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Response of Seashore Paspalum (*Paspalum vaginatum* Swartz.) Grass to different Aeration and Fertilization Levels

Sharaf El-Din, M. N.; M. Y. A. Abdalla; A. A. E. Helaly and O. A. Quawasha
Veget. and Flor. Dept., Fac. of Agric., Mansoura Uni., Egypt

ABSTRACT

The investigation was carried out in the experimental site of El- Delta Company for Fertilizers and Chemical Industries (ASMEDA) and the Laboratory of Vegetable and Floriculture Department, Faculty of Agriculture, Mansoura University, Egypt during the two successive seasons of 2016 and 2017 to study the effect of four aeration levels [A_0: without aeration(control),A_1:intended three tines and the distance between them was 15 cm,A_2:intended four tines and the distance between them was 10 cm and A_3:intended five tines and the distance between them was 7.5 cm] and two different application rates of NPK fertilizers [F_1: recommended and F_2: 75% of recommended]and their interactions on some vegetative growth parameters and chemical constituents of seashore paspalum (*Paspalum vaginatum* Swartz.) grass. The obtained results showed significant effects of aeration levels and different fertilization rates on studied vegetative growth parameters and chemical constituents of paspalum plants. During both seasons, significant increases were found in clipping fresh and dry weights (g/m^2), chlorophyll a and b(mg/g fresh weight) and macronutrient percentage of paspalum plants grown under all aeration levels but the highest significant values were found under the fourth level of aeration (A_3) followed by the third aeration level (A_2) then the second one(A_1) and at least control (A_0). Also, the second application rate of fertilization (F_2) led to a significant increase in studied growth parameters and chemical constituents of paspalum plants compared to the first rate of fertilization(F_1). Regarding the interaction effect, the obtained data showed that the highest significant values of investigated growth parameters and chemical constituents were recorded in the treatment of A_3F_2, while the lowest values were those of A_0F_1 treatment during the both seasons.

Keywords: Paspalum; Aeration, Fertilization ,vegetative growth.

INTRODUCTION

The soils underneath lawns naturally become compacted over time as lawns are walked on, played on and even driven on or ridden on by cars and bikes. Compaction leads to soil structure degradation, where the size and shape of pores are changed (Hamza and Anderson, 2005).The effect of compacted lawn soils is that the soil granules are become so tightly squashed together that water, oxygen and nutrients can no longer flow freely within the soil and to the roots of the lawn. The roots of the lawn will also become restricted and will have a stunted growth which further impacts lawn health most severely (Chen and Weil, 2010; Glab and Kopee, 2009). As the problem continues to get worse over time, the lawn will become sickly and often feeling hard under foot, eventually reaching a stage of continuing poor lawn health. Many researchers agree that soil compaction leads to plant yield reduction (Whalley *et al*., 2008). Some soils underneath lawns become more compacted, more quickly due to having a high clay component. Compaction is greater on heavy clay soils than on sandy soil and it is greatest in upper 1 to 1.5 inches of soil. Soil aeration, also commonly called core aeration,is the process of puncturing the soil to allow better water penetration and to introduce more oxygen into the soil. This process is most often done with manual or mechanized equipment that either removes cores of soil from the top layer, or by simply puncturing the soil with spikes. In most cases, the actual soil composition is adjusted to promote more oxygenation and water absorption. Core aeration can benefit the lawn by improving air exchange between the soil and atmosphere, enhancing soil-water uptake, improving fertilizer uptake and use, reducing water runoff and puddling, improving turf grass rooting and root penetration, increasing the activity of soil microorganisms that decompose thatch and reduced soil compaction enhancing heat- and drought-stress tolerance(Chen *et al*., 2001; Pote *et al.*, 2003; Shah *et al*., 2004; Franklin *et al*., 2007).

Environmental and agronomic benefits of aeration have been investigated, with most studies focusing on productivity or yields (Chen *et al*., 2001; Shah *et al*., 2004). In some cases, mechanical aeration did not increase yield when manures were applied (Malhi *et al*., 2000), while in other cases (Davies *et al*., 1989; Chen *et al*., 2001; Shah *et al*., 2004) forage yields were increased. A few studies have evaluated the effectiveness of aeration to reduce nutrient losses (Pote *et al*., 2003; Franklin *et al*., 2007) and have obtained different results as well.

