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RESPONSE OF BERMUDA GRASS (*CYNODON DACTYLON,* L.) TO NITROGEN FERTILIZATION AND MOWING DATES.

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ABSTRACT

A split plot field experiment was conducted to study the influence of four ammonium sulphate rates (0, 20, 30 and 40 g / m^2) and five mowing dates (starting May 1st till November 20th) on Bermuda grass. Obtained results showed that ammonium sulphate at the high rate (40 g / m^2) surpassed other rates in augmenting different vegetative growth parameters and chemical constituents. These traits were gradually increased by gradual increase in the rates of ammonium sulphate fertilization. On the other hand, the fourth mowing date (September 30th) gave the best vegetative growth parameters and highest values of chemical constituents in comparison with the fifth mowing, date (November 20th). However, combined treatment of ammonium sulphate at 40 g / m^2 and fourth mowing date on September 30th gave the best results.

INTRODUCTION

Bermuda grass (*Cynodon dactylon*, L.), belongs to family Poaceae (Gramineae), is the most familiar turf-grass used in landscape design in Egypt. Turfgrass is considered the main element of landscape design. It is the background of foundation for details; constructions, trees, shrubs and flowers. The quality of turf-grass is greatly affected by chemical fertilization especially nitrogen. Number of authors pointed out the capability of nitrogen fertilizers at different

rates in improving vegetative growth parameters (plant height, covering density percentage, clipping fresh and dry weights) and increasing chemical constituents (total chlorophylls, sugars nitrogen, phosphorus and potassium percentage) of: *Cynodon dactylon.* (Johanson and Burns, 1985, Mc Caslin *et al.,* 1989, White and Schmidt, 1990, Hossni, 1993, Pitman, 1999 and Surour, 2001) ; *Lolium perenne* (Canaway and Hacker; 1988 ; Razmjoo, and Kaneko; 1993 and Soliman 1997); *Agrostis palustris* (Mc Crimnon and Karnok, 1992 and Huang and Petrovic; 1995); *Festuca arundinacea* (Johanson and Carrow; 1993, Zhang *et al.,* 1998 and Pitman, 1999); *Poa pratensis* (Wilkinson, 1977, Bi Yufen and Sun Jixiong; 1994 and Zhang *et al.,* 1998) and *Zoysia japonica* (Dunn *et al.,* 1995 and Carroll *et al.,* 1996).

The objective of the present study was to find out the most suitable quantity of nitrogen rate and mowing date which give the best quality of vegetative growth parameters and chemical constituents of bermuda grass.

MATERIALS AND METHODS

This experiment was carried out at the Experimental unit of Orman Botanical Garden, Giza, Egypt during two successive seasons (2007 / 2008) to examine, the effect of different nitrogen rates and mowing dates on growth of bermuda grass (*Cynodon dactylon*, L.). The soil of the experiment was well prepared, then divided into plots of 1 m^2, area (1 × 1 m) each. Physical and chemical analysis of the soil are shown in Table A. Seeds of bermuda grass provided by Genetics International Inc, California, USA , were planted on March 1st for both seasons at the rate of 30 g / m^2 clay soil.

The plants were mowed 5 times around the year, starting May 1st till November 20th. The first mowing was after 60 days from sowing, the plants were cut at 3 cm height. Mowing was then carriedout every 50 days at the same height.

Table A : Physical and chemical analysis of used soil .

Soil properties	Values	Soil properties	Values
Sand %	16.61	pH 1 : 2.5	8.03
Silt %	39.79	Ex.Ca^{++} mg/100 g soil	17.90
Clay %	43.60	Total N %	0.14
Organic matter %	2.30	Available P ppm	19.00
$CaCo_3$ %	1.54	Exch. K^+ mg/100g (soil)	2.19
E.C. m.mhos/cm	0.67		

Calcium as superphosphate (15.5 % P_2O_5) was mixed with the soil at the rate of 25 g / m^2 before sowing , ammonium sulphate (20.5 % N) at the rate of 0, 20, 30 and 40 g / m^2 was added monthly starting from April to October in both seasons, potassium sulphate (48 % K_2O) was also applied with nitrogen at the rate of 15 g / m^2.

