The 2nd Conf. of SSFOP "Future of Ornamental Plants in Egypt and Arab World", Cairo, Egypt, 21/2/2016
Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864

RESPONSE OF SEASHORE PASPALUM TURFGRASS TO IRRIGATION PERIODS AND HUMIC ACID

Boshra A. El-Sayed*, S.M. Shahin**, T.M. Noor El-Deen* and M.A. El-Ashwah*

* Ornamental Plants and Landscape Gardening Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt.
** Botanical Gardens Res. Dept., Hort Res. Inst., ARC, Giza, Egypt.

ABSTRACT: A trial was carried out in the open field at the Nursery of Hort. Res. Inst., Giza, Egypt during 2014 and 2015 seasons to examine the effect of irrigation periods, alone or plus foliar spraying with humic acid on growth and quality of seashore paspalum (*Paspalum vaginatum* Swartz). The irrigation periods were once every 3, 6 or 9 days, and the humic acid (liquid organic fertilizer, NPK 10:10:10) was applied at 20 ml/l, after each grass cut. The turfgrass was cultivated by sprigs in plastic trays (40×30×12 cm) filled with a mixture of sand and clay (1:1, v:v).

The obtained results indicated that plant height, covering rate percentage, number of shoots/tray and grass fresh and dry weights were descendingly decreased in the two seasons with elongating the irrigation period to reach the minimum values when irrigation was done once every 9 days. However, applying humic acid significantly improved all previous traits, even for the 9 days interval treatment. The opposite was the right regarding the content of chlorophyll a, b and carotenoids (mg/g fresh weight), total sugars (mg/g dry weight), as well as indoles and phenols (mg/100 g fresh weight), as they were progressively increased with prolonging irrigation period. Humic acid treatment was also led to raised content of the different constituents mentioned above. The supremacy in vegetative growth parameters was achieved by the combination of irrigation every 3 days + 20 ml/l humic acid, but in chemical composition it was by irrigation every 9 days + 20 ml/l humic acid combined treatment.

So, it could be recommended to spray humic acid at the rate of 20 ml/l on the foliage of seashore paspalum turf after each cut at irrigation rate of once every 9 days to obtain the best growth and performance from a commercial point of view.

Key words: *Paspalum vaginatum* Swartz, irrigation periods, humic acid, vegetative growth parameters, covering rate percentage.

Scientific J. Flowers & Ornamental Plants, 3(1):71-78 (2016).

Received:
10/1/2016

Revised by:
Prof. Dr. F.A. Al-Mana, King Saud Univ., KSA.

Prof. Dr. A.M. Hosni, Ain Shams Univ., Egypt.

INTRODUCTION

Seashore paspalum (*Paspalum vaginatum* Swartz., Fam. Poaceae) is one of the most widely used grasses for lawn establishment in Egypt. It is easily propagated by sprigs and fast spreading with lateral growing stems called stolons. It makes an excellent perennial turf in tropical and subtropical areas and can tolerate irrigation water with high salt content, withstand mowing, treading, as well as wear and tear (Morton, 1974). In spite of its exceptional water salt tolerance, it is not considered drought tolerant (Plain, 1985).

Growth and quality of turfgrasses are greatly dependent on both good nutrition and sufficient water. This fact was affirmed by Hunter and Butler (2005) who reported that humic acid significantly increased fresh and dry weights of *Agrostis stolonifera* herb with improving leaf colour and P content. Nutrients leaching was also minized due to enhancing the water holding capacity of the soil when humic acid was applied. Similar observations were also revealed by Mueller and Kussow (2005) on creeping bentgrass, El-Sayed *et al*. (2008 a) and Abdel-Fattah *et al*. (2008) on Tifway bermuda hybrid, as well as El-Sayed (2012) who found that actosal (a humic acid NPK organic fertilizer) at 20 ml/l caused a marked improvement in plant height, covering rate, number of plants/pot and herb fresh and dry weights of seashore paspalum sward. They also found that chlorophyll a, b and carotenoids content in the leaves and total sugars, indoles and phenols content in the herb were increased.