Seashore paspalum (*Paspalum vaginatum* Swartz) is a prostrate, perennial turf grass indigenous to tropical and coastal areas worldwide. It is highly tolerant of various environmental stresses. Compared to Bermuda grass, seashore paspalum can form a higher quality turf in reduced light conditions, in soils ranging in pH from 3.6 to 10.2, in waterlogged soils, and with fewer applications of nitrogen fertilizer. It tolerates soil salinity levels as high as 54 dSm-1, a level at which most horticultural crops cannot survive (Brosnan and Deputy (2008). However, adequate management practices and their economical implications that permit acceptable playability for paspalum grasses are mostly unknown and undocumented (Al Tamirano, 2010).

The aim of this investigation was to study the effect of four aeration levels [A_0: without aeration (control), A_1: intended three tines and the distance between them was 15 cm, A_2: intended four tines and the distance between them was 10 cm and A_3: intended five tines and the distance between them was 7.5 cm] and two different application rates of NPK fertilizers [F_1: recommended and F_2: 75% of recommended] and their interactions on some vegetative growth parameters and chemical constituents of seashore paspalum (*Paspalum vaginatum* Swartz.) grass as well as to find out the best one.

MATERIALS AND METHODS

To achieve the goal of this investigation, field experiments was established during the two successive seasons of 2016 and 2017 in the experimental site of El-Delta Company for Fertilizers and Chemical Industries

(ASMEDA), Talkha District, Dakahlia Governorate and the Laboratory of Vegetable and Floriculture Department, Faculty of Agriculture, Mansoura University, Egypt.

During the both studied seasons, 32 plots (each 1.0×1.0 m) were established at the experimental site (ASMEDA) to investigate the response of paspalum (*Paspalum vaginatum* Swartz.)grass to different levels of aeration under two different rates of fertilization. The combined effects of aeration and fertilization on growth of paspalum grass were investigated by combining four aeration levels and two fertilization rates under a completely randomized design, with four replicates for each treatment. The aeration levels were: A_0: without aeration (control), A_1: intended three tines with a distance of 15 cm between them, A_2: intended four tines with a distance of 10 cm between them and finally A_3: intended five tines with a distance of 7.5 cm between], whereas the application rates of nitrogen, phosphorus and potassium fertilization were (F_1) recommended and (F_2)75%of recommended doses.

This experiment began in both seasons (2016 and 2017) on April; 5thand lasted till October, 5th of each year. After planting the sods of plants in the plots, the soil was compacted using a metal cylinder. Coverage percentage had not been changed throughout the experiment due to the use of sods for planting. All agricultural operations were performed according to the traditional local agriculture management practices.

Plots were aerated monthly from April to September using an aeration device fashioned by attaching cores, tines to rows on a metal plate and pushing the implement into the soil. A hole with an approximate diameter of 2 cm was produced due to aeration treatments. The tine implements were 10 cm long and produced a tapered, wedge-shaped slit with an approximate 1.0 by5.0 cm opening at the soil surface. Each aeration treatment was inserted to a depth of 8 cm and impacted a similar-sized surface area of the plot (100 cm^2). The numbers of holes were 66,100 and 130 for A_1, $A_2$and A_3 treatments, respectively.

NPK fertilizers were applied as following:

F_1 (recommended NPK)

- Nitrogen fertilizer was used as ammonium nitrate (33.5%N) and applied at the rate of 125 g N/ plot. Phosphorus fertilizer was used as calcium super phosphate (15 % P_2o_5) and applied at the rate of 66 g P/ plot. Potassium fertilizer was used as potassium sulfate (39.84% K) and applied at a rate of 22 g K/ plot.

F_2 (75%of recommended NPK)

- Nitrogen fertilizer was used as ammonium nitrate (33.5%N) and was applied at the rate of 93.75 g N/ plot. Phosphorus fertilizer was used as calcium super phosphate (15 % P_2o_5) and applied at the rate of 49.5 g P/ plot. Potassium fertilizer was used as potassium sulfate (39.84% K) and applied at a rate of16.5 g K/ plot.

