Zagazig J. Agric. Res., Vol. 46 No. (6A) 2019

Plant Production Science

http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

GROWTH, ROOT SYSTEM, SALT RESISTANCE INDEX AND LEAF PIGMENTS OF *Paspalum vaginatum* AS AFFECTED BY SALINE IRRIGATION WATER LEVEL AND AMINO ACIDS TYPE

Mohammed A.E. Mohammed*, A.E. Awad and A.S. Gendy

Hort. Dept., Fac. Agric., Zagazig Univ., Egypt

Received: 25/07/ 2019 ; Accepted: 25/08/2019

ABSTRACT: This investigation was carried out at a Privet Farm, El-Ibrahimia District, Sharkia Governorate, Egypt during the two consecutive seasons of 2016/2017 and 2017/2018 to study the effect of different saline irrigation water levels (0.0, 10000, 15000 and 20000 ppm NaCl), amino acids type (0.0, proline at 200 ppm, putrescine at 200 ppm and proline + putrescence each one at 200 ppm) and their combinations on plant growth, root system, salt resistance index and leaf pigments content of seashore paspalum (*Paspalum vaginatum*, Swartz) turfgrass. Plastic pots in 35 cm diameter filled with 5.5 kg of sand and clay mixture (1:2, *V/V*) were used in this experiment. The obtained results showed that plant growth (plant height , covering density percentage and herb fresh and dry weights), root system (root fresh and dry weights and root length), salt resistance index and leaf pigments (chlorophyll a, chlorophyll b and carotenoids contents) were descendingly decreased with increasing salinity level of irrigation water comparing with the control in both seasons, but they were progressively increased as the concentration of amino acids (proline and putrescine) was used. From these results, it can be recommended to irrigate seashore paspalum turfgrass with saline water up to 10000 ppm NaCl and sprayed with proline + putrescine each at 200 ppm to obtain the best growth, colour and higher covering density.

Key words: *Paspalum vaginatum*, Saline irrigation water, amino acid, growth, root system, chlorophyll.

INTRODUCTION

Seashore paspalum (*Paspalum vaginatum*, Swartz) is a succulent warm-season turf type grass that belongs to family Gramineae, but it retains a healthy appearance all year-round, unlike bermuda grass that tends to go off color during cooler months and short days (**Huxley *et al*., 1992**). It is easily propagated by cuttings and pre-prepared rolls, and fast spreads with lateral growing stems called stolons. It makes an attractive perennial turf in tropical and subtropical areas and can tolerate irrigation water with high salinity levels, with stand mowing, treading as well as wear and tear (**Morton, 1974**). Seashore paspalum has demonstrated superior salt tolerance compared to other turf grasses (**Marcum and Murdoch, 1990; Shahba, 2010**).

***Corresponding author: Tel. :** +201100760919
E-mail address: ahmed97911111@gmail.com

There are different stresses such as salt, drought, heat and oxidative stresses for plants (**Zhang and Yang, 2004**). Salinization of soils or waters is one of the world's most serious environmental problems in agriculture. It is necessary to determine the environmental factors under which turf grasses plants give higher growth and better quality. Nearly half of the irrigated surface is seriously affected by salinity and/or secondary alkalinity (**Flagella *et al*., 2002**). Increased need for salt tolerant grasses is still continues due to salt accumulation in soil, increased restrictions on groundwater utilization and salt water intrusion into ground water (**Hoss, 1981** and **Lee *et al*., 2004**).

Gamal El-Din and Abd El-Wahed (2005) showed that a foliar application of 50 mg/l ornithine and 100 mg/l proline increased plant height, number of branches, fresh and dry weights of aerial vegetative parts and flower head of chamomile (*Matricaria chamomilla* L. Rausch). Poly amines (PAs), such as putrescine is plant growth regulators and low-molecular-mass polycations occurring in all living organisms **(Kusano *et al*., 2008)**. Some reports have indicated the relationships between PAs and environmental stress **(Galston *et al*., 1997; Bouchereau *et al*., 1999)**. Biosynthesis of PAs may be an integral part of plant's response to salinity stress **(Alcazar *et al*., 2010).** Increasing polyamine biosynthesis might protect the plants from salinity by removing free radicals, maintaining membrane and cellular structures, keeping a cation–anion balance **(Bouchereau *et al*., 1999)**.

This study was undertaken to evaluate the effects of proline and putrescine, assess their ability to stimulate vegetative growth and root system and salt resistance index as well as chlorophylls of seashore paspalum (*Paspalum vaginatum*, Swartz) under different saline water irrigation levels.

