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Growth and Development of Different Turfgrasses as Influenced by Nitrogen Application and Leaf Nitrogen Contents

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ABSTRACT

Effect of various levels of N on Bermudagrass (*Cynodon dactylon* L.) var. 'Dacca' and Zoysia grass (*Zoysia spp.*) locally known as 'Chinese' were studied with a view to determine the influence of nitrogen fertilizer rates on growth and development of these turfgrass varieties. The specific objectives of the study were to find out the relationship of leaf nitrogen contents with different indices of growth and to investigate the growth and biomass response of these turfgrasses to various nitrogen levels under the agro-ecological conditions of Faisalabad. Plant height, number of tillers, number of leaves per tiller, turfgrass quality, shoot fresh weight, leaf area and leaf N percentage were highest for 30 g N/m^2/month in both grasses, whereas, shoot fresh and dry weight ratio was more for 20 g N/m^2/month. Moreover, tiller density, length of leaf blade, rate of coverage, shoot fresh weight, shoot dry weight, leaf area and leaf N percentage was observed more in spring as compared to autumn. While other indices of study like plant height, number of leaves per tiller, turfgrass quality and stolon diameter presented similar response during both seasons. Furthermore, regression equations indicated positive relationship between nitrogen application and different growth indices of these turfgrasses.

Key Words: Bermudagrass; Zoysia grass; Nitrogen; Leaf; Growth

INTRODUCTION

Growing turfgrasses is a big enterprise owing to the great demand for the establishment of lawns. Additional environmental benefits related to turf are to protect houses and recreational places from dust and mud, and safeguard against the intensity of glare and heat (Turgeon, 1996).

Turfgrass quality is usually related to fertilizer application and management practices. Nitrogen fertilizer formulations are undergoing a change in order to produce acceptable turfgrass response and reduce management costs. Nitrogen influences root growth, disease susceptibility, heat, cold and drought tolerance and regrowth potential (Horst *et al.,* 1985). While Davis (1969) concluded that nitrogen is an indispensable part of proteins, chlorophyll, amino acids, amides and alkaloids. Since turfgrasses are maintained in a vegetative condition and prevented from going dormant whenever feasible, their annual nitrogen requirements are higher than for most plants.

Kern (1970) reported that application of N late in the season improved the winter colour of the turf, sward density and root formation. It was observed that efficiency of nitrogen fertilizers for turfgrasses can be increased by the use of slowly available N sources such as natural organics, slightly soluble N fertilizers and coated materials (Boonduang *et al.,* 1976). Whereas, Canaway (1984) attributed that above ground biomass increased markedly with increasing N except at the highest levels where there was a decline, particularly on soil. Late season N application prolonged desirable turfgrass colour in the fall and again the following spring with no visible signs of increased winter kill (Goatley *et al*., 1994).

The objectives of this study were to optimize nitrogen fertilization on warm season turfgrasses and to investigate the growth and biomass response of these turfgrasses to various N levels under the agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

This study was conducted at the Floriculture Research Area, Department of Horticulture, University of Agriculture, Faisalabad, during 2001-2002. Prior to this study, annual floriculture crops were grown in the area where this research was conducted. The soil of the area was loamy with a pH of 7.9 and 1.3% organic matter.

Two turfgrasses *Cynodon dactylon* var. 'Dacca' and *Zoysia spp*. locally known as 'Chinese' were grown with each comprising of four treatments replicated thrice. Source of nitrogen was urea (46%) which was applied at 0, 10, 20 and 30 g N/m^2/month. The experiment was laid out according to split plot design by randomizing varieties in main plots and nitrogen levels in subplots. Equal sized plugs were planted in the plots measuring 3 m x 1 m in size during 3rd week of July, 2001 on well prepared and leveled soil surface. Plug to plug distance was kept at 8 inches (20 cm). Fertilizer was applied according to the treatments; whereas, other management practices like irrigation, weeding and mowing were same for all treatments during entire period of study. All plots received a weekly application of irrigation water during the growing season. Moreover, turfs were mowed biweekly to a height of 2.5 cm. Grass clippings were removed from the experimental plots. Plugs were allowed to establish for a period of 60 days and then data on

different growth and biomass indices of the grasses were collected by adopting standard procedures during the conduct of the experiment.

Soil analysis for N estimation was also carried out in order to determine the fertility status of soil. Plant height and length of leaf blade were measured with the help of measuring tape. Number of tillers present in 3 square inches and number of leaves per tiller were calculated by counting (Beard, 1973). For recording data on "rate of coverage", procedure described by Fucik and Turley (1991) was followed. Turfgrass quality was evaluated by using the method described by Cooper and Spokas (1991) and Dest and Guillard (1987). "Shoot fresh weight" was measured by the procedure described by Clyde *et al.* (1989) and for leaf N percentage estimation, method described by Chapman and Parker (1961) was followed. Leaf area was measured by the formula given by Carleton and Foote (1965).