Nitrogen fertilization with the above mentioned rates was added in five equal doses (mid. April, May, June, July, August and September). Phosphorus fertilization was applied in two equal doses in April and September with the above mentioned rates. Potassium fertilization with the above mentioned rates was added in two equal doses in April and September.

Irrigation was applied as follows:7 liters/m^2/day from April to 1stof September, then 7 liters/m^2/three days from 1stof September till mid- October.

The plants were cut at 4 cm height from the soil surface; 18 cuts were taken throughout each season, every 10 days from April to October. The first cut was done on April, 15_{th} and the last one was done on October, 5_{th}.

Clipping fresh and dry weight (g/m^2) was determined in the third cut of each month for all treatments during the two seasons.

At the of the experiment in both seasons, N, P and K% as well as chlorophyll a and b (mg/g fresh weight) were determined.

To determine macro-nutrients concentration in plant tissues, 0.2 g from each sample was digested using 5.0 cm^3 from the mixture of perchloric ($HClO_4$) acids and sulfuric (H_2SO_4) (1:1) as described by Peterburgski (1968). N% was determined by micro-Kjeldahl method according to Jackson (1967). P% was determined colorimetrically by spectrophotometer as described by Peters *et al.* (2003) and K% was determined by using flame photometer according to the modified method of Peters *et al.* (2003). Fresh leaf sample were obtained to determine chlorophyll a and b (mg/g F.W) according to Goodwine (1965). It was estimated from five plants randomly chosen from each experimental unit.

The collected data were tabulated and statistically analyzed according to Gomez and Gomez (1984) and the L.S.D. test at 5% was followed to compare between means of treatments.

RESULTS AND DISCUSSION

Effect of aeration, fertilization and their interactions on some vegetative growth parameters of paspalum plants during 2016 and 2017seasons

a- Clipping fresh weight (g/m^2)

Data in Tables (1) and (2) observed that clipping fresh weights (g/m^2) of paspalum plants significantly increased with increasing the aeration level. During all months of measurements on both seasons, the significantly highest values of clipping fresh weight were obtained from the treatment A_3, followed by A_2 then A_1. The lowest values in this regard were those of the treatment A_0 (without aeration).

The effect of different fertilization rates on clipping fresh weight is also illustrated in Tables (1) and (2). The data indicated that the second application rate of fertilization (F_2: 75% of recommended NPK) led to a significant increase in clipping fresh weight of plants compared to the first rate of fertilization (F_1: recommended NPK) throughout all months of measurements in both seasons.

Concerning the effect of interaction between aeration levels and fertilizer rates on clipping fresh weight, data in the same Tables revealed that there were significant differences between the different interaction treatments throughout all months of measurements in both seasons. The significantly highest values of clipping fresh weight in both seasons were obtained from the treatment (A_3 F_2). These results may be due to the saline effect of fertilizer or the great aeration helped plants to get the maximum benefit of nutrients. The obtained results are in agreement with those obtained by Bittman *et al*., 2005; Lau *et al*., 2003; Pote *et al*. (2003).

Table 1. Effect of aeration levels, fertilization rates and their interactions on clipping fresh weight (g/m^2) of paspalum plants during 2016 season

Character		Fresh weight of clpping g/m^2					
Treatments		Mowing dates					
		May	June	July	August	September	October
Aeration treatments							
A_0		440.38	658.50	574.13	468.75	491.75	561.75
A_1		626.25	854.50	849.25	590.25	564.75	582.63
A_2		802.00	913.38	917.50	736.00	690.75	748.38
A_3		996.38	1158.00	974.13	1018.25	873.13	1019.63
LSD $_{at\ 5\%}$		19.65	19.85	9.58	14.04	6.58	17.28
Fertilization treatments							
F_1		673.50	681.19	780.06	666.63	592.38	689.50
F_2		759.00	1111.00	877.44	740.00	717.81	766.69
LSD $_{at\ 5\%}$		15.37	9.47	8.94	8.03	9.41	12.93
Interaction							
A_0	F_1	412.75	569.00	450.50	400.25	425.50	508.75
	F_2	468.00	748.00	697.75	537.25	558.00	614.75
A_1	F_1	579.50	602.25	827.00	567.00	507.25	536.75
	F_2	673.00	1106.75	871.50	613.50	622.25	628.50
A_2	F_1	738.25	641.00	891.75	696.75	626.75	703.50
	F_2	865.75	1185.75	943.25	775.25	754.75	793.25
A_3	F_1	963.50	912.50	951.00	1002.50	810.00	1009.00
	F_2	1029.25	1403.50	997.25	1034.00	936.25	1030.25
LSD $_{at\ 5\%}$		30.75	18.95	17.87	16.07	18.83	25.86