MATERIALS AND METHODS

The pot experiment involving seashore paspalum (*Paspalum vaginatum*, Swartz) was carried out in 2016/2017 and 2017/2018 seasons at a Privet Farm, El-Ibrahimia District, Sharkia Governorate, Egypt, to study the effect of saline irrigation water levels and amino acid types on seashore paspalum plant. Circle pieces from pre-prepared rolls of seashore paspalum at a radius of 15 cm (its fresh weight ranged between 134-150g) were planted on 25th September during both seasons in the center of 35 cm diameter pots (1 piece/pot) filled about 5.5 kg of a mixture of sand: clay (1:2 *V/V*). The Seashore paspalum pieces were obtained from a privet nursery, Belbas District, Sharkia Governorate, Egypt. The physical and chemical properties of the experimental soil used are shown in Table 1, according to **Chapman and Pratt (1978)**.

After pieces were transplanted, gently pressed by hand to be more contact with the mixture soil, then it was covered with a thin layer (1 cm) of the same soil. Pots were daily irrigated with tap water (about 300 ml) to wet only the zone in which pieces are imbedded. This was done for two weeks; the plants then received the following treatments:

1. Saline irrigation water at levels of 0.0, 10000, 15000 and 20000 ppm of NaCl, where the pots were irrigated biweekly with 750 ml of the different saline water levels till the end of the experiment (10th March).
2. Amino acids types of 0 (as control), proline (Pro), putrescine (Put) and proline + putrescine as foliar spray at 200 ppm for each one were applied every month after one month from transplanting data.
3. The combination between saline irrigation water levels and amino acids types to consist 16 treatments.

These treatments were arranged in a split-plot in randomized complete blocks design with 3 replicates. Saline irrigation water levels were randomly arranged in the main plots and amino acids types were distributed randomly in the sub plots.

The source of putrescine acid [1,4-diaminobutane ($NH_2(CH_2)_4NH_2$)] and proline acid [Pyrrolidine-2-carboxylic acid ($C_5H_9NO_2$)] was TECHNO GENE Company, Dokky, Giza, Egypt.

The first cut was handly done after 45 days from planting (on 10th November) using a very sharp stainless steel cutter leaving stubbles with 1 inch long. Other four cuts were monthly undertaken thereafter.

Data Recorded

Plant growth

Before each cut in the two seasons, plant height (cm) was recorded, while covering density percentage as described by **Mahdi (1953)** and herb fresh and dry weights (g/pot) of the resulted clippings after mowing were determined after each cut. All these traits were averaged for all the cuts and tabulated.

Root parameters

At the end of the experiment in the two seasons, root fresh and dry weights (g) and root length were determined. Besides, the salt resistance index (SRI %), as a real indicator for salinity tolerance was calculated from the equation mentioned before by **Wu and Huff (1983)**: SRI (%)=Mean root length of the salt treated plants/mean root length of control one × 100.

Table 1. Physical and chemical properties of experimental mixture soil (average of the two seasons)

Physical analysis			
Clay (%)	**Silt (%)**	**Fine sand (%)**	**Coarse sand (%)**
40.36	13.26	20.62	26.76

Chemical analysis											
pH	**E.C m.mohs/cm**	**Organic mater (%)**	**Soluble cations (meq./l)**			**Soluble anions (meq./l)**			**Available (ppm)**		
			Mg^{++}	Ca^{++}	Na^{+}	Cl^{-}	HCO_3^{-}	SO_4^{--}	N	P	K
7.92	2.28	1.58	9.7	16.6	18.1	8.5	2.7	4.5	18	20	17

Pigments content

In fresh leaf samples taken from the last cut (on 10th March), photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) were measured according to the methods of **Saric *et al*. (1967)**.

Statistical Analysis

The statistical layout of this experiment was split-plot experiment in completely randomized block design. Data were analyzed according to **Gomez and Gomez (1984)**. The means were compared using computer program of Statistix version 9 (**Analytical Software, 2008**).

RESULTS AND DISCUSSION

Plant Growth

As shown in Tables (2, 3, 4 and 5), using saline water treatments significantly decreased plant height, covering density percentage and herb fresh and dry weights/pot of *Paspalum vagimatum* compared to control in both seasons. In the same time, the plant growth parameters were decreased with the increasing of the levels of salinity to reach its minimum by using that of 20000 ppm. Moreover, **Pessarakli and Touchane (2006)** found that mechanism of salt may result in cell division inhibitory and hence, reduces the rate of plant development. Also, **Harivandi *et al*. (1992)** suggested that plants known to exhibit salt tolerance often mediate salt stress by osmotic adjustment, therefore minimizing changes in turgor potential and reducing the overall effect on plant growth responses linked to carbon dioxide assimilation and cell elongation. In addition, **Jou *et al.* (2006)** revealed that ATPase participates in the endoplasmic reticulum Golgi mediated protein sorting machinery for both housekeeping function and compartmentalization of excess Na+ under high salinity. In this connection, **Pompeiano *et al*. (2016)** indicated that the use of straight seawater or brackish water for "Sea Spray" seashore paspalum as a salt tolerant species, creating the opportunity to develop turfgrass landscapes in arid and seashore regions.

