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Effect of Different Levels of Salinity and Anti-Transpiration on the Growth Characteristics and Chemical Composition of *Panicum maximum* (Jacq.)

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Abstract: This study aimed to determine the effect of different salinity and anti-transpiration levels on the growth and biochemical composition of *Panicum maximum* plants (Guinea grass) during the spring and summer of 2020. Two different anti-transpiration treatments [molasses (sugarcane) (5 mL/L), kaolin (50 g/L) and control] and three salinity levels (S1 well water as the control and salinity S2 2000 ppm; S3 4000 ppm, S4 6000 ppm) were used in 12 treatments in 72 pots (3 anti-transpiration treatments × 4 salinity treatments × 6 replicates); a randomized complete design was used. Results revealed that the plants achieved the highest plant height (123.77 cm) and dry weight (521.87 g/m^2) with kaolin and no salt addition treatment during summer. A higher percentage of proteins and carbohydrates were found in spring than in summer, but there was no significant difference in the salinity levels. A high percentage of ash and fiber contents was also observed during summer, with no significant differences between the anti-transpiration treatments. It could be concluded that *P. maximum*, as one of the most important fodder crops, could be cultivated in marginal lands, especially during the summer season.

1 Introduction

Ruminant feeding is an obstacle to animal production in semi-arid areas, especially during the dry season. The requirements of human crops that bring about competition with adequate animal feeding requirements impede the industrial investment in ruminant feed.

Panicum is a Latin name derived from the name millet. The highest plant height of *Panicum maximum* reaches 3.5 m, and it is used in manufacturing bread (Gibbs et al 1990). It is also a sustainable forage grass that can support a ruminant feeding system in Nigeria.

The original home of *P. maximum* plants in Africa has spread to many places in Africa over large areas, especially in West Africa; it also grows naturally in Nigeria. *P. maximum* plants are similar to tropical plants, where a decrease in carbohydrates and crude proteins (CPs) occurs with age. It is a perennial plant in the ground for up to 10 years, and it can withstand different environmental conditions, such as fire and shade, as it grows in sugar cane fields under shaded conditions. It can also be fed as greens at the manger or as hay or silage, and it plays an important role in grassland improvement and livestock feeding (Bamikole et al 2001).

One-third of the global cultivated areas is cultivated with crops used for animal feeding. Economic integration must be implemented to address global food challenges. Agricultural production, including livestock, is one of the main protein sources worldwide.

Saline soil has a great effect on providing necessary elements for plants, causing soil toxicity and affecting the plants' absorption of elements. In addition, soil salinity can also affect the plant's ability to absorb water (Bano and Fatima 2009).

In arid and semi-arid areas like Egypt, anti-transpiration may reduce water consumption and improve water use efficiency (Singh et al 1999, Makus 1997).

Spraying plant leaves with kaolin reduces water loss. The photosynthetic rate is more than transpiration, which increases the building process; the largest process of demolition results from breathing inside the plants (Nakano and Uehara 1996).

Guinea grass (*P. maximum* Jacq) is one of the most important fodder crops worldwide; many ruminants depend on it, and it is an important commercial horticultural crop. Therefore, it was selected as a model crop for this study. Experiments were conducted to study the effects of different salinity and anti-transpiration levels on the growth and chemical composition of *P. maximum* plants during different seasons.

2 Materials and Methods

This study was conducted on a farm in New Salhia in Ismailia Governorate and the Regional Center for Food and Feed (R.C.F.F.) Laboratories Agricultural Research Center during the spring and summer seasons of 2020.

2.1 Treatments and Experimental Design

The treatments were two anti-transpiration types with a control and three salinity levels with a control, with six replicates and their interactions.

