH of 9.4 during summer 1998), which is commonly found in the USGA specification green in College Station, Texas.

Overall, there was a significant increase in *Poa trivialis* shoot density from the severe infrequent vertical mowing treatment, but seedlings were generally confined to the grooves created by the vertical mower

blades. Turfgrass quality was also negatively affected over the next seven to eight months following the severe fall vertical mowing. The current results of this study suggest that the combination of light frequent vertical mowing and light frequent topdressing produced overseeding shoot densities similar to those found in the heavy vertical mowing treatments, and produced more uniform putting surfaces. It may be beneficial for golf course superintendents to utilize light, frequent vertical mowing and topdressing for maximum turfgrass quality in any of these five cultivars. This approach may require more labor and equipment costs and may not be suitable for Champion if thatch has already accumulated to problematic levels, but generally this approach would be more advantageous than severe vertical mowing. The light, frequent vertical mowing tended to enhance scalping damage in Champion in summer 1999. No treatment combination appeared effective in controlling thatch accumulation in this cultivar.

1999 ANNUAL RESEARCH PROGRESS REPORT

Performance and Management of New Dwarf Bermudagrasses

I. INTRODUCTION

Several new dwarf bermudagrasses are currently receiving wide-spread use. Few studies have been conducted to determine the management requirements and relative performance of these grasses in replicated trials. The growth habits of these new grasses may create distinctly different management requirements from Tifdwarf and Tifgreen. The objectives of this study are to determine the effects of vertical mowing, topdressing, and nitrogen fertility on performance, thatch development, fall and spring overseeding transition, and turf quality of five dwarf bermudagrasses. This program is a cooperative research project funded jointly by the Texas Agricultural Experiment Station (TAES) and the United States Golf Association (USGA). This project was initiated in April 1997. Annual progress reports are submitted 1 November each year and semi-annual progress reports are submitted in 1 May. This report constitutes the 1999 annual progress report for the project and highlights activities between 1 January 1999 and 8 November 1999.

II. PROFESSIONAL AND TECHNICAL SUPPORT

Mr. Mark Hall, Research Associate, provides day-to-day oversight for the experimental protocol associated with this project. Mr. Hall holds a Master of Science Degree in Agronomy from Texas A&M University. He has been employed by the Soil and Crop Science Department about 10 years.

Mr. Jason Gray joined the project in August 1997. Mr. Gray is a graduate of Pennsylvania State University. He is currently pursuing a Master of Science Degree in Agronomy and this project will serve as his thesis project.

Mr. Jason Gaudreau, Agricultural Research Technician, II, and Graduate Research Assistant, is responsible for supervision of the day-to-day activities associated with this project, such as mowing and irrigation. He also assists with the overseeding aspects of the project. Mr. Gaudreau holds a Bachelor of Science Degree in Agronomy from Texas A&M University and is currently pursuing a Master of Science Degree in Agronomy.

III. METHODS

Five bermudagrasses, including MiniVerde, Champion, Floradwarf, TifEagle, and Tifdwarf were planted at the rate of 12 bushels of sprigs per 1000 square feet to 50 feet by 20 feet main plots in a strip-split plot experimental design on April 15, 1997. Sub-plots are annual nitrogen treatments of 6, 10, 14, and 18 lb of nitrogen per 1000 square feet. Nitrogen treatments were applied as bi-weekly treatments throughout the year. Sub-sub plots were vertical mowing treatments of *1)* light, bi-weekly treatments May through September, and *2)* severe vertical mowing once during spring transition and once immediately prior to overseeding in October. Sub-sub-sub plots were topdressing treatments of *1)* 0.02 inches applied bi-weekly May through September followed by a 0.20 inch application at overseeding to total 0.35 inches, and *2)* 0.15 inches in June and 0.20 inches in October totaling 0.35 inches. All treatments were replicated three times and occured in all possible combinations. Nitrogen, vertical mowing, and topdressing treatments were initiated in August 1997 after all grasses were fully established. During grow-in the experimental area was topdressed and groomed to smooth the surface.

Irrigation and mowing were uniformly applied. The experimental area was maintained at 0.125 inch during the summer and 0.156 inch during winter and early-spring by daily mowing. Pesticides were applied during 1998 on a curative basis for army worms, sod webworms, and mole crickets. No differences in insect pest activity were observed among treatments. Herbicides and fungicides were not applied.

The entire experiment was overseeded with *Poa trivialis* in October 1997 and 1998. Monthly visual assessments of turfgrass quality and color were made. Bermudagrass quality was evaluated at least monthly on a 1 to 9 scale where 1 equals brown, seemingly dead turf and 9 equals darkest green, most dense, uniform, smooth and of finest texture. Putting surface quality was also assessed by determining ball roll distance with a modified stimpmeter.

IV. RESULTS

Turf quality data were pooled across seasons and are presented as mean response for winter, spring, summer, and fall of each year. Fall means include sampling dates in October taken following overseeding through the end of December and are representative of turfgrass quality during *Poa trivialis* overseeding establishment. Winter means include sampling dates from the first of January through 15-May and are representative of dormant bermudagrass plus overseeded *Poa trivialis* quality. Spring means include sampling dates from 16-May through the end of July and are representative of turfgrass quality during spring transition from *Poa trivialis* back to 100 percent bermudagrass. Summer means include sampling dates from the first of August up to overseeding in October and are representative of bermudagrass quality. Summer data were the only true evaluation of each of the five bermudagrass cultivars since all treatments were overseeded each fall.