As for the effects of irrigation periods, Schaan *et al*. (2003) mentioned that elongating irrigation periods saved irrigation fresh water and N loss, but led to little changes in colour, cover and plant water status of both *Cynodon dactylon* L. "Tifway" and *Lolium perenne* L. "Champion". El-Maadawy *et al*. (2005) postulated that increasing irrigation rate raised plant height and clippings in addition to underground parts fresh and dry weights of *Paspalum vaginatum* and *Cynodon dactylon* X *C. transvaalensis* hybrids Tifway and Tifgreen. Tifway recorded the highest chlorophyll a, carbohydrates and N content, while *P. vaginatum* recorded the highest carotenoids, P and K content. Analogous results were also attained on other ornamentals, such as those of Al-Qubaie *et al*. (2003) on *Ficus benghalensis, Tamarix articulata, Terminalia catappa, Bougainvillea glabra, Jasminum azoricum* and *Conocarpus erectus*, Shahin *et al*. (2007) on *Agave americana* cv. Marginata and El-Sayed *et al*. (2008 b) on *Dodonea viscosa*.

Therefore, this study was aimed to explore the effect of irrigation periods, alone or with humic acid organic fertilizer on growth and quality of seashore paspalum turf.

MATERIALS AND METHODS

This investigation was conducted under the full sun conditions through the two consecutive seasons of 2014 and 2015 at the Nursery of Hort. Res. Inst., Giza, Egypt to study the effect of irrigation periods, alone or with humic acid on growth, quality and chemical composition of seashore paspalum turf.

As for plant material, sprigs of *Paspalum vaginatum* Swartz (about 10 cm long) were planted on March, 15th for both seasons in plastic trays (40 x 30 x 12 cm; long, width and depth, respectively) filled with about 10 kg of an equal mixture of sand and clay per tray. The physical and chemical properties of the sand and clay soil used in the two seasons are shown in the Table (a).

Table a. Some physical and chemical properties of the used sand and clay medium during 2014 and 2015 seasons.

Soil type	Seasons	Particle size distribution (%)				S.P.	EC (dS/m)	pH	Cations (meq/l)				Anions (meq/l)		
		Coarse sand	Fine sand	Silt	Clay				Ca++	Mg++	Na+	K+	HCO_3	Cl^-	SO_4
Sand	**2014**	89.03	2.05	0.40	8.52	23.01	3.56	7.90	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2015	84.76	6.29	1.50	7.45	21.87	3.71	7.80	19.42	8.33	7.20	0.75	1.60	7.80	26.30
Clay	**2014**	10.18	46.17	19.53	24.12	35.00	3.48	8.27	17.50	9.42	20.00	0.79	3.80	10.00	33.91
	2015	10.30	46.54	18.88	24.28	33.07	3.36	7.96	18.00	8.95	20.50	0.85	3.65	10.20	34.25

The sprigs (20 sprigs/tray) were regularly scattered on the top soil of the trays, then gently pressed with handpalm for more attachment to the soil, and finally covered with a thin layer (0.5 cm) of the same soil mixture. After planting, the trays were daily sprayed with a little amount of water (about 300 ml) to wet only the zone in which sprigs are imbedded using watering can with very fine pores until sprouting, which completely established within 2 weeks. Trays were then subjected to the following treatments:

a. Irrigation period treatments:

The experimental planted trays were irrigated once every 3, 6 or 9 days with 500 ml of fresh water/tray starting from April, 1st until end of the experiment on October, 31st. On the whole, the trays were irrigated 72, 36 and 24 times throughout the course of the study for the 3 irrigation period treatments mentioned above, respectively.

b. Humic acid treatments:

Each irrigation period treatment was combined together with a humic acid NPK (10:10:10) liquid organic fertilizer, which was added as a foliar spray after each cut at the rate of 20 ml/l to form 3 combined treatments as follows:

1. Irrigation once every 3 days + 20 ml/l humic acid.
2. Irrigation once every 6 days + 20 ml/l humic acid.
3. Irrigation once every 9 days + 20 ml/l humic acid.

The constituents of the humic acid organic fertilizer are recorded and illustrated in Table (b).