Results showed that addition of proline or proline + putrecine significantly increased all the studied growth parameters, *i.e.* plant height, covering density and fresh and dry weight of herb/pot of seashore paspalum plants comparing with control plants in both seasons (Tables 2, 3, 4 and 5). **El-Sherbeny and Da Silva (2013)** found that a foliar application of 100 $mg{\cdot}l^{-1}$ proline increased plant height, number of branches, fresh and dry weights of leaves of (*Beta vulgaris* L. subsp. cicla) plant. Moreover, **Nassar *et al*. (2003)** demonstrated that addition of arginine or putrescine induced significant increases in growth (fresh and dry weights) of bean plants.

Results under discussion in Tables 2, 3, 4 and 5 indicate that, spraying seashore paspalum turfgrasses under water salinity levels with proline plus putrecine at 200 ppm gave the highest plant height, covering density percentage as well as herb fresh and dry weights/pot (g) of *Paspalum vagimatum* in comparison to those under water salinity levels in the two seasons in most cases. In the same time, using amino acids at this concentration reduced the harmful effect of salinity stress in this respect. These results are in line with those reported by **Talat *et al*. (2013)** on wheat plant.

Table 2. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* plant height (cm) during 2016/2017 and 2017/2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	**Pro.***	**Put.****	**Pro.+ Put.**	**Mean (S)**
			2016/2017 season		
Control	38.67	39.67	39.33	42.67	40.08
10000	37.33	38.33	38.33	41.33	38.83
15000	35.33	37.33	36.33	38.67	36.92
20000	31.67	34.00	32.33	35.00	33.25
Mean (A)	35.75	37.33	36.58	39.42	
LSD at 5%	**(S)= 0.76**		**(A)= 0.58**	**(S×A)= 1.25**	
			2017/2018 season		
Control	37.67	40.33	38.67	43.33	40.00
10000	36.33	39.33	38.67	42.67	39.25
15000	34.33	36.33	35.67	39.00	36.33
20000	30.33	34.33	33.00	35.67	33.33
Mean (A)	34.67	37.58	36.50	40.17	
LSD at 5%	**(S)= 0.74**		**(A)= 0.77**	**(S×A)= 1.52**	

* Pro. = Proline and **Put. = putrescine

Table 3. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* covering density (%) during 2016/2017 and 2017/ 2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	**Pro.***	**Put.****	**Pro.+ Put.**	**Mean (S)**
			2016/2017 season		
Control	146.77	156.34	150.75	157.09	152.74
10000	144.15	153.85	148.26	157.96	151.06
15000	140.17	142.04	140.42	143.91	141.63
20000	113.31	120.40	119.03	122.64	118.84
Mean (A)	136.10	143.16	139.61	145.40	
LSD at 5%	**(S)= 2.33**		**(A)= 1.61**	**(S×A)= 3.92**	
			2017/2018 season		
Control	145.52	151.12	148.51	157.34	150.62
10000	143.04	150.13	147.02	156.09	149.07
15000	137.81	140.42	137.81	143.53	139.89
20000	111.32	123.51	122.89	127.24	121.24
Mean (A)	134.42	141.29	139.06	146.05	
LSD at 5%	**(S)= 1.94**		**(A)= 1.25**	**(S×A)= 2.89**	

* Pro. = Proline and **Put. = putrescine

Table 4. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* herb fresh weight /pot (g) during 2016/2017 and 2017/2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	Pro.*	Put.**	Pro.+ Put.	Mean (S)
			2016/2017 season		
Control	58.51	60.33	59.72	68.30	61.97
10000	57.01	60.11	58.76	66.04	60.48
15000	49.29	51.67	49.93	52.21	50.78
20000	42.07	45.50	44.71	48.70	45.24
Mean (A)	51.72	54.65	53.28	58.81	
LSD at 5 %	(S)= 0.93		(A)= 0.92	(S×A)= 1.85	
			2017/2018 season		
Control	60.38	64.72	61.68	70.64	64.53
10000	58.98	62.39	60.02	66.01	61.85
15000	50.52	55.13	53.57	56.86	54.02
20000	43.62	46.93	46.76	50.31	46.90
Mean (A)	53.37	57.29	55.51	60.95	
LSD at 5 %	(S)= 0.95		(A)= 1.03	(S×A)= 2.01	