Two anti-transpiration types were used: molasses (sugarcane) (5 mL/L) and kaolin (50 g/L), including a control. Three salinity levels with a control (S1, brackish well water) were also prepared: S2, S3, and S4 brackish well water with 2000, 4000, and 6000 ppm of Rasheed salt, respectively. (ppm=part per million)]. Well water was found to have variable salinity, ranging from 1725 to 2210 ppm, and salt concentrations were added to the well water based on different months and final salt concentration, reaching1725-8210ppm (**Table 1).**

Table 1. Salinity levels (ppm) of irrigated water during the experimental period

Month	Salinity (ppm)			
	S1	S2	S3	S4
4/2020	1725	3725	5725	7725
5/2020	2158	4158	6158	8158
6/2020	2058	4058	6058	8058
7/2020	2100	4100	6100	8100
8/2020	1955	3955	5955	7955
9/2020	2210	4210	6210	8210

S1= well water (control), S2= Well water + 2000 ppm, S3= Well water + 4000 ppm, S4= Well water + 6000 ppm

2.2 Cultivation

Seedlings for different treatments were planted in 72 pots. The pots were 30 cm tall, with a 30 cm top diameter and 20 cm bottom diameter. Each pot was filled with 5 kg of soil mixture of animal waste (organic fertilizer) and sand in a ratio of 1:2. Guinea grass seedlings were obtained from a farm in Zagazig Governorate. Three seedlings were planted in each pot.

2.3 Irrigation rate and amount of water used

P. maximum plants are not very water-loving, so it is preferable to increase the number of irrigations with less amount of water in each irrigation.

In this experiment, irrigation was conducted thrice a week during the summer months (July, August, and September) due to high evaporation and transpiration rates caused by high temperatures. Due to low temperatures during spring, irrigation was conducted twice a week. Water was used at an average rate of 16 L/m^2/week.

2.4 Fertilizers

NPK 20/20/20 fertilizer was used at 50 g/2 L/m^2/month. NPK was added monthly after 10 days of each cutting.

2.5 Data Recorded for experiments

Mowing was done every 30 days within six months. The average data in three months of spring (April, May, and June) and summer (July, August, and

September) were recorded. Samples of three plants were dried and used for chemical analysis. The average dry forage yield per unit m^2 was calculated.

2.6 Vegetative growth

P. maximum plant samples were collected from each treatment and were separated to determine the plant height, number of leaves, number of branches, leaf area, and dry weight (each per square meter and cm of height).

2.7 Chemical composition

2.7.1 Sample preparation

Three samples were cut and oven-dried at 60°C for 72 h until a constant weight was obtained; these were ground to pass through a 40-mesh sieve and were stored at 5°C until further analysis.

2.7.2 Proximate analysis

Dry matter was calculated based on CP, ether extract, ash, and crude fiber contents of the samples, as determined according to (AOAC 2012). The total carbohydrate contents were determined by subtraction:
% carbohydrate = 100 – (% moisture + % ether extract + % ash + % crude fiber + % crude protein). Energy values were calculated using the Atwater factor method [(9 × fat) + (4 × carbohydrate) + (4 × protein)], as described by (Eneche 1991, Chima and Igyor 2007, Nwabueze 2007).

2.8 Statistical analysis

The data obtained were analyzed using CoStat software (version 6.4, CoHort Software, USA), following the method described by Gomez (1984). Mean values were differentiated using Duncan's test at a 5% significance level, as described by Duncan (1955).

3 Results and Discussion

3.1 Growth characteristics

The data **(Table 2**) shows the effects of salinity and anti-transpiration on the plant height and cutting dry weight of *P. maximum* plants during spring and summer. The highest ($P > 0.05$) plant height was recorded in the control (105.93 cm) compared to other salinity levels. In contrast, the lowest height was recorded at a concentration of 6000 ppm (83.30 cm); the highest height was also recorded during summer, which is suitable weather (107.42 cm), compared to that in spring. There was no significant difference between anti-transpiration levels. Concerning the interaction between salinity and anti-transpiration, the results showed the plant height with the control salinity with kaolin, while the interaction between salinity and the cutting season obtained the highest height (120.03 cm) during summer. As for the interaction between anti-transpiration and the cutting season, the highest height was obtained during summer, and there was no significant difference between the anti-transpiration agents. As for the interaction between the anti-transpiration agents, salinity, and the cutting season, the highest height (123.77 cm) was obtained from the treatment with the control salinity with kaolin during summer.