All the data regarding the parameters of the experiment were analyzed statistically using the procedure described by Steel and Torrie (1980). Means were separated using Duncan's multiple range test at 0.05 probability level.

RESULTS AND DISCUSSION

The present research project was envisaged with the aim of studying the response of bermudagrass and zoysiagrass to different levels of nitrogen application during different seasons. Data on various indices of growth were collected and analyzed statistically. The results obtained are interpreted as follows:

Results obtained on height of plant depicted that 30 g N/m^2/month proved best treatment as compared to 20 g N/m^2/month, 10 g N/m^2/month and control. Whereas, in case of varietal behaviour regarding this parameter, Dacca grass has shown superiority over Chinese grass. It was also noted that results were non-significant in case of seasons. For number of tillers, maximum tillers were obtained in 30 g N/m^2/month application as compared to rest of the treatments while in case of varieties, Chinese grass proved better than Dacca grass. Moreover, spring season exhibited superiority over autumn regarding this factor of study (Table I). Furthermore, regression equations presented positive response of this parameter to N application.

As far as number of leaves per tiller was concerned, 30 g N/m^2/month revealed significantly better results than other treatments. Moreover, Dacca grass presented more number of leaves as compared to Chinese grass with similar effects during both seasons on both turfgrass varieties. Furthermore, regression equations indicated positive relationship between nitrogen application and number of leaves per tiller. In case of length of leaf blade, 30g N/m^2/month dominated over all other treatments and Dacca grass presented long leaf blades as compared to Chinese grass. Moreover, spring season showed superiority over autumn for this index of growth.

Results obtained on rate of coverage depicted that 30 g N/m^2/month application proved best treatment as compared to 20 g N/m^2/month, 10 g N/m^2/month and control. However, a rapid increase in rate of coverage was observed with N application at 10 g N/m^2/month level from control especially in case of Dacca grass and then with increasing N level from 10 g N/m^2/month to 20 g N/m^2/month and 30 g N/m^2/month, rate of coverage was also increased but at a slower rate. Moreover, varietal behaviour regarding this parameter of study has shown slightly significant differences with superior results presented by Dacca grass. Turfgrass quality was evaluated at predetermined times on a scale of 1 to 9. A score of nine indicated dark green high quality turf. For turfgrass quality, maximum results were obtained in 30 g N/m^2/month application which exhibited significant difference from all other treatments. However, rapid increase in turfgrass quality was observed in Chinese

Table I. Average effects of various levels of N on plant height, number of tillers and number of leaves per tiller of both turfgrasses over the growing seasons

N levels	Plant height (cm)				Number of tillers				No. of leaves per tillers			
	Autumn		Spring		Autumn		Spring		Autumn		Spring	
	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese
0 g N/m^2/month	8.6	3.2	6.3	2.9	9.2	15.5	12.4	18.4	8.2	3.1	6.5	3.0
10 g N/m^2/month	10.1	3.6	7.8	3.4	10.7	17.6	13.4	21.5	9.5	4.0	8.3	3.7
20 g N/m^2/month	11.1	3.7	11.5	4.2	13.2	21.4	16.7	24.4	10.9	4.3	11.2	5.1
30 g N/m^2/month	12.4	4.3	15.4	4.9	13.4	22.7	21.0	26.8	11.2	4.6	12.7	5.7

Table II. Average influence of various levels of N on rate of coverage, turfgrass quality and leaf N % age of both turfgrasses

N levels	Rate of coverage		Turfgrass quality		Leaf N %age	
	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese
0 g N/m^2/month	14.58	7.50	5.0	1.0	0.88	0.83
10 g N/m^2/month	19.58	9.58	6.3	3.7	1.38	1.05
20 g N/m^2/month	21.25	11.25	7.7	5.0	1.69	1.34
30 g N/m^2/month	21.67	12.67	9.0	5.0	1.98	1.68

Table III. Mean efficacy of various levels of N on shoot fresh weight, shoot dry weight and shoot fresh and dry weight ratio of both turfgrasses during different seasons

N levels	Shoot fresh weight (g)				Shoot dry weight (g)				Shoot fresh and dry weight ratio			
	Autumn		Spring		Autumn		Spring		Autumn		Spring	
	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese
0 g N/m^2/month	0.73	0.57	1.00	0.55	0.26	0.30	0.46	0.34	2.72	1.86	2.11	1.59
10 g N/m^2/month	0.96	0.67	2.16	1.41	0.31	0.34	0.85	0.75	3.20	1.98	2.57	1.84
20 g N/m^2/month	1.10	0.86	2.93	2.21	0.34	0.54	1.11	1.17	3.28	2.05	2.79	1.87
30 g N/m^2/month	1.47	0.95	4.09	2.44	0.52	0.55	1.52	1.27	2.85	1.77	2.62	1.81

Table IV. Mean effects of various levels of N on length of leaf blade, stolon diameter and leaf area of both turfgrasses during different seasons