Table 2. Effect of aeration levels, fertilization rates and their interactions on clipping fresh weight (g/m^2) of paspalum plants during 2017 season

Character		Fresh weight of clipping g/m^2					
Treatments		Mowing dates					
		May	June	July	August	September	October
							Aeration treatments
A_0		468.88	635.88	580.88	461.38	475.88	541.25
A_1		591.50	828.25	846.50	588.00	556.63	615.13
A_2		788.38	895.13	917.13	720.25	662.75	718.88
A_3		1001.13	1020.38	1000.50	1005.00	832.38	873.63
LSD $_{at\ 5\%}$		15.34	12.06	8.20	8.58	7.21	5.15
Fertilization treatments							
F_1		664.19	654.00	782.38	658.13	593.00	649.31
F_2		760.75	1035.81	890.13	729.19	670.81	725.13
LSD $_{at\ 5\%}$		14.60	9.90	9.22	6.56	3.68	4.26
Interaction							
A_0	F_1	429.50	543.50	470.75	400.25	450.00	517.00
	F_2	508.25	728.25	691.00	522.50	501.75	565.50
A_1	F_1	538.75	592.25	813.25	556.50	520.50	597.25
	F_2	644.25	1064.25	879.75	619.50	592.75	633.00
A_2	F_1	749.25	667.50	888.00	688.50	611.50	675.25
	F_2	827.50	1122.75	946.25	752.00	714.00	762.50
A_3	F_1	939.25	812.75	957.50	987.25	790.00	807.75
	F_2	1063.00	1228.00	1043.50	1022.75	874.75	939.50
LSD $_{at\ 5\%}$		29.20	19.80	18.43	13.10	7.36	8.52

b- Clipping dry weight (g/m^2)

The results in Tables (3) and (4) show that dry weight (g/m^2) of the plants significantly increased with the increase of the tines number, where the greatest significant values of dry weight were found under the fourth level of aeration (A_3) along the experiment followed by the third aeration level (A_2), the second aeration level (A_1) and control (A_0), respectively.

This trend was found in both studied seasons. For example, in may, the plants grown under A_3 treatment (130holes) produced the significantly heaviest dry weight followed by A_2 treatment (100holes). The least significant value was found at control treatment A_0 (without aeration). Generally, all values of shoots dry weight that obtained from the use of the fourth level of aeration were significant while, the least values were resulted from the first level of aeration (A_0) till October during 2016 and 2017 seasons.

The effect of different fertilization levels on shoots dry weight (g/m^2) of plants was shown in the same Tables. The data show that the second rate of fertilization(F_2:0.75 from recommended) led to a significant increase in shoots dry weight of plants grown compared to the first rate of fertilization (F_1: recommended) in all months where, in the first season, the shoot dry weight of plants was increased from 92.91, 95.09, 110.61, 91.89,80.93 and 101.53 g/m^2 at F_1 treatment to 105.43, 155.14, 120.86, 104.01, 100.06 and 114.60 g/m^{2}at F_2 treatment for May, June, July, August, September and October, respectively. The same trend was

found for the second season where the shoot dry weight of plants was increased from 99.57 , 92.01 , 109.55 , 91.73 , 82.44 and 90.65 g/m^2 at F_1 treatment to 114.58 ,144.99 , 125.16 ,101.69 , 93.81 and 100.84 g/m^{2}at F_2 treatment for May, June, July, August, September and October, respectively.