The highest ($P > 0.05$) cutting dry weight was recorded in the control (401.20 g/m^2) compared to that in other salinity levels. In contrast, the lowest dry weight was recorded at a concentration of 6000 ppm (125.20 g/m^2), while the highest cutting dry weight was recorded during summer (289.71 g/m^2); there was no significant difference between the anti-transpiration levels. Concerning the interaction between salinity and anti-transpiration, the results showed the highest dry weight (436.59 g/m^2) from the treatment with the control salinity with kaolin, while the interaction between salinity and the cutting season obtained the highest dry weight (473.57 g/m^2) with the control salinity during summer. As for the interaction between anti-transpiration and the cutting season, the highest dry weight was obtained during summer, and there was no significant difference between the anti-transpiration agents. As for the interaction between the anti-transpiration agents, salinity, and the cutting season, the highest dry weight (521.87 g/m^2) was obtained from the treatment with the control salinity with kaolin during summer. Muhammad Rusdy (2014) reported that the dry matter yields were 30.10, 29.90, and 28.63 g/pot for guinea grass cut intervals of 30, 45 and 90 days respectively.

The data **(Table 3**) shows the effect of salinity and anti-transpiration on the number of branches and leaves of *P. maximum* plants during spring and summer. The results showed an increase ($P > 0.05$) in the number of branches during spring (216.42 n/m^2) compared to that during summer. An increase in the number of branches was also observed in the control (259.82 n/m^2) compared to other salinity levels. While there was no significant difference between

Table 2. Average seasonal plant height (cm) and dry weight (g/m^2) of *Panicum maximum* plants as affected by different salinity and anti-transpiration levels

Characters		plant length (cm)			dry weight g/m^2		
Salinity	Anti-transpiration	Seasons			Seasons		
		Spring	Summer	mean	Spring	Summer	mean
S1	control	89.77^{fg}	118.85^{ab}	104.31^{abc}	300.05^{def}	416.38^{bc}	358.22^{b}
	Kaolin	92.27^{efg}	123.77^{a}	108.02^{a}	351.32^{cd}	521.87^{a}	436.59^{a}
	molasses	93.42^{efg}	117.48^{ab}	105.45^{ab}	335.12^{cde}	482.45^{ab}	408.78^{ab}
	mean	91.82^{de}	120.03^{a}	105.93^{A}	328.83^{b}	473.57^{a}	401.20^{A}
S2	control	86.55^{gh}	109.90^{bc}	98.23^{bc}	$231.20^{e:h}$	$261.57^{d:g}$	246.38^{c}
	Kaolin	87.72^{g}	110.10^{bc}	98.91^{bc}	$245.08^{d:g}$	306.60^{def}	275.84^{c}
	molasses	84.82^{ghi}	108.33^{bcd}	96.58^{cd}	$192.87^{f:j}$	302.77^{def}	247.82^{c}
	mean	86.36^{e}	109.44^{b}	97.90^{B}	223.05^{c}	290.31^{b}	256.68^{B}
S3	control	76.38^{hij}	$101.28^{c:f}$	88.83^{de}	$118.13^{h:k}$	$222.33^{e:h}$	170.23^{d}
	Kaolin	74.55^{ij}	103.02^{cde}	88.78^{de}	103.82^{ijk}	$215.73^{f:i}$	159.78^{d}
	molasses	73.27^{j}	105.58^{cd}	89.43^{de}	105.78^{ijk}	$227.07^{e:h}$	166.43^{d}
	mean	74.73^{f}	103.29^{c}	89.01^{C}	109.24^{d}	221.71^{c}	165.48^{C}
S4	control	67.82^{j}	$100.37^{c:f}$	84.09^{e}	73.87^{k}	$170.38^{g:k}$	122.13^{d}
	Kaolin	73.37^{j}	93.62^{efg}	83.49^{e}	75.95^{k}	$172.22^{g:k}$	124.08^{d}
	molasses	67.93^{j}	$96.70^{d:g}$	82.32^{e}	81.62^{jk}	$177.18^{g:k}$	129.40^{d}
	mean	69.71^{f}	96.90^{d}	83.30^{D}	77.14^{d}	173.26^{c}	125.20^{D}
Mean	control	80.13^{b}	107.60^{a}	93.86^{A}	180.81^{b}	267.67^{a}	224.24^{A}
	Kaolin	81.98^{b}	107.63^{a}	94.80^{A}	194.04^{b}	304.10^{a}	249.07^{A}
	molasses	79.86^{b}	107.03^{a}	93.44^{A}	178.85^{b}	297.37^{a}	238.11^{A}
	mean	80.65^{B}	107.42^{A}	94.04	184.57^{B}	289.71^{A}	237.14