Treatments were initiated in early September 1997 and there was at best a weak response to rate of applied N for cultivars in fall 1997 (Figure 1). Quality in all five cultivars increased with increasing N, but all means were below a minimum acceptable level for golf-green turf (a rating of 5 on a 1 to 9 scale), which may be attributable to fall overseeding. Turfgrass quality in all five overseeded cultivars generally increased with N in winter 1998. MiniVerde and Champion had a strong response to N and quality increased above acceptable around 488kg N $ha^{-1}year^{-1}$. Turf quality in TifEagle and Tifdwarf increased to acceptable only at the highest rate of N. Quality in Floradwarf was unacceptable at all N rates.

Quality increased with N in all cultivars as transition progressed from *Poa trivialis* to 100% bermudagrass in spring 1998 (Figure 1). Acceptable turfgrass quality was exceeded again at a rate of 488 kg N $ha^{-1}year^{-1}$ in Champion and MiniVerde. Turfgrass quality in Tifdwarf showed a response to increasing N and exceeded acceptable quality near 683 kg N $ha^{-1}year^{-1}$. The response of quality to increasing N in TifEagle was weak and approached the minimum acceptable level only at the highest N rate, and quality in Floradwarf did not reach an acceptable level at any rate of N.

Quality increased with N for all cultivars in summer 1998 (Figure 1). MiniVerde and Champion exceeded a minimum acceptable quality rating at the lowest N rate and TifEagle, and Tifdwarf exceeded acceptable quality at 488 kg N $ha^{-1}year^{-1}$. Response in TifEagle and Champion tended to plateau above 488 kg N $ha^{-1}year^{-1}$. However, turf quality tended to increase with increasing N up to 683 kg N $ha^{-1}year^{-1}$ in MiniVerde and Tifdwarf. Quality in Floradwarf approached a minimum acceptable level at the highest rate of N and the lowest N rate produced plots with significant percentages of bare ground (a rating of 3 signifies 40 to 60% bare soil). During late summer and early fall of 1998 scalping damage began to appear in Champion at 683 and 878 kg N $ha^{-1}year^{-1}$. This scalping damage affected quality in fall 1998 and continued through summer 1999 for Champion.

Quality increased with N in Floradwarf and Tifdwarf, stayed nearly constant in TifEagle, and decreased with N in Champion and MiniVerde in fall 1998 as all cultivars were again overseeded with *Poa trivialis* (Figure 2). TifEagle produced acceptable quality at all rates of N and quality in Champion and MiniVerde fell below an acceptable level above 488 kg N $ha^{-1}year^{-1}$. No rate of N produced acceptable quality in Floradwarf or Tifdwarf in fall 1998.

Quality continued to decrease with N in overseeded Champion in winter 1999 (Figure 2). Floradwarf continued to produce unacceptable quality at all rates of N and did not have a significant response to N. Quality in MiniVerde and TifEagle remained nearly constant in response to N except that the highest quality was produced at 488 kg N $ha^{-1}year^{-1}$ in both cultivars.

Quality in Champion continued to decrease with increasing N in the spring of 1999 (Figure 2). Other cultivars tended to show little response to N. Floradwarf continued to produce unacceptable quality regardless of N rate. During the spring of 1999, Bermudagrass decline (*Guamanomyces graminis* var. *graminis*) was diagnosed (Joseph Krausz, personal communication) on the experimental site and apparently affected turf quality in Floradwarf and Champion during spring and summer 1999. Floradwarf and Champion may be more susceptible to the pathogen as indicated by expression of bermudagrass decline symptoms (chlorosis, loss of vigor, reduction in shoot density) and poor overall turf quality during spring and summer 1999. Bermudagrass decline symptoms were most prevalent in Champion and Floradwarf, although symptoms of decline occurred in Tifeagle and Tifdwarf at the lowest N rate. Miniverde did not exhibit symptoms at any rate of applied N.

Response of turf quality to increasing N was strong in MiniVerde and Tifdwarf during summer 1999 and acceptable quality was exceeded at all rates of N (Figure 2). TifEagle demonstrated little response to N and produced acceptable quality above 292 kg N $ha^{-1}year^{-1}$. Champion continued to have the same decline in quality and increase in severity of scalping damage with increasing N that had occurred in summer 1998 and spring 1999. Floradwarf produced unacceptable quality at all N rates

Bermudagrass shoot density was not responsive to topdressing treatments and only slightly responsive to N and vertical mowing. There was a significant N by vertical mowing interaction present in spring and fall 1999 sampling dates in Champion that may explain the reduction in turfgrass quality during the same time period. Shoot density decreased from 140 to 80 shoots cm^{-2} with increasing N in the frequent vertical mowing treatment in fall 1999 while staying nearly constant around 125 in the infrequent vertical mowing treatment. These data suggest that it may be detrimental to utilize a frequent vertical mowing regime in Champion especially with a high rate of N.

Shoot density increased in all cultivars with increasing N in spring 1998, whereas there was less response to N when shoot density was sampled in fall 1998 (Figure 3). Shoot density increased in all cultivars except Champion with increasing N in spring 1999. Shoot density in Champion increased up to 488 kg N $ha^{-1}year^{-1}$ and then decreased with increasing N. This may be related to scalping damage observed in those treatments beginning in August 1998 and continuing in spring and summer 1999. Tifdwarf had similar shoot density with all three N rates below 878 kg N $ha^{-1}year^{-1}$, but did have higher density in that treatment. Shoot density increased with increasing N in Floradwarf, MiniVerde, TifEagle, and Tifdwarf in fall 1999, but decreased with increasing N in Champion.