A completely randomized design was employed in the two seasons with three replicates as each replicate contained 3 trays (Mead *et al*., 1993).

After 45 days from planting (on May, 1st), the first cut was mechanically done by hand with very sharp stainless steel cutter leaving stubbles with 1 inch long, while the other five cuts were carried out monthly thereafter.

Before each cut in the two seasons, plant height (cm) was recorded, while number of plants/tray and the fresh and dry weights of the resulted clippings after mowing (g) were determined after each cut. Furthermore, the percentage of covering rate was calculated from the following equation:

Covering rate % = No. plants/tray ÷ tray area (cm^2) x 100

However, means of each parameter mentioned before in the six taken cuts were collected and expressed in the tables as an average for all cuts. In fresh leaf samples taken from the last cut, photosynthetic

Table b. Main characteristics of the used liquid organic fertilizer (humic acid) during 2014 and 2015 seasons.

Component	Value	Component	Value	Component	Value
Humic acid (%)	2.9	EC (d S/m)	59.3	B (mg/l)	70
Organic matter/total solid (%)	42.51	N (%)	10	Fe (mg/l)	900
Total humic acid/total solid (%)	165.8	P (%)	10	Mn (mg/l)	90
Organic carbon (%)	24.64	K (%)	10	Zn (mg/l)	90
C/N ratio	2.46	Ca (%)	0.06	Cu (mg/l)	90
pH	8.20	Mg (%)	0.05		

pigments content (chlorophyll a, b and carotenoids, mg/g f.w.) was measured according to the method described by Moran (1982), as well as total indoles and total phenols (mg/100 g f.w.) by the methods of A.O.A.C. (1980) and William *et al*. (1965), respectively. Meanwhile, in dry samples taken from herb of the last cut, total sugars content (mg/g d.w.) was assessed using the method explained by Herbert *et al*. (1971).

Data were then tabulated and subjected to analysis of variance according to the program of SAS Institute (1994) using Duncan's Multiple Range Test (Duncan, 1955) for verifying the significancy between various treatments.

RESULTS AND DISCUSSION

Effect of irrigation periods, alone or with humic acid on:

1. Vegetative growth:

It's clear from data presented in Tables (1 and 2) that plant height (cm), covering rate (%), No. plants/tray and fresh and dry weights of the herb (g) were descendingly reduced in the two seasons with elongating the irrigation period to reach the minimum values when the irrigation was done once every 9 days. That may be reasonable because seashore paspalum grass is not considered drought tolerant (Plain, 1985). Applying humic acid, however improved all previous parameters, even for the 9 days interval treatment that gave means closely near to those of the 3 days interval one in most cases of both seasons. The prevalence in the two seasons, on the other hand was for the combination of irrigation every 3 days + 20 ml/l humic acid, as it gave the highest records compared to either single or combined treatments in the two seasons. This may be attributed to the role of either water availability that increases cell turgidity and enlargement (Abe and Nakai, 1999), or humic acid that increases the availability of nutrients in the soil through influences on soil microbial activity. Besides the humic acid compound contains NPK and some micronutrients necessary for good growth and enhance the soil water holding capacity that are considered (Dorer and Peacock, 1997).

These results go in line with those of Schaan *et al*. (2003) on *Cynodon dactylon* L. "Tifway" and *Lolium perenne* L. "Champion", Hunter and Butler (2005) on *Agrostis stolonifera* and Abdel-Fattah *et al*. (2008) and El-Sayed (2012) on Tifway.

2. Chemical Composition:

Data in Table (3) exhibit that chlorophyll a, b and carotenoids content (mg/g f.w.) was progressively increased in response to prolonging irrigation interval, either in the absence or the presence of humic acid with significant differences in most instances of both seasons. Application of humic acid significantly improved content of the previous pigments when compared to the individual corresponding irrigation period with few exceptions in the two seasons. Hence, the highest content of photosynthetic pigments was registered by the combined treatment between irrigation every 9 days and humic acid at 20 ml/l.