S1 = well water (control), S2 = Well water + 2000 ppm, S3 = Well water + 4000 ppm, S4 = Well water + 6000 ppm
Small letters (a,b,c….) in the same column differ significantly between treatments at $p < 0.05$

Table 3. Average seasonal number of branches and leaves of *Panicum maximum* plants as affected by different salinity and anti-transpiration levels

Characters		number of branches /m^2			number of leaves /m^2		
Salinity	Anti-transpiration	Seasons			Seasons		
		Spring	Summer	mean	Spring	Summer	mean
S1	control	271.77^{abc}	$213.43^{c:f}$	242.60^{ab}	773.43^{abc}	581.77^{def}	677.60^{ab}
	Kaolin	303.43^{a}	$236.77^{b:e}$	270.10^{a}	825.93^{ab}	660.93^{bcd}	743.43^{a}
	molasses	325.10^{a}	208.43^{def}	266.77^{a}	863.43^{a}	619.27^{cde}	741.35^{a}
	mean	300.10^{a}	219.54^{c}	259.82^{A}	820.93^{a}	620.66^{b}	720.79^{A}
S2	control	$265.10^{a:d}$	138.43^{ghi}	201.77^{c}	695.10^{bcd}	409.27^{gh}	552.18^{c}
	Kaolin	278.43^{ab}	161.77^{fgh}	220.10^{bc}	$724.27^{a:d}$	456.77^{efg}	590.52^{bc}
	molasses	$235.10^{b:e}$	$156.77^{f:i}$	195.93^{c}	596.77^{def}	440.93^{fgh}	518.85^{c}
	mean	259.54^{b}	152.32^{de}	205.93^{B}	672.04^{b}	435.66^{c}	553.85^{B}
S3	control	195.10^{efg}	117.60^{hij}	156.35^{d}	450.93^{fg}	340.10^{ghi}	395.52^{d}
	Kaolin	165.10^{fgh}	115.93^{hij}	140.52^{de}	405.93^{gh}	313.60^{ghi}	359.77^{d}
	molasses	$150.93^{f:i}$	134.32^{ghi}	142.63^{de}	363.43^{ghi}	365.80^{ghi}	364.62^{d}
	mean	170.38^{d}	122.62^{e}	146.50^{C}	406.77^{cd}	339.83^{d}	373.30^{C}
S4	control	143.43^{fgh}	94.93^{ij}	119.18^{de}	349.27^{ghi}	261.27^{hi}	305.27^{d}
	Kaolin	145.10^{fgh}	68.43^{j}	106.77^{e}	360.93^{ghi}	188.43^{i}	274.68^{d}
	molasses	118.43^{hij}	105.43^{hij}	111.93^{e}	324.27^{ghi}	283.93^{ghi}	304.10^{d}
	mean	135.66^{e}	89.60^{f}	112.63^{D}	344.82^{cd}	244.54^{e}	294.68^{D}
Mean	control	218.85^{a}	141.10^{b}	179.98^{A}	567.18^{a}	398.10^{b}	482.64^{A}
	Kaolin	223.02^{a}	145.73^{b}	184.37^{A}	579.27^{a}	404.93^{b}	492.10^{A}
	molasses	207.39^{a}	151.24^{b}	179.31^{A}	536.98^{a}	427.48^{b}	482.23^{A}
	mean	216.42^{A}	146.02^{B}	181.22	561.14^{A}	410.17^{B}	485.66