Poa trivialis shoot density determined each fall after overseeding, indicated that there was an interaction between vertical mowing and topdressing that suggests frequent light vertical mowing be coupled with frequent light topdressing to produce higher shoot density in Champion, Floradwarf, and MiniVerde. Shoot density increased an average of 10 in Champion, 23 in Floradwarf, and 13 in MiniVerde with light, frequent than for severe, infrequent vertical mowing when each was combined with light, frequent topdressing. Data suggest that infrequent topdressing of Champion, Floradwarf and MiniVerde should be combined with infrequent vertical mowing. This improved shoot density by an average of 58 in Champion, 12 in Floradwarf, and 65 in MiniVerde for infrequent than for frequent vertical mowing when each was combined with infrequent topdressing. An interaction between vertical mowing and topdressing in Tifdwarf revealed an improvement of 60 *Poa trivialis* shoots cm^{-2} in infrequent topdressing treatments combined with infrequent rather than frequent vertical mowing. Data also suggested that frequent topdressing combined with infrequent rather than frequent vertical mowing improved *Poa trivialis* shoot density from 74 to 162 shoots cm^{-2} in Tifdwarf. *Poa trivialis* shoot density was not responsive to any main effects in Floradwarf, MiniVerde, or TifEagle. On one date in Champion, a vertical mowing effect showed that *Poa trivialis* shoot density increased from a mean of 126 to 164 shoots cm^{-2} with severe, infrequent compared to light, frequent vertical mowing. This trend was present on two other dates. In Tifdwarf, *Poa trivialis* shoot density was increased from 78 to 142 shoots cm^{-2} in fall 1997 and 142 to 185 shoots cm^{-2} in fall of 1998 in severe, infrequent compared to frequent light vertical mowing treatments.

Turf quality among vertical mowing treatments was significantly different on most observation dates in all cultivars (Table 1). Infrequent, severe vertical mowing treatments at overseeding and in May during spring transition generally caused a decline in turf quality in all cultivars for the duration of fall, winter, and spring. Severe vertical mowing treatments caused a reduction in turf quality from fall 1997 through spring 1998 in all cultivars. Overseeding germination in Champion, MiniVerde, and Tifdwarf was greater in infrequent vertical mowing treatments in 1997 and 1998, but seedlings were generally confined to vertical mowing "grooves" in these treatments. The infrequent severe vertical mowing treatment generally produced a "corn-row" appearance, whereas the frequent light vertical mowing treatment produced a more uniform overseeded putting surface. The non-uniform appearance caused by severe vertical mowing resulted in poor turf quality ratings for as much as seven months following overseeding .

A negative response to infrequent severe vertical mowing continued in summer 1998 from the treatment applied in late May in all cultivars but Champion (Table 1). In fall 1998, Floradwarf and Tifdwarf had a response opposite to that in 1997 as quality increased for infrequent, severe vertical mowing compared to frequent vertical mowing. The other three cultivars had a similar negative response to severe vertical mowing as they did in 1997. Negative response to severe vertical mowing continued in winter 1998 in all cultivars except Floradwarf and MiniVerde. There was no significant response to vertical mowing in any cultivar in spring 1999 and Champion and Floradwarf had a negative quality response to frequent, light vertical mowing during summer 1999. The decline in quality due to frequent, light vertical mowing in Champion and Floradwarf may have been associated with bermudagrass decline. Mechanical stress caused by light, frequent vertical mowing treatments may have weakened and predisposed Champion and Floradwarf to increased bermudagrass decline severity. A program of two annual severe vertical mowing treatments negatively affected turf quality in all five cultivars over most seasons. Data also suggest that frequent light vertical mowing be accompanied by frequent light topdressing for improved overseeding shoot density.

Differences among topdressing treatments were significant on only one date in TifEagle and one in Tifdwarf. The fall 1998 topdressing effect in TifEagle suggests that frequent light topdressing improved quality by one-third of a point. An increase of one-fifth of a point was found in Tifdwarf in summer 1999. This is probably not of practical significance to the observer. Other than those two dates, topdressing did not play a major role in turf quality.

There was a strong relationship between ball roll and N rate when averaged across four sampling dates. The 292 kg N $ha^{-1}year^{-1}$ treatment produced the longest ball roll distance in all cultivars (Figure 4). There was a decline in ball roll distance with increasing N in all five cultivars. There may not be a great benefit to increased shoot density found in MiniVerde, Champion, and TifEagle compared with Tifdwarf, if ball rolls are not increased. Ball roll distance in Tifdwarf had a significant relationship to vertical mowing treatment where the infrequent vertical mowing treatments produced longer rolls by an average of 8 cm compared to frequent vertical mowing treatments. Topdressing regimes did not affect ball roll distance.

Several of the new dwarf cultivars in this experiment had very high rates of thatch accumulation even at a low rate of applied N (Figure 5). A vertical mowing by topdressing interaction effect on thatch depth occurred for Floradwarf and MiniVerde. This interaction was significant in two out of four sampling dates in each cultivar. In the spring and fall of 1998, frequent topdressing combined with infrequent vertical mowing reduced thatch by 57 and 24% compared with frequent topdressing combined with frequent topdressing in Floradwarf. A similar trend was observed in 1999. In spring and fall 1998, infrequent topdressing combined with frequent vertical mowing had 26 and 9% less thatch than infrequent topdressing combined with infrequent vertical mowing. A similar trend was observed in 1999.

In MiniVerde, fall 1998 and 1999 data suggested that in frequent topdressing treatments, frequent vertical mowing reduced thatch accumulation by 31 and 9% respectively, and the other two dates revealed similar responses. In infrequent topdressing treatments, infrequent vertical mowing reduced thatch by 28 and 29%, which was similar also on the two other dates. This same response was significant in ash weight data for MiniVerde in spring 1998 and fall 1999 and was similar though not significant on the other two dates.

There was one significant N by topdressing interaction effect on thatch depth for spring 1999 in TifEagle. Further analysis of the interaction revealed that the least depth of thatch occurred in the 488 kg N $ha^{-1}year^{-1}$ rate in both topdressing treatments. Thatch increased in the 683 kg N $ha^{-1}year^{-1}$ rate and then decreased in the frequent topdressing treatment while thatch depth continued to increase in the infrequent topdressing treatment. There were no other interactions present in the thatch depth data and main effects of N and vertical mowing will now be discussed.