* Pro. = Proline and **Put. = putrescine

Table 5. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* herb dry weight/pot (g) during 2016/2017 and 2017/2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	Pro.*	Put.**	Pro.+ Put.	Mean (S)
			2016/2017 season		
Control	24.25	25.42	24.90	28.38	25.74
10000	22.46	24.65	23.94	27.16	24.55
15000	20.03	21.43	20.40	21.63	20.87
20000	17.24	18.34	18.05	19.79	18.35
Mean (A)	20.99	22.46	21.82	24.24	
LSD at 5%	(S)= 0.78		(A)= 0.52	(S×A)= 1.18	
			2017/2018 season		
Control	24.28	26.11	24.91	28.10	25.85
10000	23.75	25.05	24.40	26.77	24.99
15000	20.29	22.40	21.23	22.86	21.69
20000	17.55	18.96	18.92	20.43	18.97
Mean (A)	21.47	23.13	22.36	24.54	
LSD at 5%	(S)= 0.46		(A)= 0.34	(S×A)= 0.75	

* Pro. = Proline and **Put. = putrescine

Root Parameters

Results presented in Tables 6, 7 and 8 show that, root fresh and dry weights/pot and root length were significantly decreased by saline water irrigation levels in the two seasons compared to control in most cases. However, the decrease in root length were about 37.99 and 38.86 % for the salinity level 20000 ppm in the first and second seasons, respectively. Salinity may decrease biomass production and rooting, because it causes a lowering of plant water potentials, specific ion toxicities, or ionic imbalances (**Neumann, 1997**). These results are in accordance with those found by **Guo *et al.* (2016)** on seashore paspalum.

Root fresh and dry weights/pot and root length were increased by using proline or putrescine alone or together compared to control in both seasons (Tables 6, 7 and 8). Moreover, the best treatment in this regard was proline at 200 ppm + putrescine at 200 ppm in the two seasons. Proline at different concentrations has been shown to simulate growth of *Urtica pilulifera,* L. (**Wahba *et al.*, 2007**). **El-Sherbeny and Da Silva (2013)** found that a foliar application of 100 mg·l^{-1} proline increased fresh and dry weights of roots of beetroot plant. However, **Bais *et al*. (1999)** inferred that putrescine treatment played an important role in chicory root growth and development.

The results illustrated in Tables 6, 7 and 8 reveal that combination treatments between amino acids and salinity significantly affect the root fresh and dry weights/pot and root length. Although, there was significant increase, in this regard, due to spraying the seashore paspalum plants with proline at 200 ppm + putrescine at 200 ppm and were exposing to water salinity at 10000 ppm. Such results hold true in the both seasons. However, adding putrescine to wheat plants creates significant increase in fresh and dry weights under water stress condition (**Ahmed and Sadak, 2016**).

Salt Resistance Index (%)

A real indicator for salt tolerance (the salt resistance index), was as 100% for control plants grown in soil without saline water irrigation and without foliar spray with amino acids (Table 9). However, the percent of this index was increased to more than 100% for plants irrigated with either fresh water or saline water at low level (10000 ppm) and sprayed with 200 ppm of proline or putrescine alone or together in both seasons.

This means that proline and putrescine as a amino acids plays a vital role in improving salinity tolerance of paspalum plants irrigated with saline water up to 10000 ppm to be more than that of control through elongating their root. In general, proline+ putrescine concentration of 200 ppm gave higher salt resistance indices than individual effect, in which the percent of such index was more than 100 % even for plants irrigated with saline water up to 10000 ppm in the two seasons. The plants irrigated with 10000 ppm saline water and sprayed with proline + putrescine at 200 ppm exhibited good tolerance for salinity giving SRI % closely near to that of control plants in both seasons (124.40 % in the first season and 119.30 % in the second one).

Furthermore, **Dergham *et al*. (2017**) indicated that paspalum plants grown in the sandy soil can tolerate salinity of irrigation water up to 12000 ppm if they were fertilized with the higher rate of kristalon (4 g/tray), while in the calcareous soil, that was true for plants irrigated with saline water up to 16000 ppm and dressed with the same rate of kristalon (4 g/tray).

Pigments Content

In the present study, it was found that the lowest value for each of chlorophyll a and chlorophyll b in leaves of seashore paspalum was recorded with saline water irrigation treatments at 15000 and 20000 ppm, in most cases, while the best value in this connection was achieved with each of control ant the lowest level (10000 ppm) of water salinity. A similar trend to that of vegetative and root growth traits was also obtained in relation to leaf content of chlorophyll (a) and chlorophyll (b) (Tables 10 and 11), as the content of these constituents was descendingly decreased with increasing water salinity level, but ascendingly increased as the use of amino acids was increased. In contrast, carotenoids content (mg/g fw) was increased by increasing saline water irrigation levels in both seasons (Table 12). These results may be due to salt-induced water stress reduction of chloroplast stoma volume and regeneration of reactive oxygen species in playing an important role in the inhibition of photosynthesis seen in salt