S1 = well water (control), S2 = Well water + 2000 ppm, S3 = Well water + 4000 ppm, S4 = Well water + 6000 ppm
Small letters (a,b,c….) in the same column differ significantly between treatments at $p < 0.05$

the anti-transpiration levels. Besides, for the interaction between salinity and anti-transpiration, the highest number of branches (270.10 n/m^2) was obtained from the treatment with the control salinity and kaolin, while the interaction between salinity and the planting season obtained the highest number of branches (300.10 n/m^2) during spring. For the interaction between anti-transpiration and the cutting season, the highest number of branches was obtained during spring, and there was no significant difference between the anti-transpiration agents. For the interaction between the anti-transpiration agents, salinity and the cutting season, the highest number of branches (325.10 n/m^2) was obtained with the control treatment with molasses during spring.

The results also showed an increase ($P > 0.05$) in the number of leaves during spring (561.14 n/m^2) compared to that during summer, similar to the report of Jimoh et al (2019). There was an increase in the number of leaves in the control (720.79 n/m^2) compared to that in other salinity levels, while the lowest number of leaves was observed at the 6000 ppm salinity level (264.98 n/m^2). There was no significant difference between the anti-transpiration levels. Concerning the interaction between salinity and anti-transpiration, the highest number of leaves (743.43 n/m^2) was observed from the control salinity level with kaolin, while the interaction between salinity and the cutting season obtained the highest number of leaves (820.93 n/m^2) from the treatment with the control salinity during spring. The results showed the highest number of leaves during spring, and there was no significant difference between the anti-transpiration agents. As for the interaction between the anti-transpiration agents, salinity, and the cutting season, the highest number of leaves (863.43 n/m^2) was obtained with the control salinity with molasses during spring.

The data **(Table 4)** shows the effect of salinity and anti-transpiration on the leaf area of *P. maximum* plants during spring and summer.

Table 4. Average seasonal leaf area (cm^2/m^2) of *Panicum maximum* plants as affected by different salinity and anti-transpiration levels

Salinity	Anti-transpiration	leaf area cm^2/m^2		
		Seasons		
		Spring	Summer	Mean
S1	control	9900.48^{bcd}	10795.08^{abc}	10347.78^{b}
	kaolin	12543.60^{a}	13199.87^{a}	12871.73^{a}
	molasses	12185.38^{ab}	12625.23^{a}	12405.31^{a}
	mean	11543.16^{a}	12206.73^{a}	11874.94^{A}
S2	control	8859.57^{cde}	7536.07^{def}	8197.82^{c}
	kaolin	9135.03^{cde}	8079.65^{de}	8607.34^{c}
	molasses	7115.63^{efg}	9359.17^{cde}	8237.40^{c}
	mean	8370.08^{b}	8324.96^{b}	8347.52^{B}
S3	control	4747.62^{ghi}	$7038.12^{e:h}$	5892.87^{d}
	kaolin	4243.48^{i}	$5298.03^{f:i}$	4770.76^{d}
	molasses	3808.70^{i}	$5126.07^{f:i}$	4467.38^{d}
	mean	4266.60^{d}	5820.74^{c}	5043.67^{C}
S4	control	4276.93^{i}	4409.32^{hi}	4343.13^{d}
	kaolin	4088.12^{i}	$5422.65^{f:i}$	4755.38^{d}
	molasses	4416.23^{hi}	$5440.73^{f:i}$	4928.48^{d}
	mean	4260.43^{d}	5090.90^{cd}	4675.66^{C}
Mean	control	6946.15^{a}	7444.65^{a}	7195.40^{A}
	kaolin	7502.56^{a}	8000.05^{a}	7751.30^{A}
	molasses	6881.49^{a}	8137.80^{a}	7509.64^{A}
	mean	7110.07^{B}	7860.83^{A}	7485.45