A split plot design with three replicates was used. Treatments were arranged in 4 × 5 plot layout with ammonium sulphate as a main plot and mowing dates as sub-plot. After each mowing date the following data were recorded : plant height (cm); covering density percentage (determined by using wooden quadrate of 10 × 10 cm (a gird) divided into 100 squares by cross-string, so that each square represented 1.0 percent of the total area of the gird. The gird was dropped at random 5 times on the plot. By careful estimation of the number of squares occupied by grass, the percentage of covered area was calculated according to El – Tantawy *et al.,* 1993); clipping fresh and dry weights (g). Leaves content of total chlorophylls (mg / g F.W), total sugars (mg / g D.W), nitrogen, phosphorus and potassium (mg / g D.W) were determined according to Fadl and Sari – El deen (1978), Somoggi and Shaffer (1933) and Page *et al.,* (1982), respectively. All obtained data for both seasons were statistically analyzed and means of treatments were compared according to the L.S.D. method indicated by Little and Hills (1978).

RESULTS AND DISCUSSION

Vegetative growth characters :

Results in Tables 1 and 2 show that nitrogen fertilization treatments, significantly affected the four vegetative growth traits in the two seasons comprised with the unfertilized plants. The increase in plant height, covering density percentage, clipping fresh and dry weights was coincided with the increase in nitrogen fertilization rate with the tallest plants, most covering density percentage and heaviest clipping fresh and dry weights being obtained with the highest nitrogen rate. The increase in these four vegetative growth parameters reached 33.1, 15.5, 9.8 and 24.4 % in the first season, and 28.3, 12.9, 9.2 and 23.1 % in the second season, respectively, over those of untreated plants. Many authors pointed out the efficiency of nitrogen fertilization in increasing various vegetative growth traits of different turf-grass i.e Johanson and Burns (1985), Mc Caslin *et al.,* (1989), White and Schmidt (1990), Hossni (1993), Pitman (1999) and Surour (2001) on *Cynodon dactylon*; Canaway and Hacker (1988), Razmjoo and Kaneko (1993) and Soliman (1997) on *Lolium perenne*; Mc Crimnon and Karnok (1992) and Huang and Petrovic (1995) on *Agrostis palustris*; Johanson and Carrow (1993), Zhang *et al.,* (1998) and Pitman (1999) on *Festuca arundinacea*; Wilkinson (1977), Bi Yufen and Sun Jixiong (1994) and Zhang *et al.,* (1998) on *Poa pratensis* and Dunn *et al.,* (1995) and Carroll *et al.,* (1996) on *Zoysia japonica.*

Vegetative growth was also increased by mowing dates starting on the 1st of may up till the fourth mowing date on September, 30th, then declined on the fifth mowing date (November, 20th) in both seasons. This decline may be due to the low temperature recorded in November. The highest values of plant height, covering density percentage and clipping fresh and dry weights were recorded on the fourth mowing (No.4) in both seasons.

The interaction between the two factors was significant in both seasons. The best results were obtained due to supplying Bermuda grass with ammonium sulphate at 40 g / m^2 and mowing on September 30th (No.4).

Response of Bermuda grass to fertilization and mowing dates.

Table 1: Effect of nitrogen fertilization and mowing dates on plant height, covering density percentage and clipping fresh weight / plant of Bermuda grass (*Cynodon dactylon*, L.) during 2007 and 2008 seasons.