Table 6. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* root fresh weight/pot (g) during 2016/2017 and 2017/ 2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	Pro.*	Put.**	Pro.+ Put.	Mean (S)
			2016/2017 season		
Control	80.67	82.49	82.91	86.71	83.19
10000	80.61	82.49	81.58	85.31	82.50
15000	74.76	76.34	75.68	78.33	76.28
20000	58.11	59.70	59.14	62.16	59.53
Mean (A)	73.54	75.26	74.58	78.13	
LSD at 5%	(S)= 0.51		(A)= 0.49	(S×A)= 0.98	
			2017/2018 season		
Control	82.86	83.47	82.80	86.70	83.96
10000	81.57	82.61	81.76	85.23	82.79
15000	74.99	77.02	75.53	78.56	76.52
20000	57.11	60.01	59.04	62.09	59.56
Mean (A)	74.13	75.78	74.78	78.15	
LSD at 5%	(S) = 0.54		(A) = 0.98	(S×A) = 1.78	

* Pro. = Proline and **Put. = putrescine

Table 7. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* dry root weight /pot (g) during 2016/2017 and 2017/ 2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	Pro.*	Put.**	Pro.+ Put.	Mean (S)
			2016/2017 season		
Control	36.36	38.37	38.96	40.13	38.52
10000	36.07	38.01	37.83	39.61	37.88
15000	34.36	34.68	34.80	37.11	35.24
20000	26.53	26.73	27.11	28.18	27.14
Mean (A)	33.33	34.45	34.68	36.25	
LSD at 5%	(S)= 0.64		(A)= 0.51	(S×A)= 1.09	
			2017/2018 season		
Control	36.68	38.08	37.50	38.71	37.74
10000	36.17	37.05	36.71	37.74	36.92
15000	33.53	34.73	33.71	35.04	34.25
20000	25.13	26.67	25.79	28.20	26.45
Mean (A)	32.88	34.13	33.42	34.92	
LSD at 5%	(S) = 0.63		(A) = 0.47	(S×A) = 1.03	

* Pro. = Proline and **Put. = putrescine

Table 8. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* root length (cm) during 2016/2017 and 2017/2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	**Pro.***	**Put.****	**Pro.+ Put.**	**Mean (S)**
			2016/2017 season		
Control	13.50	15.68	14.45	16.50	15.03
10000	12.90	15.32	14.45	16.03	14.67
15000	9.27	9.62	9.20	11.18	9.82
20000	8.17	9.10	8.82	9.67	8.94
Mean (A)	10.96	12.43	11.73	13.35	
LSD at 5%	**(S) = 0.33**		**(A) = 0.35**	**(S×A) = 0.69**	
			2017/2018 season		
Control	13.33	15.15	14.50	16.10	14.77
10000	12.60	15.17	14.10	15.88	14.44
15000	8.57	9.98	8.70	11.40	9.66
20000	7.83	9.15	8.93	10.22	9.03
Mean (A)	10.58	12.36	11.56	13.40	
LSD at 5%	**(S) = 0.59**		**(A) = 0.28**	**(S×A) = 0.76**	

* Pro. = Proline and **Put. = putrescine

Table 9. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* salt resistance index (%) during 2016/2017 and 2017/ 2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	**Pro.***	**Put.****	**Pro.+ Put.**	**Mean (S)**
			2016/2017 season		
Control	104.71	121.64	112.07	128.00	116.60
10000	100.00	118.88	112.07	124.40	113.84
15000	71.89	74.54	71.45	86.64	76.13
20000	63.24	70.53	68.40	74.98	69.29
Mean (A)	84.96	96.40	91.00	103.50	
LSD at 5%	**(S) = 3.60**		**(A) = 3.74**	**(S×A) = 5.94**	
			2017/2018 season		
Control	100.00	113.72	108.94	120.91	110.89
10000	94.65	114.03	105.91	119.30	108.47
15000	64.28	74.82	65.25	85.46	72.45
20000	58.85	68.67	67.09	76.66	67.82
Mean (A)	79.45	92.81	86.80	100.58	
LSD at 5%	**(S) = 5.90**		**(A) = 2.12**	**(S×A) = 6.93**	

* Pro. = Proline and **Put. = putrescine

Table 10. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* chlorophyll a content (mg/g as fresh weight) during 2016/2017 and 2017/2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	Pro.*	Put.**	Pro.+ Put.	Mean (S)
			2016/2017 season		
Control	2.74	2.80	2.76	2.84	2.97
10000	2.77	2.84	2.79	2.98	2.85
15000	2.62	2.66	2.66	2.71	2.66
20000	2.48	2.50	2.50	2.55	2.51
Mean (A)	2.65	2.70	2.70	2.77	
LSD at 5%	(S)= 0.016		(A)= 0.018	(S×A)= 0.035	
			2017/2018 season		
Control	2.82	2.88	2.88	2.93	2.87
10000	2.79	2.87	2.84	2.89	2.84
15000	2.48	2.57	2.53	2.65	2.56
20000	2.48	2.52	2.50	2.54	2.51
Mean (A)	2.64	2.71	2.69	2.75	
LSD at 5%	(S)= 0.018		(A)= 0.014	(S×A)= 0.030	