There was a significant response of thatch depth to rate of applied N within cultivars. Data are presented graphically for thatch accumulation in response to rate of applied nitrogen for four sampling dates during 1998 and 1999. In spring 1998, none of the five cultivars had accumulated a significant amount of thatch (Figure 5). The first thatch depth measurement was taken 12 months after planting. By fall 1998, several cultivars had substantial increases in thatch and thatch depth increased in all cultivars in response to rate of applied N (Figure 5). Champion produced a high level of thatch at the lowest rate of N and increased with added N. The rapid accumulation of thatch in Champion probably accounts for the scalping damage that occurred in Champion at 683 and 878 kg N $ha^{-1}year^{-1}$ in August of 1998 and continued through 1999. MiniVerde, TifEagle, and Tifdwarf had strong responses to rate of applied N indicating that moderate N could be used to limit thatch accumulation in these cultivars. Tifdwarf did not produce significant thatch at any rate of N by fall 1998.

Thatch levels in Champion, TifEagle, and Tifwarf did not have a significant response to applied N in spring 1999 (Figure 5). Champion had the greatest thatch accumulation at 488 kg N $ha^{-1}year^{-1}$, a trend that continued in fall 1999. MiniVerde and Floradwarf had a significant response to N and continued to demonstrate a strong increase in thatch with rate of applied N . All five cultivars had more thatch in spring of 1999 than in the previous fall and Tifdwarf had considerable thatch in spring 1999. These data suggest that there is a possible contribution to thatch from the overseeded *Poa trivialis* from the fall of one year to the spring of the next. It is possible that the overseeded grass contributes a significant amount of organic matter (carbon) to the turfgrass environment and when the overseeded grass dies in the spring, there may be an increase in the C:N ratio that reduces thatch decomposition. Further research is needed to explore this suggestion.

Thatch depth in Champion demonstrated little response to N and substantial thatch occurred for all N rates in fall 1999 (Figure 5). Thatch depths in Floradwarf and MiniVerde responded to increasing N, but the response tended to plateau in MiniVerde at 683 kg N $ha^{-1}year^{-1}$. TifEagle produced considerable thatch at all N rates and did not have a significant response to N rate. Scalping damage evident in Champion in fall 1998 when thatch depth reached a similar level did not occur in TifEagle in 1999. Thatch depth in Tifdwarf had a significant response to increasing N as it did in the previous two sampling dates, but absolute amounts of thatch were less in fall 1999 than spring 1999. This may be due to increased rates of decomposition due to cultural treatments, or the addition of topdressing creating more mat than thatch in this cultivar. A significant main effect from vertical mowing revealed that infrequent vertical mowing reduced thatch depth by 13% in TifEagle in spring 1999.

Thatch depth in Champion had a very strong response to N in 1998 that was not as apparent in 1999. This may be due to thatch accumulation reaching a limit where any additional thatch production was limited because of severe scalping damage in Champion for summer of 1999. Thatch depth in TifEagle and MiniVerde generally increased with increasing N and could become a problem in these cultivars at high rates of N fertilization. Tifdwarf did not produce a detrimental level of thatch at any rate of N employed in this experiment (Figure 5).

V. SUMMARY

In general, Champion produced acceptable quality, which increased with increasing N for winter, spring, and summer of 1998. When excessive thatch accumulated in the 683 and 878 kg N $ha^{-1}year^{-1}$ treatments in late summer 1998, scalping damage began to reduce the quality of Champion at those rates of N. This trend continued in Champion during spring 1999 scalping occurred at all rates of N in summer 1999. This decline in quality trend is further evident in bermudagrass shoot density determinations for fall 1999. Quality of MiniVerde and overseeded MiniVerde tended to increase with N over much of the experiment, and acceptable quality was achieved at the 292 kg N $ha^{-1}year^{-1}$ for most dates. Floradwarf tended to have a significant response to N throughout the experiment, but acceptable quality was rarely reached in this cultivar regardless of N applied. Turf quality in TifEagle and overseeded TifEagle generally did not deviate far from a rating near minimum acceptable and demonstrated little response to increasing N. Tifdwarf tended to have a strong response to N during the summer seasons, and thatch did not become a problem in this cultivar. Acceptable quality was generally obtained at 488 kg N $ha^{-1}year^{-1}$, but there was added benefit to increasing N up to the highest rate.

Judicious nitrogen management will be important in the management of all of these cultivars, but may be more crucial in Champion, MiniVerde, and TifEagle. Thatch accumulation was highly responsive to N in all three cultivars. Thatch became a severe problem in Champion during the first summer of the experiment and showed the potential to affect MiniVerde and TifEagle similarly in the future if there is continued use of high N rates. Severe, infrequent compared with light, frequent vertical mowing reduced thatch in Floradwarf, MiniVerde, TifEagle and Tifdwarf, but the subsequent reduction in turfgrass quality with the severe vertical mowing treatment may be too detrimental for golf course greens. In MiniVerde, data suggest that the combination of frequent topdressing and frequent light vertical mowing reduced thatch while not decreasing quality. There were no significant topdressing main effects in any cultivar in relation to thatch depth. Both treatments did equally well in controlling the rate of thatch accumulation.