S1 = well water (control), S2 = Well water + 2000 ppm, S3 = Well water + 4000 ppm, S4 = Well water + 6000 ppm

Small letters (a,b,c….) in the same column differ significantly between treatments at $p < 0.05$

The largest (P > 0.05) leaf area (7860.83 cm^2/m^2) was obtained during summer compared to that during the spring season. There was an increase in the leaf area in the control (11874.94 cm^2/m^2) compared to other salinity levels, and there was no significant difference between the anti-transpiration levels. Concerning the interaction between salinity and anti-transpiration, the largest leaf area (12871.73 cm^2/m^2) was obtained with the salinity control treatment with kaolin, while the interaction between salinity and the cutting season obtained the largest leaf area (12206.73 cm^2/m^2) with the salinity control treatment during summer. There was no significant difference between the anti-transpiration levels and the cutting season. As for the interaction between the anti-transpiration agents, salinity, and the cutting season, the largest leaf area (13199.87 cm^2/m^2) was obtained from the control salinity treatment with kaolin during summer.

3.2 Chemical composition

The data **(Table 5**) shows the effect of transpiration resistance and salinity on CP contents of *P. maximum* plants during spring and summer.

The highest (P>0.05) CP (18.78%) content was obtained during spring compared to that during summer, similar to the report of Wan Hassan et al (1987) and Panditharatne et al (1978). There was no significant difference between the anti-transpiration and salinity levels. The interaction between salinity and the cutting season obtained the highest percentage of CP (19.24%) from the 6000 ppm salinity treatment during spring. Salinity also had a significant effect on the forage quality. As the salinity level increased, the CP content increased. According to Ihsan et al (2018), as for the interaction between the anti-transpiration agents, salinity, and the cutting season, the highest CP (19.57%) was obtained from the control salinity treatment with molasses during spring (Johnson et al 1968).

Table 5. Average seasonal percentage of crude protein content of *Panicum maximum* plants as affected by different salinity and anti-transpiration levels

Salinity	Anti-transpiration	Crude Protein%		
		Seasons		
		Spring	Summer	Mean
S1	control	18.36^{ab}	15.15^{c}	16.75^{a}
	Kaolin	18.04^{abc}	15.16^{c}	16.60^{a}
	molasses	18.50^{ab}	16.72^{abc}	17.61^{a}
	mean	18.30^{ab}	15.67^{c}	16.99^{A}
S2	control	18.94^{ab}	17.35^{abc}	18.14^{a}
	Kaolin	18.77^{ab}	17.23^{abc}	18.00^{a}
	molasses	18.87^{ab}	16.98^{abc}	17.92^{a}
	mean	18.86^{a}	17.18^{bc}	18.02^{A}
S3	control	18.77^{ab}	17.02^{abc}	17.90^{a}
	Kaolin	18.82^{ab}	16.50^{bc}	17.66^{a}
	molasses	18.59^{ab}	17.25^{abc}	17.92^{a}
	mean	18.73^{a}	16.92^{bc}	17.83^{A}
S4	control	19.57^{a}	16.73^{abc}	18.15^{a}
	Kaolin	19.11^{ab}	16.34^{bc}	17.73^{a}
	molasses	19.05^{ab}	16.88^{abc}	17.96^{a}
	mean	19.24^{a}	16.65^{c}	17.95^{A}
Mean	control	18.91^{a}	16.56^{b}	17.74^{A}
	Kaolin	18.69^{a}	16.31^{b}	17.50^{A}
	molasses	18.75^{a}	16.96^{b}	17.85^{A}
	mean	18.78^{A}	16.61^{B}	17.70

S1 = well water (control), S2 = Well water + 2000 ppm, S3 = Well water + 4000 ppm, S4 = Well water + 6000 ppm

Small letters (a,b,c….) in the same column differ significantly between treatment at $p < 0.05$

The data **(Table 6)** shows the effect of anti-transpiration agents and salinity on the ash content of *P. maximum* plants during spring and summer.