* Pro. = Proline and **Put. = putrescine

Table 11. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* chlorophyll b content (mg/g as fresh weight) during 2016/2017 and 2017/2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	Pro.*	Put.**	Pro.+ Put.	Mean (S)
			2016/2017 season		
Control	0.84	0.87	0.86	0.96	0.88
10000	0.85	0.86	0.84	0.99	0.88
15000	0.73	0.79	0.77	0.85	0.78
20000	0.70	0.76	0.75	0.80	0.75
Mean (A)	0.78	0.82	0.80	0.90	
LSD at 5%	(S) = 0.017		(A) = 0.013	(S×A) = 0.028	
			2017/2018 season		
Control	0.84	0.89	0.86	0.97	0.89
10000	0.85	0.88	0.85	0.99	0.89
15000	0.68	0.77	0.72	0.81	0.75
20000	0.69	0.76	0.72	0.79	0.74
Mean (A)	0.76	0.82	0.79	0.89	
LSD at 5%	(S) = 0.006		(A) = 0.010	(S×A) = 0.018	

* Pro. = Proline and **Put. = putrescine

Table 12. Influence of saline water level (S), amino acid type (A) and their combination (S×A) treatments on *Paspalum vaginatum* carotenoids content (mg/g as fresh weight) during 2016/2017 and 2017/2018 seasons

Salinity level (ppm)	Amino acid (200 ppm)				
	0.0	**Pro.***	**Put.****	**Pro.+ Put.**	**Mean (S)**
			2016/2017 season		
Control	0.58	0.54	0.50	0.44	0.51
10000	0.62	0.58	0.56	0.49	0.56
15000	0.65	0.62	0.61	0.49	0.59
20000	0.65	0.62	0.63	0.52	0.60
Mean (A)	0.62	0.59	0.57	0.48	
LSD at 5%	**(S) = 0.021**		**(A) = 0.014**	**(S×A) = 0.033**	
			2017/2018 season		
Control	0.60	0.56	0.57	0.42	0.54
10000	0.61	0.58	0.59	0.47	0.56
15000	0.62	0.59	0.59	0.49	0.57
20000	0.59	0.58	0.62	0.52	0.58
Mean (A)	0.60	0.58	0.59	0.48	
LSD at 5%	**(S) = 0.010**		**(A) = 0.008**	**(S×A) = 0.017**	

* Pro. = Proline and **Put. = putrescine

stressed plants (**Price and Hendry, 1991; Allen, 1995**). **Pompeiano *et al*. (2016)** noted that pigment content in the leaves of *Paspalum vaginatum* "Salam" was not affected by salinity level, though chlorophyll a was slightly decreased at the highest salinity level (20000 ppm).

In addition, chlorophyll a and chlorophyll b were significantly increased by using each of proline or putrescine alone or in mixture compared to control (untreated plants) in both seasons. The applied putrescine treatments significantly increased the content of wheat photosynthetic pigments over the control values (**El–Bassiouny *et al*., 2008**).

The results reported in Tables 10, 11 and 12 suggest that, using proline + putrescine at 200 ppm under all water salinity levels, significantly increased chlorophyll a and b content as compared to saline water irrigation treatments alone in the two seasons. In the same time, the combination treatment between water salinity at 10000 ppm and amino acids was more effective in plant pigments content values than the other treatments of salinity or amino acids each alone in the two seasons. Furthermore, some treatments of amino acids, to some extent, reduced the harmful effect of water salinity in chlorophyll a and b content of seashore paspalum turfgrasses.

Conclusion

From above mentioned results, it is preferable to spray *Paspalum vaginatum* turfgrasses with proline + putrescine at 200 ppm under moderate water salt stress (10000 ppm) to enhance the plant growth, root system and salt resistance index as well as chlorophyll content of seashore paspalum plant under Sharkia Governorate conditions.

REFERENCES

Ahmed, M. R. M. and M. Sh. Sadak (2016). Effect of putrescine foliar application on wheat genotypes (*Triticum aestivum* L.) under water stress conditions. Int. J. Pharm. Tech. Res., 9 (8): 94-102.

Alcazar, R., T. Altabella and F. Marco (2010). Polyamines: molecules with regulatory functions in plant abiotic stress tolerance. Planta, 231: 1237-1249.

Allen, R.D. (1995). Dissection of oxidative stress tolerance using transgenic plants. Plant Physiol., 7:1049-1054.

Analytical Software (2008). Statistix Version 9, Analytical Software, Tallahassee, Florida, USA.