A rate of 488 kg N $ha^{-1}year^{-1}$ was adequate for maintaining acceptable quality in TifEagle and MiniVerde during the summer of 1998 and 1999 and quality increased with N in MiniVerde. In Champion, exceeding a rate of 488 kg N $ha^{-1}year^{-1}$ had deleterious effects due to excessive thatch accumulation and subsequent scalping damage. Acceptable quality was maintained in Tifdwarf at a low rate of N and quality tended to increase with N during the summer months. Since there was not excessive thatch accumulation across a wide range of vertical mowing or topdressing regimes, a high rate of N could be used in Tifdwarf. No rate of N or set of other cultural practices produced even a minimum acceptable level of quality in Floradwarf. Floradwarf's poor quality may be due to sensitivity of Floradwarf to bermudagrass decline or poor growth response due to high pH (soil test data revealed a pH of 9.4 during summer 1998), which is commonly found in the USGA specification green in College Station, Texas.

Overall, there was a significant increase in *Poa trivialis* shoot density from the severe infrequent vertical mowing treatment, but seedlings were generally confined to the grooves created by the vertical mower blades. Turfgrass quality was also negatively affected over the next seven to eight months following the severe fall vertical mowing. The current results of this study suggest that the combination of light frequent vertical mowing and light frequent topdressing produced overseeding shoot densities similar to those found in the heavy vertical mowing treatments, and produced more uniform putting surfaces. It may be beneficial for golf course superintendents to utilize light, frequent vertical mowing and topdressing for maximum turfgrass quality in any of these five cultivars. This approach may require more labor and equipment costs and may not be suitable for Champion if thatch has already accumulated to problematic levels, but generally this approach would be more advantageous than severe vertical mowing. The light, frequent vertical mowing tended to enhance scalping damage in Champion in summer 1999 and no set of treatments was adequate in this experiment to slow the rate of thatch accumulation in this cultivar.

VI. FUTURE WORK

The study will continue to focus on thatch accumulation and performance during 2000. Bermudagrass decline became a problem on the research area during 1999 for Champion and Floradwarf and the response of the other cultivars to bermudagrass decline will be monitored closely during 2000. The development of bermudagrass decline will provide insight into the future management of this disease. We also diagnosed a new patch disease differentially affecting the cultivars during the spring and early summer of 1999. This is the first documentation of the disease occurring in bermudagrass. The disease was only recently diagnosed in creeping bentgrass. The disease is caused by *Ophiosphaerella* spp. and is influenced by cultivar, nitrogen fertility, vertical mowing, and topdressing. The reoccurrence and progress of the disease will be closely monitored in 2000.

This USGA funded research has provided a wealth of information on the management of new dwarf bermudagrasses and has identified several potential problems that should be considered when making cultivar selection. Cultivar specific management requirements, such as nitrogen fertility, topdressing, and vertical mowing have been identified. We will continue to provide updates to the scientific community and to professional turf managers through presentations at turf conferences, regional seminars, and popular articles about this ongoing research. We will be preparing a referred publication concerning this research in 2000.