Table 3. Effect of aeration levels, fertilization rates and their interactions on clipping dry weight (g/m^2) of paspalum plants during 2016 season

Character		Dry weight of clipping g/m^2					
Treatments		Mowing dates					
		May	June	July	August	September	October
Aeration treatments							
A_0		58.41	91.80	82.75	64.80	64.01	77.26
A_1		87.65	119.31	116.30	82.11	78.59	83.79
A_2		113.95	127.45	128.91	101.71	96.05	111.60
A_3		136.66	161.90	134.98	143.19	123.31	159.61
LSD $_{at\ 5\%}$		2.81	2.61	0.80	0.78	6.33	2.67
Fertilization treatments							
F_1		92.91	95.09	110.61	91.89	80.93	101.53
F_2		105.43	155.14	120.86	104.01	100.06	114.60
LSD $_{at\ 5\%}$		2.03	1.34	0.43	0.65	3.57	1.50
Interaction							
A_0	F_1	53.66	79.20	66.48	55.35	51.43	68.70
	F_2	63.17	104.40	99.03	74.25	76.60	85.83
A_1	F_1	81.08	84.30	115.50	77.95	70.73	76.50
	F_2	94.22	154.33	117.10	86.28	86.45	91.08
A_2	F_1	106.74	89.28	126.05	95.00	87.25	105.18
	F_2	121.17	165.63	131.78	108.43	104.85	118.03
A_3	F_1	130.17	127.58	134.43	139.28	114.30	155.75
	F_2	143.15	196.23	135.53	147.10	132.33	163.48
LSD $_{at\ 5\%}$		4.06	2.67	0.85	1.30	7.15	3.01

Table 4. Effect of aeration levels, fertilization rates and their interactions on clipping dry weight (g/m^2) of paspalum plants during 2017season

Character		Dry weight of shoots g/m^2					
Treatments		Mowing dates					
		May	June	July	August	September	October
Aeration treatments							
A_0		70.18	89.03	81.41	63.85	66.63	74.71
A_1		88.49	116.41	118.39	81.96	77.64	86.00
A_2		117.79	125.35	128.93	100.85	92.51	100.24
A_3		151.85	143.21	140.69	140.16	115.73	122.04
LSD $_{at\ 5\%}$		2.13	1.92	1.42	1.67	2.19	1.18
							Fertilization treatments
F_1		99.57	92.01	109.55	91.73	82.44	90.65
F_2		114.58	144.99	125.16	101.69	93.81	100.84
LSD $_{at\ 5\%}$		1.10	1.43	1.52	1.53	1.01	1.03
Interaction							
A_0	F_1	64.38	75.90	65.68	54.65	62.88	71.50
	F_2	75.98	102.15	97.15	73.05	70.38	77.93
A_1	F_1	80.73	83.68	113.88	77.73	72.48	84.60
	F_2	96.25	149.15	122.90	86.20	82.80	87.40
A_2	F_1	112.10	94.15	124.45	96.50	84.83	94.40
	F_2	123.48	156.55	133.40	105.20	100.20	106.08
A_3	F_1	141.08	114.33	134.20	138.03	109.58	112.10
	F_2	162.63	172.10	147.18	142.30	121.88	131.98
LSD $_{at\ 5\%}$		2.20	2.86	3.05	n.s	2.01	2.06

With regard to the effect of interaction between aeration and fertilization on shoots dry weight, data in Tables (3and 4) indicate that, in all months, the greatest significant values of shoot dry weight were occurred due to the use of the fourth level of aeration (A_3) when fertilized with the second level of fertilization(F_2:0.75 from recommended).

The values of shoots dry weight of plants (g/m^2) under the two different fertilization levels significantly increased with increasing of aeration levels from the first (A_0 control) to the fourth (A_3) but the values of plants were fertilized with the second level of NPK (F_2:0.75 from recommended) is greater than the values of plants were fertilized with the first level of NPK (F_1: recommended), where the highest values of dry weight of paspalum shoots were at (A_3F_2). As well the data of the same tables show that the lower values of dry weight of plant shoots were at (A_0F_1). Also, No significant interactions were found between aeration and fertilization on dry weight of shoots g/m^2 on August during the second season.