Bais, H.P., J. George and G.A. Ravishankar (1999). Influence of polyamines on growth of hairy root cultures of witloof Chicory (*Cichorium intybus* L cv. Lucknow local) and formation of coumarins. J. Plant Growth Regul., 18: 33-37.

Bouchereau A., A. Aziz and F. Larher (1999). Polyamines and environmental challenges: recent development. Plant Sci., 140: 103-125.

Chapman, D. H. and R. F. Pratt (1978). Methods of Analysis for Soils, Plants and Waters. Div. Agric. Sci. Univ. Calif. USA, 16-38.

Dergham, A.H., S.S. Ahmed and S.M. Shahin (2017). The interactive effects of saline irrigation water and fertilization on growth and quality of seashore paspalum turf grown in some soils of Egypt. Middle East J. Agric. Res., 6 (3): 700-711.

El-Bassiouny, H.M., H.A. Mostafa, S.A. El-Khawas, R. A. Hassanein, S. I. Khalil and A. A. Abd El-Monem (2008). Physiological responses of wheat plant to foliar treatments with arginine or putrescine. Aust. J. Basic and Appl. Sci., 2 (4): 1390-1403.

El-Sherbeny, M.R. and J.A.T. Da Silva (2013). Foliar treatment with proline and tyrosine affect the growth and yield of beetroot and some pigments in beetroot leaves. J. Hort. Res., 21 (2): 95-99.

Flagella, Z., V. Cantore, M.M. Giuliani, E. Tarantio and A. De Caro (2002). Crop salt tolerance physiological, yield and quality aspects. Rec. Res. Dev. Plant Biol., 2: 155-186.

Galston, A.W., R. Kaur-Sawhney and T. Altabella (1997). Plant polyamines in reproductive activity and response to a biotic stress. Bot. Acta., 110: 197-207.

Gamal El-Din K.M. and M.S.A. Abd El-Wahed (2005). Effect of some amino acids on growth and essential oil content of chamomile plant. Int. J. Agric. Biol., 7: 376-380.

Gomez, N.K. and A.A. Gomez (1984). Statical Procedures for Agricultural Research. 2nd Ed., John wiley and sons, New York, USA, 680.

Guo, H., Y. Wang, D. Li, J. Chen, J. Zong, Z. Wang, X. Chen and J. Liu (2016). Growth response and ion regulation of seashore paspalum accessions to increasing salinity. Environ. and Exp. Bot., 131: 137-145.

Harivandi, M.A., J.D. Butler and D.M. Soltanpour (1992). Salt influence on germination and seedling survival of six cool-season turfgrass species. Commun. Soil Sci. Plant Anal., 23 (7): 519-529.

Hoss, D.D. (1981). Salt injury – an increasing problem. USGA Green Sect. Record, 19: 1-3.

Huxley, A., M. Griffiths and M. Levy (1992). The New Royal Hort. Society Dictionary of Gardening. The Stockton Press, 257 Park Avenue South, New York, N.Y. 10010, USA, 3: 790.

Jou, Y., C. Chiang, G. Jouh and H. Yen (2006). Functional characterization of ice plant, an AAA-type ATPase associated with the endoplasmic reticulum-Golgi network; and its role in adaptation to salt stress. Plant Physiol., 141 (1): 135-146.

Kusano, T., T. Berberich and C. Tateda (2008). Polyamines: essential factors for growth and survival. Planta, 228: 367-381.

Lee, G., R.R. Duncan and R.N. Carrow (2004). Salinity tolerance of *Seashore paspalum* ecotypes: Shoot growth responses and criteria. Hort. Sci., 39 (5): 1138-1142.

Mahdi, M.Z. (1953). The Influence of Management on Botanical Composition and Quality of Turf. Ph.D. Thesis, Fac. Agric., Calif. Univ., Los Angeles, USA.

Marcum, K.B. and C.L. Murdoch (1990). Growth responses, ion relations, and osmotic adaptations of eleven C4 turf grasses to salinity. Agron. J., 82:892–896.

Morton, J.F. (1974). Salt tolerant silt grass (*Paspalum vaginatum* Swartz). Proceeding of the Florida State, Hort. Sci., Miami Univ., USA, 86:482-490.

Nassar, A.H., K.A. El-Tarabily and K. Sivasithamparam (2003). Growth promotion of bean (*Phaseolus vulgaris* L.) by a polyamine-producing isolate of Streptomyces griseoluteus. Plant Growth Regul. Kluwer Acad. Publishers, Dordrecht, Netherlands, 40 (2): 97 – 106.

Neumann, P. (1997). Salinity resistance and plant growth revisited. Plant Cell Environ., 25: 1193-1198.

Pessarakli, M. and H. Touchane (2006). Growth response of Bermuda grass and eashore paspalum under various levels of sodium chloride stress. J. Food, Agric. and Environ., 4 (3/4): 240-243.