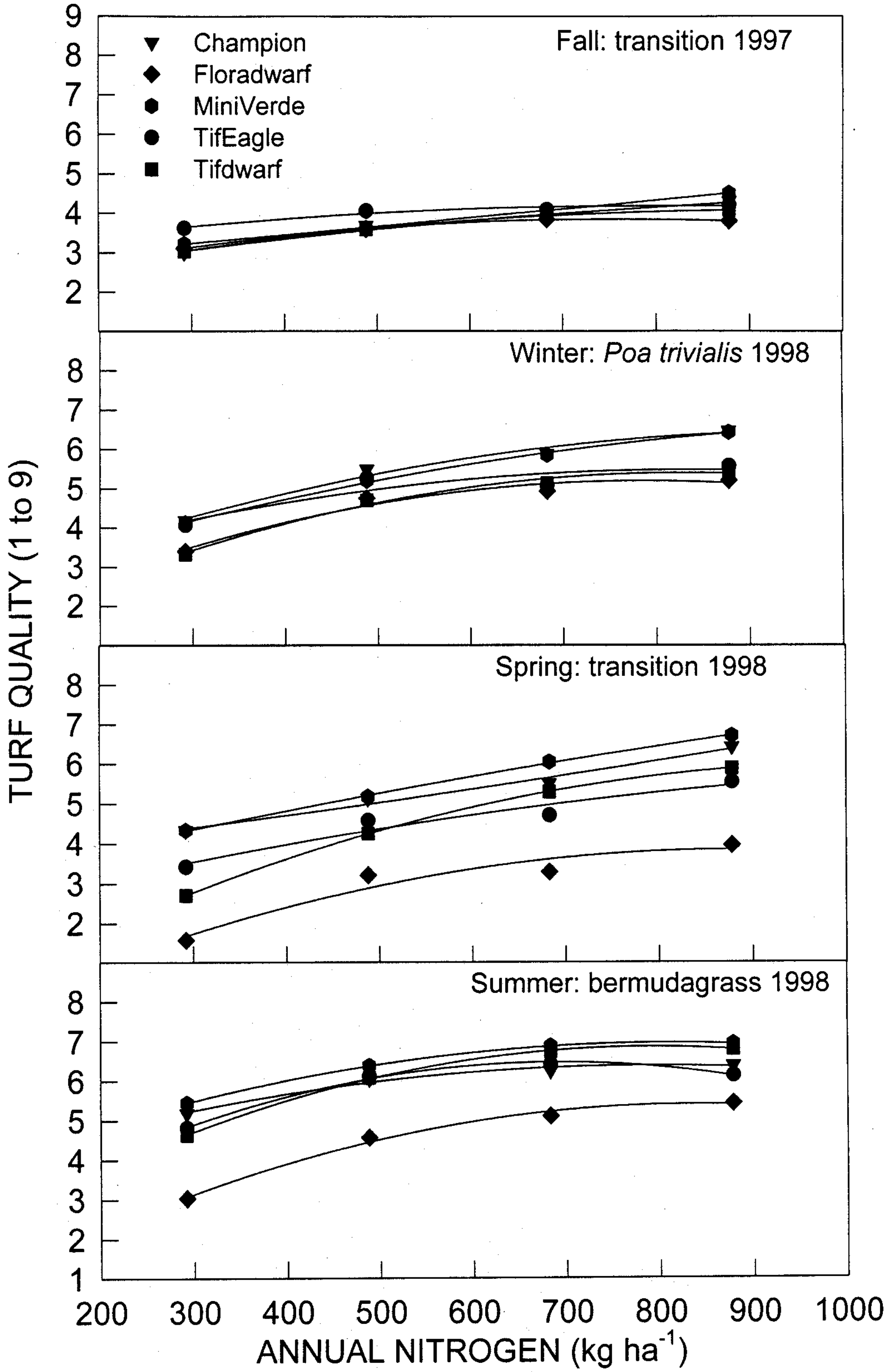

Figure 1. Relationship of turfgrass quality to rate of applied nitrogen for five bermudagrass cultivars from fall 1997 to summer 1998.

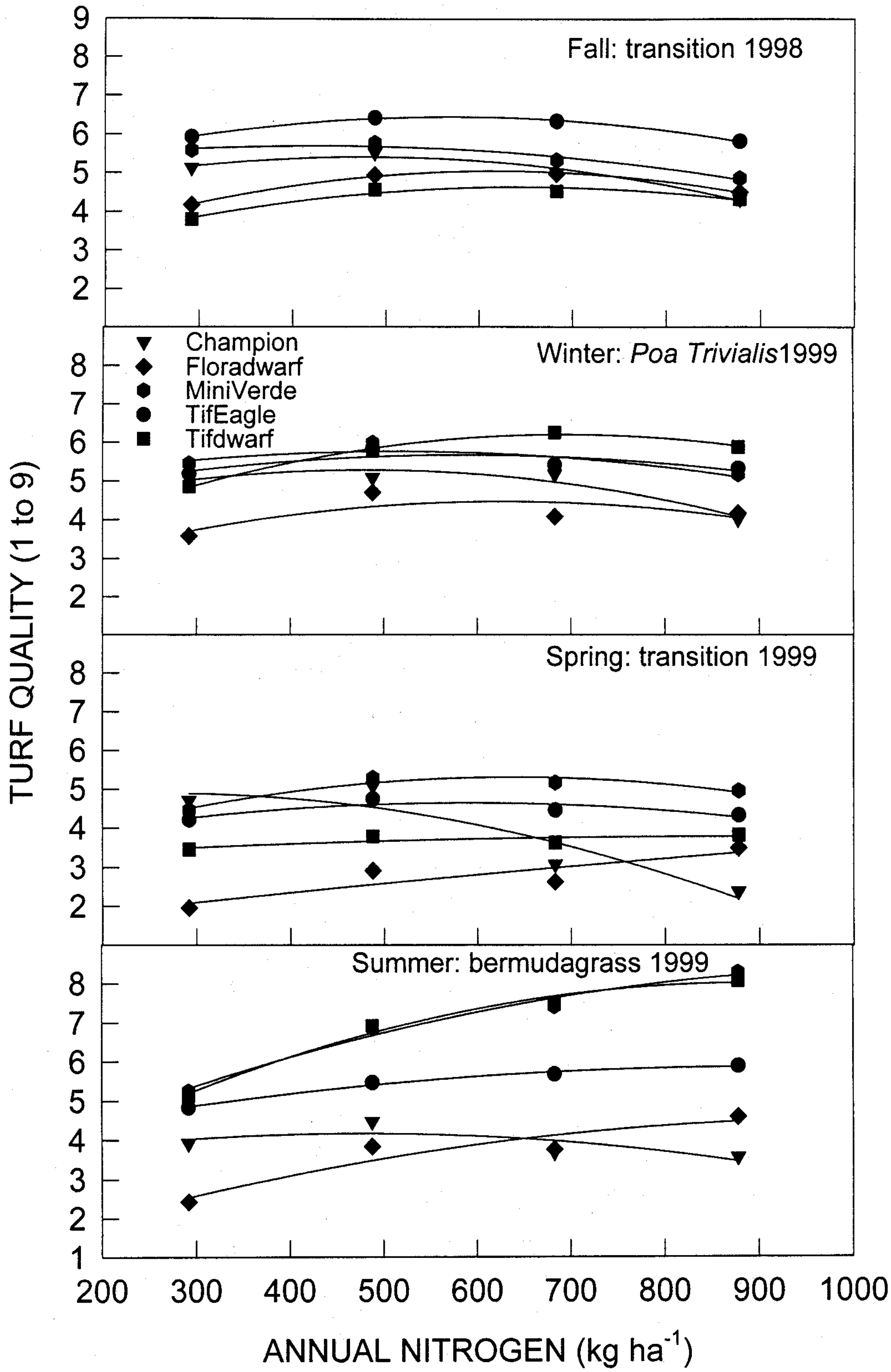

Figure 2. Relationship of turfgrass quality to rate of applied nitrogen for five bermudagrass cultivars from fall 1998 through summer 1999.