A high percentage (P > 0.05) of ash was obtained during summer (11.66%) compared to that during spring, which was in accordance with Dele et al (2018). There was also no significant difference in the percentage of ash in the control, 2000 ppm, and 6000 ppm treatments (11.42%, 11.67%, and 11.62%, respectively); the lowest percentage was obtained from the 4000 ppm treatment (11.18%), and there was no significant difference between the kinds of anti-transpiration. The interaction between salinity and the cutting season obtained the highest percentage of ash (12.06%) with 2000 ppm salinity during summer. The highest percentage of ash (11.88%) was also obtained from the treatment with kaolin agents during summer. As for the interaction between the anti-transpiration agents, salinity, and the cutting season, the highest percentage of ash (12.22%) was obtained from the 2000 ppm salinity treatment with kaolin during summer.

The data **(Table 7)** shows the effect of anti-transpiration agents and salinity levels on the fat and fiber contents of *P. maximum* plants during spring and summer.

The results showed an increase (P > 0.05) in fibers with the salinity in the control treatment compared to those with other salinity levels; the lowest fiber content was observed in treatments with 2000 ppm and 4000 ppm salinity levels (25.52% and 25.30%, respectively). A higher crude fiber ratio during summer (28.06%) than that during spring coincides with the report of Jimoh et al (2019), there was no significant difference between the anti-transpiration levels. While the interaction between salinity and the cutting season obtained the highest percentage of crude fiber (30.18%) with the control salinity during summer, the interaction between anti-transpiration and the cutting season showed the highest crude fiber percentage during summer; as for the interaction between the anti-transpiration agents, salinity, and the cutting season, the highest crude fiber percentage (31.63%) was observed with the control salinity and anti-transpiration treatment during summer.

Table 6. Average seasonal ash percentage of *Panicum maximum* plants as affected by different salinity and anti-transpiration levels

Salinity	Anti-transpiration	Ash%		
		Seasons		
		Spring	Summer	mean
S1	control	11.05^{bcd}	$11.22^{a:d}$	11.14^{ab}
	Kaolin	10.99^{bcd}	11.74^{abc}	11.37^{ab}
	molasses	$11.40^{a:d}$	12.13^{a}	11.77^{a}
	mean	11.15^{b}	11.70^{ab}	11.42^{AB}
S2	control	$11.34^{a:d}$	12.22^{a}	11.78^{a}
	Kaolin	$11.24^{a:d}$	12.22^{a}	11.73^{a}
	molasses	$11.27^{a:d}$	11.73^{abc}	11.50^{a}
	mean	11.28^{b}	12.06^{a}	11.67^{A}
S3	control	$11.33^{a:d}$	$11.22^{a:d}$	11.28^{ab}
	Kaolin	$11.43^{a:d}$	$11.55^{a:d}$	11.49^{a}
	molasses	10.64^{d}	10.88^{cd}	10.76^{b}
	mean	11.13^{b}	11.22^{b}	11.18^{B}
S4	control	11.76^{abc}	$11.45^{a:d}$	11.60^{a}
	Kaolin	$11.32^{a:d}$	12.02^{ab}	11.67^{a}
	molasses	$11.63^{a:d}$	$11.56^{a:d}$	11.59^{a}
	mean	11.57^{ab}	11.67^{ab}	11.62^{A}
Mean	control	11.37^{b}	11.53^{ab}	11.45^{A}
	Kaolin	11.25^{b}	11.88^{a}	11.56^{A}
	molasses	11.23^{b}	11.57^{ab}	11.40^{A}
	mean	11.28^{B}	11.66^{A}	11.47

S1 = well water (control), S2 = Well water + 2000 ppm, S3 = Well water + 4000 ppm, S4 = Well water + 6000 ppm

Small letters (a,b,c….) in the same column differ significantly between treatment at p < 0.05

Table 7. Average seasonal percentage of crude fiber and EE (ether extract) content of *Panicum maximum* plants as affected by different salinity and anti-transpiration levels