A similar trend was also attained concerning total sugars content (mg/g d.w.), as well as indoles and phenols content (mg/100 g f.w.) in the two seasons (Table, 4). The highest values were obtained from the combined treatments, with the superiority of 9 days irrigation interval + 20 ml/l humic acid combination, which gave the utmost high means in the first and second seasons. This may indicate the role of humic acid in raising the soil water holding capacity and supplying the plants with some nutrients necessary for healthy growth (Higa and Wididana, 1991). Also, this may explain and interpret enhancing tolerance of paspalum plants to low water supply through maintenance of accumulation of several metabolites, particularly amino acids, sugars and organic acids, which play a specific role in the stress response pathways such as stress signalling, osmotic adjustment and

Table 1. Effect of irrigation periods, alone or with humic acid on plant height, covering rate and number of plants/tray of *Paspalum vaginatum* Swartz turf during 2014 and 2015 seasons.

Treatments	Plant height (cm)		Covering rate (%)		No. Plants/tray	
	2014	2015	2014	2015	2014	2015
Irri. every 3 days (A)	20.22cb	21.02c	70.55c	72.70c	41.26bc	50.00b
Irri. every 6 days (B)	17.61c	18.21cd	60.20d	63.28d	40.33c	45.21c
Irri. every 9 days (C)	9.95d	9.99d	59.21d	60.10e	40.00c	43.71d
A + HA (20 ml/l)	27.09a	30.07a	91.30a	95.34a	48.22a	53.62a
B + HA (20 ml/l)	22.34b	25.86b	76.00b	80.89b	43.35b	50.71b
C + HA (20 ml/l)	20.12cb	21.23c	70.60c	72.34c	40.90cb	45.60c

*** Irri. = Irrigation, and HA = Humic acid.**
*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.**

Table 2. Effect of irrigation periods, alone or with humic acid on fresh and dry weights of *Paspalum vaginatum* Swartz turf during 2014 and 2015 seasons.

Treatments	Fresh weight (g)		Dry weight (g)	
	2014	2015	2014	2015
Irri. every 3 days (A)	51.50ab	54.27b	21.22b	23.10b
Irri. every 6 days (B)	46.33b	49.00cb	18.31c	20.31c
Irri. every 9 days (C)	39.00c	45.26c	14.27d	15.17d
A + HA (20 ml/l)	53.10a	62.61a	23.92a	25.86a
B + HA (20 ml/l)	50.22ab	59.23ab	21.58b	23.35b
C + HA (20 ml/l)	43.67bc	45.62c	18.26c	17.92cd

*** Irri. = Irrigation, and HA = Humic acid.**
*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.**

Table 3. Effect of irrigation periods, alone or with humic acid on pigments content (mg/g f.w.) in the leaves of *Paspalum vaginatum* Swartz turf during 2014 and 2015 seasons.

Treatments	Chlorophyll a		Chlorophyll b		Carotenoids	
	2014	2015	2014	2015	2014	2015
Irri. every 3 days (A)	1.02d	1.25d	0.98c	1.25c	2.85d	2.88d
Irri. every 6 days (B)	1.59c	1.70c	1.31bc	1.62bc	3.40c	3.71c
Irri. every 9 days (C)	2.05ab	2.66ab	1.44b	1.76b	4.21b	4.32b
A + HA (20 ml/l)	1.61c	1.79c	1.00c	1.30c	3.50c	3.67c
B + HA (20 ml/l)	1.99b	2.00b	2.10a	2.31a	4.39b	4.48b
C + HA (20 ml/l)	2.97a	3.16a	2.50a	2.61a	5.61a	5.87a

*** Irri. = Irrigation, and HA = Humic acid.**
*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.**

Table 4. Effect of irrigation periods, alone or with humic acid on total sugars, indoles and phenols content in the herb of *Paspalum vaginatum* Swartz turf during 2014 and 2015 seasons.