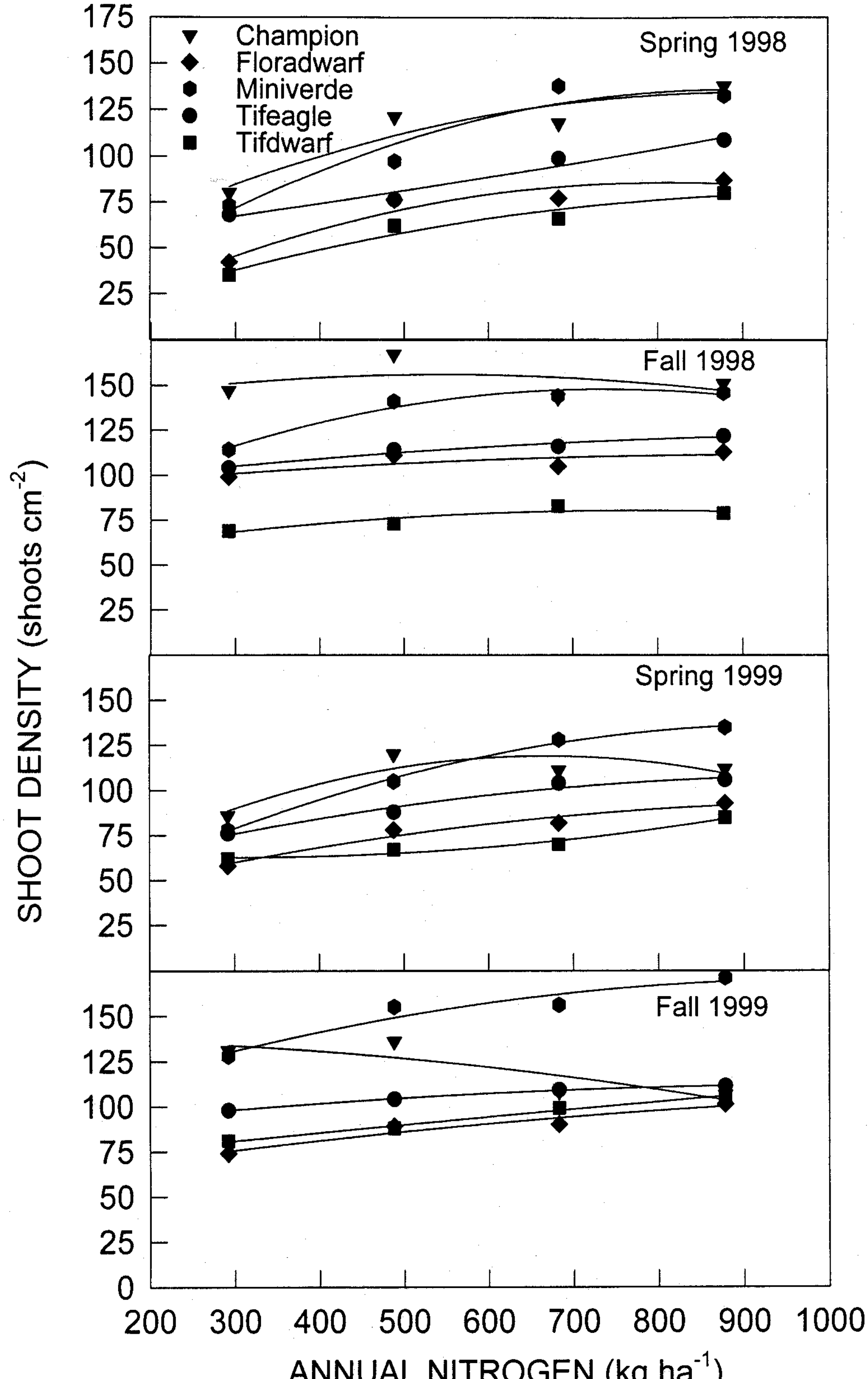

Figure 3. Relationship of shoot density to rate of applied nitrogen for five bermudagrass cultivars during spring and fall of 1998 and 1999.

Table 1. Relationship of mean turfgrass quality to vertical mowing treatments for 1997 through 1999 for five bermudagrass cultivars.

Cultivar		1997	1998				1999		
		Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Champion									
	VF	4.5a[†]	5.9a	5.6a	5.9a	5.2a	5.0a	3.7a	3.3b
	VI	2.8b	5.0b	5.0b	6.0a	4.8b	4.7b	3.9a	4.5a
Floradwarf									
	VF	4.4a	5.1a	3.6a	4.6a	4.4b	4.3a	2.6a	3.4b
	VI	2.7b	4.0b	2.4b	4.4b	4.9a	3.9a	2.9a	3.9a
MiniVerde									
	VF	4.7a	5.8a	5.9a	6.5a	5.6a	5.6a	5.0a	6.9a
	VI	3.0b	5.0b	5.3b	6.3b	5.2b	5.4a	4.9a	7.0a
TifEagle									
	VF	4.9a	5.8a	5.3a	6.1a	6.4a	5.8a	4.6a	5.3a
	VI	3.1b	4.1b	3.8b	5.6b	5.9b	5.0b	4.3a	5.6a
Tifdwarf									
	VF	4.3a	4.8a	4.8a	6.0a	4.1b	6.1a	3.7a	7.0a
	VI	3.0b	4.5b	4.3b	6.1b	4.5a	5.3b	3.6a	6.8a

[†] Turf quality means dates with the same letter do not differ at the P>0.05 probability level based on Tukey's Studentized Range using ranked transformed means.
Quality was assessed on a 1 to 9 scale with 1= very poor quality and 9=excellent quality.
VF is frequent light vertical mowing treatment.
VI is infrequent severe vertical mowing treatment.