It can be stated that increasing of aeration levels led to improve the chemical and physical soil properties, thus

decrease of used fertilizers. The obtained results are in agreement with those obtained by Bittman *et al*., 2005; Lau *et al*., 2003; Pote *et al*. (2003) and David *et al*. (2008).

Effect of aeration, fertilization and their interactions on chemical constituents of paspalum plants during 2016 and 2017 seasons

- Photosynthetic pigments

It is evident from data in Tables (5) and (6) that aeration treatments and fertilization as well as their interactions significantly increased the contents of chlorophyll a and b (mg/g fresh weight) in the leaves of paspalum plants in the two seasons.

a- Chlorophyll a content (mg/g fresh weight)

Data in Table (5) show the effect of aeration levels, fertilization rates and their interactions on chlorophyll a (mg/g F.W) of paspalum plants grown on October during the two studied seasons.

The statistical analysis of the data presented in Table (5) indicate that increase the aeration level from the first (A_0) to the fourth (A_4) significantly affected the chlorophyll a (mg/g F.W) of paspalum plants during seasons of experimentation. It is clear to observe that chlorophyll a of paspalum plants significantly increased with increasing the aeration level. The significantly highest values of chlorophyll a (mg/g F.W) were obtained from the treatment A_3, followed by A_2 then A_1. The lowest values in this regard were those of the treatment A_0 (without aeration).

Table 5. Effect of aeration, fertilization and their interactions on chlorophyll a content (mg/g) of paspalum plants during 2016 and 2017 seasons

Character		Chlorophyll a	
Treatments		**2016**	**2017**
Aeration treatments			
A_0		0.348	0.376
A_1		0.370	0.400
A_2		0.392	0.422
A_3		0.413	0.437
$LSD_{at\ 5\%}$		0.004	0.004
Fertilization treatments			
F_1		0.372	0.398
F_2		0.389	0.419
$LSD_{at\ 5\%}$		0.005	0.004
Interaction			
A_0	F_1	0.341	0.370
	F_2	0.356	0.382
A_1	F_1	0.363	0.393
	F_2	0.377	0.406
A_2	F_1	0.384	0.411
	F_2	0.401	0.433
A_3	F_1	0.402	0.420
	F_2	0.424	0.455
$LSD_{at\ 5\%}$		0.011	0.008

The effect of different fertilization rates on chlorophyll a is also illustrated in Table (5) . The data indicated that the second application rate of fertilization (F_2: 75% of recommended NPK) led to a significant increase in chlorophyll a (mg/g F.W) of paspalum plants compared to the first rate of fertilization (F_1: recommended NPK) in both seasons. where, in the first season, the values of chlorophyll a increased from 0.372 to 0.389 mg/g . The same trend was found for the second season, where the values of chlorophyll a increased from 0.398 to 0.419 mg/g.

Concerning the effect of interaction between aeration levels and fertilizer rates on chlorophyll a, data in the same Table revealed that there were significant differences between the different interaction treatments. where the highest values of chlorophyll a were at (A_3F_2).In the contrary, the lower chlorophyll a values of plants were at (A_0F_1).

b-Chlorophyll b content (mg/g fresh weight)

Data in Table (6) show the effect of aeration levels, fertilization rates and their interactions on chlorophyll b(mg/g F.W) of paspalum plants grown on October during the two studied seasons.

The statistical analysis of the data presented in Table (6) indicate that increase the aeration level from the first (A_0) to the fourth (A_4) significantly affected the chlorophyll b (mg/g F.W) of paspalum plants during seasons of experimentation. It is clear to observe that chlorophyll b of paspalum plants significantly increased with increasing the aeration level. The significantly highest values of chlorophyll b were obtained from the treatment A_3, followed by A_2 then A_1. The lowest values in this regard were those of the treatment A_0 (without aeration).