Mowing dates (B)	Ammonium sulphate rates g / m² (A)									
	First season					Second season				
	0	20	30	40	Mean	0	20	30	40	Mean
Plant height (cm)										
1st	15.24	18.09	19.28	21.40	18.50	16.02	20.66	21.64	23.28	20.40
2nd	18.14	19.66	21.12	22.82	20.44	19.10	22.23	24.28	25.00	22.65
3rd	19.06	22.28	24.82	25.49	22.91	22.97	24.10	26.22	26.40	24.92
4th	20.00	23.19	25.22	26.01	23.61	23.09	25.33	27.64	27.89	25.99
5th	14.08	16.55	17.62	19.39	16.91	15.24	18.73	20.62	21.09	18.92
Mean (A)	17.30	19.95	21.61	23.03		19.28	22.21	24.08	24.73	
L.S.D. 5%	A: 1.26		B: 2.58		AB: 4.18	A: 1.59		B: 3.36		AB: 5.81
1%	A: 2.02		B: 3.42		AB: 5.54	A: 2.41		B: 4.45		AB: 7.71
Covering density percentage										
1st	64.47	68.26	72.02	76.35	70.78	66.28	70.06	76.47	77.87	72.67
2nd	71.30	74.28	77.72	79.47	75.69	73.60	78.82	80.35	80.40	78.29
3rd	75.03	78.02	84.77	84.80	80.66	79.72	82.59	86.80	86.90	84.00
4th	81.20	83.75	89.97	90.00	86.23	84.59	88.60	90.81	90.95	88.73
5th	58.44	66.71	73.25	74.00	68.10	60.71	69.25	75.33	75.90	70.30
Mean (A)	70.09	74.20	79.55	80.92		72.98	77.86	81.95	82.40	
L.S.D. 5%	A: 1.98		B: 4.41		AB: 6.24	A: 2.01		B: 4.95		AB: 7.00
1%	A: 3.63		B: 5.83		AB: 8.24	A: 3.69		B: 6.54		AB: 9.25
Clippings fresh weight (g / m²)										
1st	220.62	227.93	235.93	240.64	231.12	234.45	240.32	252.66	258.33	246.44
2nd	241.16	257.72	266.11	270.53	258.88	253.26	261.09	273.93	285.20	268.37
3rd	266.28	275.86	281.64	285.27	277.26	270.02	279.66	285.37	290.64	281.42
4th	274.66	281.19	290.77	296.73	285.83	279.35	287.16	294.26	299.41	290.05
5th	210.01	218.53	230.01	238.31	224.13	230.62	235.08	241.81	250.74	239.56
Mean (A)	242.55	252.25	260.89	266.30		253.54	260.66	269.61	276.86	
L.S.D. 5%	A: 4.26		B: 8.17		AB: 10.42	A: 3.79		B: 9.46		AB: 11.35
1%	A: 7.24		B: 10.86		AB: 13.54	A: 6.44		B: 12.52		AB: 14.76

Table 2 : Effect of nitrogen fertilization and mowing dates on clipping dry weight, total chlorophyll content and total sugars content in the leaves / plant of Bermuda grass (*Cynodon dactylon*, L.) during 2007 and 2008 seasons.