Treatments	Total sugars (mg/g d.w.)		Indoles (mg/g f.w.)		Phenols (mg/g f.w.)	
	2014	2015	2014	2015	2014	2015
Irri. every 3 days (A)	6.10d	6.21e	0.52c	0.50d	0.03d	0.04c
Irri. every 6 days (B)	6.53d	6.90de	0.59c	0.57c	0.05c	0.06c
Irri. every 9 days (C)	6.71d	7.81d	0.60c	0.63c	0.08a	0.08a
A + HA (20 ml/l)	7.00c	8.79c	0.86b	0.84b	0.06c	0.05c
B + HA (20 ml/l)	9.03b	9.90b	0.99a	0.89ab	0.07ab	0.07ab
C + HA (20 ml/l)	10.24a	12.33a	1.13a	1.17a	0.09a	0.09a

*** Irri. = Irrigation, and HA = Humic acid.**

*** Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level.**

respiration for energy production (Merewitz *et al*., 2012).

The previous findings, in general showed a similar trend to those postulated by Muller and Kussow (2005) on creeping bentgrass, El-Sayed *et al*. (2008 a) on Tifway, Shahin *et al*. on *Agave americana* cv. Marginata and El-Sayed *et al*. (2008 b) on *Dodonea Viscosa*.

According to the aforestated results, it could be concluded that application of humic acid (the liquid organic fertilizer) to seashore paspalum turf at the rate of 20 ml/l is necessary for the best growth and performance under conditions of low water supply.

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استجابة مسطح الباسبالم (شاطئ البحر) لفترات الري وحمض الهيوميك

بشرة عبد الله السيد*، سيد محمد شاهين** و طارق محمد نور الدين* و محمود عبد الفتاح السيد الأشوح*
* قسم بحوث الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر.
** قسم بحوث الحدائق النباتية، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر.

أجريت تجربة في الحقل المفتوح بمشتل معهد بحوث البساتين، الجيزة، مصر خلال موسمي ٢٠١٤، ٢٠١٥ وذلك لدراسة تأثير فترات الري (مرة كل ٣، ٦ أو ٩ أيام)، بمفردها أو مع الرش الورقي بالسماد العضوي السائل لحمض الهيوميك (10N: 10P: 10K) بمعدل ٢٠مل/ لتر عقب كل حشة على نمو وجودة مسطح الباسبالم (*Pasplaum*

vaginatum Swart) المنزرع بالعقل في صواني بلاستيك أبعادها (٤٠ × ٣٠ × ١٢سم) ملأت بحوالي ١٠كجم من مخلوط الرمل والطين (بنسبة ١ : ١ حجمًا) لكل صينية.

أوضحت النتائج المتحصل عليها أن متوسط ارتفاع النبات (سم)، النسبة المئوية لمعدل التغطية، عدد النباتات/ صينية والوزن الطازج والجاف للعشب بعد القص (جم) قد انخفض تنازليًا في كلا الموسمين كلما طالت فترة الري لتصل إلى أدنى القيم عندما أجرى الري مرة واحدة كل ٩ أيام. بينما أحدثت إضافة السماد العضوي لحمض الهيوميك تحسنًا معنويًا في جميع الصفات السابقة، حتى مع معاملة الري مرة كل ٩ أيام. ولقد كان العكس صحيحًا فيما يتعلق بمحتوى الأوراق من صبغات كلوروفيللي أ ، ب والكاروتينويدات، ومحتوى العشب من السكريات الكلية والإندولات والفينولات، حيث زاد محتوى هذه المكونات تصاعديًا كلما طالت فترة الري. أيضًا، أحدثت إضافة حمض الهيوميك زيادة واضحة في مختلف المكونات الكيميائية سابقة الذكر. أما السيادة في قياسات النمو الخضري فكانت لتوليفة الري كل ٣ أيام + الرش بحمض الهيوميك (٢٠مل/ لتر)، بينما كان التفوق في المحتوى الكيماوي للمعاملة المشتركة بين الري كل ٩ أيام والرش بحمض الهيوميك بمعدل ٢٠مل/لتر.

وعليه، فإنه يمكن التوصية برش المجموع الورقي لمسطح الباسبالم (شاطئ البحر) بالسماد العضوي السائل لحمض الهيوميك بمعدل ٢٠مل/لتر عقب كل حشة عند الري مرة واحدة كل ٩ أيام للحصول على أفضل معدل للنمو وأجمل مظهر للمسطح.