Table 6. Effect of aeration, fertilization and their interactions on chlorophyll b content (mg/g) of paspalum plants during 2016 and 2017 seasons

Character		Chlorophyll b	
Treatments		**2016**	**2017**
Aeration treatments			
A_0		0.242	0.259
A_1		0.267	0.292
A_2		0.283	0.303
A_3		0.298	0.316
$LSD_{at\ 5\%}$		0.004	0.003
Fertilization treatments			
F_1		0.265	0.282
F_2		0.280	0.303
$LSD_{at\ 5\%}$		0.004	0.003
Interaction			
A_0	F_1	0.232	0.251
	F_2	0.252	0.267
A_1	F_1	0.260	0.281
	F_2	0.274	0.303
A_2	F_1	0.278	0.293
	F_2	0.288	0.314
A_3	F_1	0.291	0.304
	F_2	0.305	0.328
$LSD_{at\ 5\%}$		0.008	0.007

The effect of different fertilization rates on chlorophyll b is also illustrated in Table (6). The data indicated that the second application rate of fertilization (F_2: 75% of recommended NPK) led to a significant increase in chlorophyll b of paspalum plants compared to the first rate of fertilization (F_1: recommended NPK) in both seasons. where, in the first season, the values of chlorophyll b increased from 0.265 to 0.280 mg/g . The same trend was found for the second season, where the values of chlorophyll b increased from 0.282 to 0.303 mg/g.

Concerning the effect of interaction between aeration levels and fertilizer rates on chlorophyll b, data in the same Table revealed that there, where the highest

values of chlorophyll b were at (A_3F_2). In the contrary, the lower chlorophyll b values of plants were at (A_0F_1).

Effect of aeration, fertilization and their interactions on nitrogen, phosphorus and potassium percentage in the leaves of paspalum plants during 2016 and 2017seasons

Regarding to the effect of aeration, data presented in Table (7) show a superior effect for aeration levels on the values of N,P and K percentage in plants. The N, P and K (%) of plant shoots significantly increased with increasing aeration levels under both studied seasons, where the highest values of N, P and K were found at the fourth aeration level (A_3).

Data in Table (7) show the effect of two different levels of fertilization (F_1 and F_2) on N, P and K (%) in plants and indicated that the second rate of fertilization(F_2:0.75 from recommended) recorded the highest values of N,P and K(%)in plant shoots compared with the first rate of fertilization(F_1: recommended).

Table 7. Effect of aeration, fertilization and their interactions on nitrogen, phosphorus and potassium (%) of paspalum plants during 2016 and 2017 seasons

Treatments		N%		P%		K%	
		2016	2017	2016	2017	2016	2017
Aeration treatments							
A_0		0.91	1.04	0.104	0.114	1.234	1.308
A_1		1.06	1.18	0.121	0.133	1.374	1.483
A_2		1.19	1.32	0.142	0.149	1.518	1.639
A_3		1.32	1.47	0.148	0.161	1.680	1.753
LSD at 5%		0.05	0.06	0.008	0.005	0.05	0.05
Fertilization treatments							
F_1		1.03	1.17	0.125	0.130	1.394	1.493
F_2		1.21	1.33	0.133	0.149	1.509	1.598
LSD at 5%		0.03	0.03	N.S	0.002	0.03	0.04
Interaction							
A_0	F_1	0.83	0.98	0.099	0.109	1.170	1.253
	F_2	1.00	1.11	0.109	0.120	1.298	1.363
A_1	F_1	0.97	1.14	0.115	0.122	1.305	1.393
	F_2	1.14	1.22	0.128	0.144	1.443	1.573
A_2	F_1	1.09	1.19	0.143	0.136	1.463	1.605
	F_2	1.28	1.45	0.142	0.162	1.573	1.673
A_3	F_1	1.23	1.37	0.144	0.153	1.638	1.720
	F_2	1.42	1.57	0.153	0.169	1.723	1.785
LSD at 5%		0.06	0.05	0.017	0.006	0.06	0.07

Also, data demonstrate that the change in fertilization level from F_1 to F_2 had no significant effect on P% on October during the first season.

As shown from Table(7) the interactions between aeration levels and fertilization levels were significant on the N,P and K % of shoots of plants during the two studied seasons.