Pompeiano, A., E. Di Patrizio, M. Volterrani, A. Scartazza and L. Guglielminetti (2016). Growth responses and physiological traits of Seashore paspalum subjected to short-term salinity stress and recovery. Agric. Water Manag., 163(1): 57-65.

Price, A.H. and G.A.F. Hendry (1991). Iron catalysed oxygen radical formation and its possible contribution to drought damage in nine native grasses and three cereals. Plant Cell Environ., 14:477-484.

Saric, M., R. Kastrori, R. Curic, T. Cupina and I. Geric (1967). Chlorophyll Determination. Univ U Noven Sadu Parktikum is Fiziologize Biljaka, Beogard, Haucna, Anjige, 215.

Shahba, M.A. (2010). Comparative responses of Bermuda grass and seashore paspalum cultivars commonly used in Egypt to combat salinity stress. J. Hort. Environ. Biotech., 51: 383–390.

Talat, A., K. Nawaz, K. Hussian, K. H. Bhatti, E. H. Siddiqi, A. Khalid, S. Anwer and M. U. Sharif (2013). Foliar application of proline for salt tolerance of two wheat (*Triticum aestivum* L.) cultivars. World Appl. Sci. J., 22 (4): 547-554.

Wahba, H. E., H. M. Motawe, A.Y. Ibrahim and A.H. Mohamed (2007). The influence of amino acids on productivity of *Urtica pilulifera* plant. In: 3rd Ed. Int. Conf. Pharm. and Drug Industries Div., Nat. Res. Council, Cairo, Egypt.

Wu, L. and D. R. Huff (1983). Characteristics of creeping bentgrass clones (*Agrostis stolonifera*, L.) from a salinity-tolerant population after surviving drought stress. Hort. Sci., 18 (6): 883-885.

Zhang, J. and J. Yang (2004). Crop yield and water use efficiency: a case study in rice. In Water Use Efficiency in Plant Biology (Ed. M.A. Bacon), Oxford, UK: Blackwell Publishing, 189-227.

Zagazig J. Agric. Res., Vol. 46 No. (1) 2019

تأثير مستوى الري بالماء المالح ونوع الأحماض الأمينية على النمو والمجموع الجذري ودليل مقاومة الملوحة والصبغات الورقية لنجيل جزر البحر

محمد أحمد السيد محمد - عبد الرحمن العريان عوض - أحمد شاكر حسين جندي

قسم البساتين - كلية الزراعة - جامعة الزقازيق - مصر

أُجريت هذه التجربة في مزرعة خاصة، مركز الإبراهيمية، محافظة الشرقية، مصر خلال الموسمين المتتاليين ٢٠١٦/٢٠١٧ و ٢٠١٧/٢٠١٨ لدراسة تأثير مستويات الري بالماء المالح (صفر، ١٠٠٠٠، ١٥٠٠٠ و ٢٠٠٠٠ جزء/مليون) ونوع الأحماض الأمينية (صفر، البرولين بتركيز ٢٠٠ جزء/ مليون، البتروسين بتركيز ٢٠٠ جزء/مليون والبرولين + البتروسين) وتفاعلاتهم على نمو النبات والمجموع الجذري ودليل مقاومة الملوحة وصبغات الأوراق لنجيل جزر البحر، تم استخدام أصص بلاستيكية بقطر ٣٥ سم وتحتوى على ٥.٥ كجم من مخلوط التربة الرمل والطمي (١:٢ حجماً) في هذه التجربة، أوضحت النتائج المتحصل عليها أن نمو النبات (ارتفاع النبات، النسبة المئوية لكثافة التغطية والأوزان الطازجة والجافة من العشب)، المجموع الجذري (الأوزان الطازجة والجافة من الجذور وطول الجذر)، دليل مقاومة الملوحة والصبغات النباتية (المحتوى من الكلوروفيل أ وب والكاروتينيدات) قد انخفضت مع زيادى مستوى ملوحة ماء الري مقارنةً بالكنترول في الموسمين، لكنها زادت معنوياً مع استخدام تركيزات الأحماض الأمينية (البرولين والبتروسين)، من خلال تلك النتائج، يمكن التوصية بري نجيل جزر البحر بالماء المالح حتى ١٠٠٠٠ جزء/مليون من كلوريد الصوديوم والرش الورقي بالبرولين والبتروسين بتركيز ٢٠٠ جزء /مليون من كل منهما للحصول على أفضل نمو ولون وأعلى كثافة تغطية تحت إجهاد الري المالح.

المحكمـــــون:

١- أ.د. طارق أبو دهب محمد أبو دهب أستاذ الزينة – كلية الزراعة – جامعة القاهرة.

٢- د. محمد أحمد إبراهيم عبدالقــادر أستاذ الزينة المساعد – كلية الزراعة – جامعة الزقازيق.