Mowing dates (B)	Ammonium sulphate rates g / m² (A)									
	First season					Second season				
	0	20	30	40	Mean	0	20	30	40	Mean
Clippings dry weight (g / m²)										
1st	49.11	54.70	58.30	64.71	56.71	51.47	62.48	65.44	69.68	62.27
2nd	57.87	61.85	63.86	69.01	63.15	60.78	67.46	73.42	75.65	69.33
3rd	63.69	67.38	75.07	77.08	70.81	72.48	75.28	79.29	81.75	77.20
4th	65.44	70.13	78.18	81.06	73.70	72.80	79.06	85.98	86.73	81.14
5th	45.60	50.05	53.28	58.63	51.89	49.10	65.42	62.35	63.78	60.16
Mean (A)	56.34	60.82	65.73	70.10		61.33	69.94	73.30	75.52	
L.S.D. 5 %	A: 1.71		B: 3.66		AB: 5.18	A: 1.29		B: 3.99		AB: 5.64
1 %	A: 3.14		B: 4.84		AB: 6.84	A: 2.37		B: 5.27		AB: 7.46
Total chlorophylls content in the leaves (mg / g. F.W)										
1st	1.876	2.308	2.326	2.487	2.249	1.892	2.389	2.440	2.551	2.318
2nd	2.262	2.478	2.582	2.602	2.481	2.444	2.559	2.662	2.704	2.592
3 rd	2.381	2.589	2.691	2.711	2.593	2.510	2.628	2.746	2.879	2.691
4th	2.390	2.595	2.699	2.820	2.626	2.534	2.662	2.776	2.961	2.733
5th	1.064	1.109	1.122	1.134	1.107	1.133	1.245	1.262	1.282	1.231
Mean (A)	1.995	2.216	2.284	2.351		2.103	2.297	2.377	2.475	
L.S.D. 5 %	A: 0.096		B: 0.162		AB: 0.229	A: 0.081		B: 0.189		AB: 0.267
1 %	A: 0.176		B: 0.214		AB: 0.303	A: 0.149		B: 0.250		AB: 0.353
Total sugars content in the leaves (mg / g. D.W)										
1st	2.01	3.04	3.10	3.26	2.85	2.10	3.15	3.20	3.33	2.95
2nd	2.36	3.10	3.23	3.38	3.02	2.53	3.20	3.41	3.50	3.16
3rd	2.50	3.18	3.46	3.62	3.19	2.69	3.33	3.58	3.74	3.34
4th	2.62	3.29	3.55	3.79	3.56	2.82	3.47	3.61	3.87	3.44
5th	1.44	2.51	2.72	2.84	2.38	1.56	2.72	2.83	2.90	2.50
Mean (A)	2.19	3.02	3.21	3.38		2.34	3.17	3.33	3.47	
L.S.D. 5 %	A: 0.07		B: 0.12		AB: 0.17	A: 0.06		B: 0.09		AB: 0.13
1 %	A: 0.13		B; 0.16		AB: 0.22	A: 0.11		B: 0.12		AB: 0.17

Chemical constituents :

Chemical constituents i.e total chlorophylls, total sugars as well as leaves nitrogen, phosphorus and potassium percentage were greatly increased in both seasons due to the high rate of ammonium sulphate (40 g / m^2) in comparison with the control plants, (Tables 2 and 3). In agreement with these results were those of Hossni, (1993) and Surour (2001) on *Cynodon dactylon* and Razmjoo and Kaneko (1993) and Soliman (1997) on *Lolium perenne*.

Regarding mowing dates, the fourth mowing date September 30^{th} produced maximum values of chemical constituents in the leaves in both seasons in comparison with the last mowing date November 20^{th}.

The interaction between nitrogen rates and mowing dates was significant for total chlorophylls and total sugars content in the leaves, while, was non significant for nitrogen, phosphorus and potassium percentage in both seasons. The best overall results were obtained due to applying the high rate of ammonium sulphate (40 g / m^2) and mowing on September 30^{th}.

In conclusion all vegetative growth parameters and chemical constituents were increased by raising ammonium sulphate fertilization rates from 20 to 40 g / m^2. These results demonstrated that Bermuda grass responded positively to nitrogen fertilization. Nitrogen is a mineral nutrient required in greatest quantities by turfgrass. It is an essential component of chlorophylls, amino acids, proteins, nucleic acids, enzymes and other plant substances.

It can be concluded that, the effect of mowing dates may be due to the differences in temperature recorded during the summer months which is responsible for the best vegetative growth and the high values of chemical constituents of plants during this period.

It was interesting to observe that the combined treatment of ammonium sulphate at 40 g / m^2 X fourth mowing date (September 30^{th}) gave the best results in both seasons.

Table 3: Effect of nitrogen fertilization and mowing dates on leaves nitrogen, phosphorus and potassium percentage / plant of Bermuda grass (*Cynodon dactylon*, L.) during 2007 and 2008 seasons.