The values of N,P and K of shoot plants (%) under the two different fertilization levels significantly increased with increasing of aeration levels from the first (A_0 control) to the fourth (A_3) but the N,P and K values of shoot plants were fertilized with the second level of NPK(F_2:0.75 from recommended) is greater than the values of shoot plants were fertilized with the first level of NPK (F_1: recommended), where the highest values of N,P and K(%) were at (A_3F_2). In the contrary, the lower values of N,P and K(%) were at (A_0F_1). It can be stated that increasing of aeration levels from the first (A_0) to the fourth (A_3) significantly affected the Nitrogen, phosphorus and potassium concentration (%) in shoot paspalum plants. These finding are consistent with Bittman *et al*., 2005; Lau *et al.,* 2003; Pote *et al.* (2003); David *et al.,(*2008) and Butler *et al.,* (2008) who indicated that core aeration has the greatest potential for reducing P losses. Export of TKP was reduced by 55%, TDP by 62%, DRP by 61%, total BAP by 54%, and dissolved BAP by 57% on core-aerated plots with applied broiler litter as compared with the control ($p < 0.05$). Core and no-till disk aeration also showed potential for reducing P export from applied dairy slurry ($p < 0.10$).

CONCLUSION

Based on the obtained results of this investigation it could be detect that the use of the fourth level of aeration (A_3: The distance between the tines was7.5 cm with five tines) under the second level of fertilization (F_2:0.75 from recommended) was the best treatment for investigated parameters.

Finally, the aeration led to improve the chemical and physical soil properties and consequently decrease of used fertilizers, enhance the photosynthetic efficiency and increase plant growth.

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استجابة حشيشه الباسبالم لمستويات تهوية وتسميد مختلفة

محمد نزيه شرف الدين ، محمد يونس علي عبد الله ، أحمد عبد المنعم هلالي و أسامه عبد الرحمن قوشه
قسم الخضر والزينة، كلية الزراعة، جامعة المنصورة

أجرى هذا البحث لدراسة مدى استجابة النمو الخضري والمكونات الكيماوية لحشيشه الباسبالم لأربع مستويات تهويه [A_0: بدون تهوية (الكنترول) -A_1: ٣ أسنان المسافة بينهم ١٥ سم - A_2: ٤ أسنان المسافة بينهم١٠سم- A_3: ٥ أسنان المسافة بينهم ٧.٥ سم] ومعدلين مختلفين من التسميد[F_1: الكمية الموصي بها من الأسمدة -F_2: ٠.٧٥ من الكمية الموصي بها من الأسمدة].نفذت التجربة بالموقع التجريبي لشركة الدلتا للأسمدة والصناعات الكيماوية والمعمل الخاص بقسم الخضر والزينة - كلية الزراعة – جامعة المنصورة خلال موسمي ٢٠١٥/٢٠١٦-٢٠١٦/٢٠١٧ (من ٥ابريل حتى ٥ أكتوبر من كل موسم). التجربة اشتملت علي ٣٢ قطعة (١.٠×١.٠ م^2). التصميم التجريبي المستخدم كان قطاعات كاملة العشوائية مع تكرار كل معامله ٤ مرات. وقد أحدثت المعاملات زيادة معنوية في قياسات النمو الخضري والمحتوي الكيميائي لنبات الباسبالم النامي حيث وجدت زيادة معنوية في كل من الوزن الطازج والجاف وكلوروفيل أ،ب والمغذيات الكبرى في أوراق نبات الباسبالم النامي مع كل مستويات التهوية ولكن أعلي قيمة وجدت عند المستوي الرابع من التهوية A_3علي طول التجربة يليه المستوي الثالثA_2 ثم الثانيA_1 ثم الكنترولA_0 . أوضحت النتائج أيضا أن معدل التسميد الثانيF_2أدي إلي زيادة معنوية في كل قياسات النمو الخضري والمحتوي الكيميائي لنبات الباسبالم النامي مقارنة بالمستوي الأول من التسميدF_1. علي جانب أخر ، فيما يتعلق بتأثير التفاعل بين المعاملات ،وجد أن اعلي قيم معنوية لعوامل النمو الخضري والمحتوي الكيماوي حدثت عند المستوي الرابع من التهوية والمعدل الثاني من التسميد (A_3F_2) بينما اقل قيمه وجدت عند المعاملة(A_0F_1) خلال موسمي الدراسة.