N levels	Length of leaf blade (cm)				Stolon diameter (mm)				Leaf area (cm^2)			
	Autumn		Spring		Autumn		Spring		Autumn		Spring	
	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese	Dacca	Chinese
0 g N/m^2/month	2.6	1.5	3.5	1.9	0.05	0.03	0.06	0.04	0.80	0.23	1.05	0.29
10 g N/m^2/month	3.3	2.0	3.7	2.5	0.07	0.05	0.07	0.05	1.00	0.31	1.12	0.39
20 g N/m^2/month	4.6	2.5	5.3	3.2	0.08	0.07	0.09	0.07	1.40	0.38	1.62	0.48
30 g N/m^2/month	5.1	2.7	5.6	3.7	0.10	0.08	0.10	0.09	1.52	0.41	1.70	0.56

Table V. Relationship between leaf N contents and different growth indices of Dacca grass during spring

Leaf N contents %	Plant height (cm)	Tiller density	Shoot fresh weight (g)	Shoot dry weight (g)	Shoot fresh and dry weight ratio	Leaf area (cm^2)
0.88	6.3d	12.4d	1.00d	0.46d	2.11c	1.05b
1.38	7.8c	13.4c	2.16c	0.85c	2.57b	1.12b
1.69	11.5b	16.7b	2.93b	1.11b	2.79a	1.62a
1.98	15.4a	21.0a	4.09a	1.52a	2.62b	1.70a

Means having same letters are statistically non-significant

Table VI. Relationship between leaf N contents and different growth indices of Chinese grass during springs

Leaf N contents %	Plant height (cm)	Tiller density	Shoot fresh weight (g)	Shoot dry weight (g)	Shoot fresh and dry weight ratio	Leaf area (cm^2)
0.83	2.9d	18.4d	0.55d	0.34d	1.59c	0.29d
1.05	3.4c	21.5c	1.41c	0.75c	1.84a	0.39c
1.34	4.2b	24.4b	2.21b	1.17b	1.87a	0.48b
1.68	4.9a	26.8a	2.44a	1.27a	1.81b	0.56a

Means having same letters are statistically non-significant

grass when N application was carried out at 10 g N/m^2/month level than control while 20 g N/m^2/month and 30 g N/m^2/month N application produced similar results for this turfgrass variety. Moreover, varietal behaviour indicated that both grasses have shown similar quality with minor difference in their average quality (Table II).

Results on shoot fresh weight elucidated that 30 g N/m^2/month topped rest of the treatments with 0 g N/m^2/month (control) at the bottom. In case of varieties, present data focused better results of Dacca grass as compared to Chinese grass while among seasons, more shoot fresh weight was observed in spring than autumn. With the advent of spring season, shoot fresh weight of both varieties was triggered up to the double which indicated that nitrogen improved biomass of turfgrasses more vigorously during spring. For verification of these results, regression equations were drawn which indicated positive response of both grasses to N application during both seasons with superiority of Dacca grass during spring. As far as shoot dry weight was concerned, 30 g N/m^2/month application proved best treatment as compared to rest of the treatments. Whereas, both varieties exhibited similar response to nitrogen application with superior results during spring (Table III). Regression equations were also drawn in order to verify above results which revealed positive relationship between shoot dry weight and nitrogen application. For shoot fresh and dry weight ratio, 20 g N/m^2/month and Dacca grass presented superior results with no effect of seasons on these results. In this case, 30 g N/m^2/month attained third position after 20 g N/m^2/month and 10 g N/m^2/month. It was also observed that shoot fresh and shoot dry weight ratio was more during autumn as compared to spring along with 20 g N/m^2/month and 10 g N/m^2/month presenting similar results.

Stolon diameter was observed maximum in 30 g N/m^2/month application which increased coarseness in turfgrasses while control (0 g N/m^2/month) presented minimum stolon diameter which is considered good in view

of texture of grass. For this factor of study, grasses exhibited significantly different response while seasons produced almost similar results. Observations pertaining to leaf area depicted that Dacca grass has shown maximum leaf area, whereas, in case of treatments, 30 g N/m^2/month presented best results as compared to all other treatments. Moreover, leaf area was observed slightly more during spring than in autumn (Table IV). Furthermore, regression equations indicated more increase in leaf area of Dacca grass than Chinese grass.

Results regarding leaf nitrogen contents revealed that leaf N status was improved by increasing the level of nitrogen fertilizer. In this case, 30 g N/m^2/month exhibited superiority over 20 g N/m^2/month, 10 g N/m^2/month and control. Whereas, in case of varietal behaviour, Dacca grass performed better than Chinese grass for this factor of study (Table V).

CONCLUSION

Nitrogen application improved different growth and biomass indices of turfgrasses vigorously with 30 g N/m^2/month application presenting superior results as compared to rest of the treatments for almost all parameters of study. Moreover, Dacca grass responded better to N application than Chinese grass whereas seasonal variations were negligible with slight superiority of spring season over autumn in some cases. Therefore, optimum use of nitrogen fertilizer in small split doses would help better towards vigorous growth of turfgrasses and to keep your lawns and green spaces attractive and healthy.

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