Mowing dates (B)	Ammonium sulphate rates g / m² (A)									
	First season					Second season				
	0	20	30	40	Mean	0	20	30	40	Mean
Leaves nitrogen percentage										
1st	3.08	3.10	3.12	3.17	3.12	3.10	3.12	3.18	3.24	3.16
2nd	3.10	3.23	3.28	3.35	3.24	3.11	3.40	3.45	3.57	3.38
3rd	3.18	3.27	3.32	3.40	3.29	3.18	3.58	3.62	3.75	3.53
4th	3.22	3.34	3.39	3.43	3.46	3.44	3.65	3.78	3.83	3.67
5th	2.63	2.70	2.75	2.88	2.74	2.70	2.75	2.80	2.93	2.80
Mean (A)	3.04	3.13	3.17	3.25		3.11	3.30	3.37	3.46	
L.S.D. 5 %	A: 0.05	B: N.S	AB: N.S			A: 0.12	B: N.S	AB: N.S		
1 %	A: 0.08	B: N.S	AB: N.S			A: 0.18	B: N.S	AB: N.S		
Leaves phosphorus percentage										
1st	0.382	0.466	0.474	0.482	0.451	0.391	0.478	0.481	0.492	0.461
2nd	0.410	0.507	0.512	0.516	0.486	0.414	0.517	0.520	0.525	0.494
3rd	0.421	0.529	0.534	0.537	0.505	0.432	0.539	0.540	0.549	0.515
4th	0.432	0.538	0.540	0.549	0.515	0.440	0.544	0.552	0.568	0.526
5th	0.210	0.315	0.332	0.344	0.300	0.222	0.334	0.340	0.352	0.312
Mean (A)	0.371	0.471	0.478	0.486		0.380	0.482	0.487	0.497	
L.S.D. 5 %	A: 0.034	B: N.S	AB: N.S			A: 0.024	B: N.S	AB: N.S		
1 %	A: 0.057	B: N.S	AB: N.S			A: 0.040	B: N.S	AB: N.S		
Leaves potassium percentage										
1st	3.42	4.52	4.66	4.70	4.33	3.51	4.70	4.72	4.84	4.44
2nd	3.50	4.58	4.72	4.78	4.40	3.69	4.75	4.80	4.87	4.53
3rd	3.67	4.74	4.80	4.87	4.52	3.75	4.80	4.89	4.95	4.60
4th	3.89	4.85	4.89	5.00	4.66	3.93	4.90	4.94	5.05	4.71
5th	2.35	3.46	3.53	3.66	3.25	2.40	3.52	3.60	3.73	3.31
Mean (A)	3.37	4.43	4.52	4.60		3.46	4.53	4.59	4.69	
L.S.D. 5 %	A: 0.21	B: N.S	AB: N.S			A: 0.25	B: N.S	AB: N.S		
1 %	A: 0.32	B: N.S	AB: N.S			A: 0.39	B: N.S	AB: N.S		

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استجابة حشيشة البرمودا للتسميد بالنيتروجين ومواعيد القص

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تجربة حقلية بطريقة القطع المنشقة تم دراسة تأثير أربعة معدلات من سلفات الأمونيوم وهى صفر ، ٢٠ ، ٣٠ و ٤٠ جرام لكل متر مربع وخمسة مواعيد للقص والتى تبدأ فى ١ مايو حتى ٢٠ نوفمبر على حشيشة البرمودا . وأظهرت النتائج أن المعدل العالى من سلفات الأمونيوم (٤٠ جرام لكل متر مربع) قد تفوق على معدلات التسميد الأخرى فى زيادة صفات النمو الخضرى والمكونات الكيماوية . وفى نفس الوقت فإن هذه الصفات قد زادت تدريجياً تبعاً للزيادة التدريجية فى معدلات التسميد بسلفات الأمونيوم و بالنظر إلى القصه الرابعة والتى أجريت فى (٣٠ سبتمبر) فقد أعطت أحسن نمو خضرى وأعلى قيم للمكونات الكيماوية بالمقارنة بالقصه الخامسة (٢٠ نوفمبر) . وكان جديراً بالملاحظة أن معاملة التداخل بين معاملة سلفات الأمونيوم ٤٠ جرام لكل متر مربع والقصة الرابعة فى ٣٠ سبتمبر أعطت أحسن النتائج .