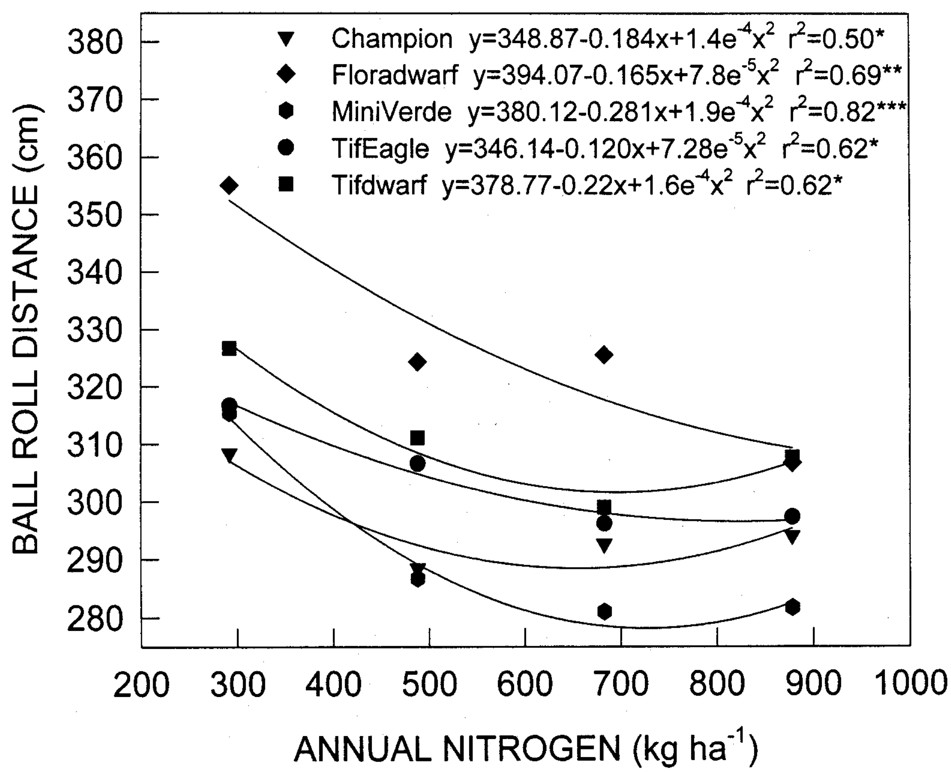

Figure 4. Relationship of ball-roll distance to rate of applied nitrogen for four sampling dates in 1998 and 1999 for five bermudagrass cultivars.

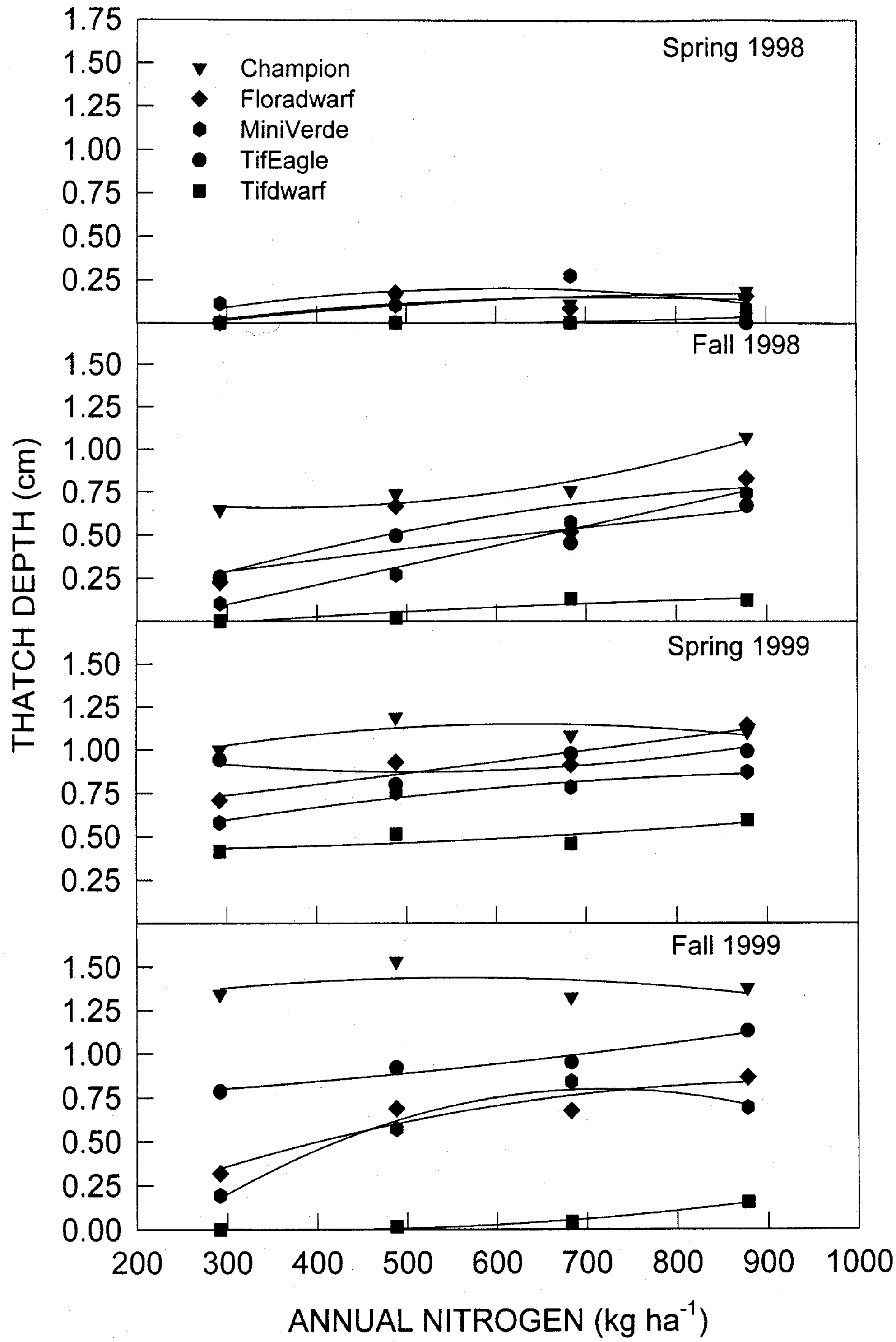

Figure 5. Relationship of thatch depth to rate of applied nitrogen for five bermudagrass cultivars for spring and fall of 1998 and 1999.