Salinity	Anti-transpiration	Crude Fiber%			EE%		
		Seasons			Seasons		
		Spring	Summer	mean	Spring	Summer	Mean
S1	control	24.68$^{c:g}$	31.63^{a}	28.16^{a}	2.69^{a}	2.90^{a}	2.79^{a}
	Kaolin	24.09$^{d:g}$	29.08^{abc}	26.58^{ab}	2.72^{a}	3.06^{a}	2.89^{a}
	molasses	24.76$^{c:g}$	29.84^{ab}	27.30^{ab}	2.70^{a}	3.39^{a}	3.05^{a}
	mean	24.51^{cd}	30.18^{a}	27.35^{A}	2.70^{c}	3.11^{abc}	2.91^{A}
S2	control	24.35$^{d:g}$	27.37$^{a:f}$	25.86^{ab}	2.78^{a}	3.57^{a}	3.18^{a}
	Kaolin	24.84$^{c:g}$	25.37$^{c:g}$	25.11^{ab}	2.70^{a}	3.66^{a}	3.18^{a}
	molasses	23.99$^{d:g}$	27.21$^{b:f}$	25.60^{ab}	2.70^{a}	3.67^{a}	3.18^{a}
	mean	24.39^{d}	26.65^{bc}	25.52^{B}	2.73^{c}	3.63^{ab}	3.18^{A}
S3	control	24.25$^{d:g}$	26.65$^{b:f}$	25.45^{ab}	2.58^{a}	3.55^{a}	3.07^{a}
	Kaolin	23.73^{efg}	27.76$^{a:f}$	25.74^{ab}	2.65^{a}	3.52^{a}	3.09^{a}
	molasses	22.09^{g}	27.30$^{b:f}$	24.70^{b}	3.00^{a}	3.87^{a}	3.43^{a}
	mean	23.36^{d}	27.23^{b}	25.30^{B}	2.74^{c}	3.65^{ab}	3.20^{A}
S4	control	23.97$^{d:g}$	28.37$^{a:d}$	26.17^{ab}	2.76^{a}	3.81^{a}	3.29^{a}
	Kaolin	23.43^{fg}	28.10$^{a:e}$	25.76^{ab}	2.91^{a}	3.61^{a}	3.26^{a}
	molasses	24.06$^{d:g}$	28.07$^{a:e}$	26.06^{ab}	3.08^{a}	3.66^{a}	3.37^{a}
	mean	23.82^{d}	28.18^{ab}	26.00^{AB}	2.92^{bc}	3.69^{a}	3.30^{A}
Mean	control	24.31^{b}	28.51^{a}	26.41^{A}	2.70^{c}	3.46^{ab}	3.08^{A}
	Kaolin	24.02^{b}	27.58^{a}	25.80^{A}	2.74^{c}	3.46^{ab}	3.10^{A}
	molasses	23.72^{b}	28.10^{a}	25.91^{A}	2.87^{bc}	3.65^{a}	3.26^{A}
	mean	24.02^{B}	28.06^{A}	26.04	2.77^{B}	3.52^{A}	3.15

S1 = well water (control), S2 = Well water + 2000 ppm, S3 = Well water + 4000 ppm, S4 = Well water + 6000 ppm
Small letters (a,b,c….) in the same column differ significantly between treatments at $p < 0.05$

The results showed an increase ($P > 0.05$) in fat percentage during summer (3.52%) compared to that during spring; there was no significant difference between the anti-transpiration and salinity levels. The interaction between salinity and the cutting season obtained the highest fat percentage (3.69%) in the treatment with 6000 ppm salinity during summer. The results also showed the highest fat percentage (3.65%) in the treatment with molasses and anti-transpiration agents during summer. No significant differences were observed in the interactions between salinity and anti-transpiration and between the cutting season, anti-transpiration, and salinity.

The data **(Table 8**) shows the effects of transpiration resistance and salinity on the total carbohydrates and energy of *P. maximum* plants during spring and summer.

The results showed an increase ($P > 0.05$) in total carbohydrates during spring (43.14%), as reported before by Johnson et al (1968), compared to that during summer, with no significant differences in salinity and anti-transpiration levels.

No significant differences were observed in the interaction between salinity and anti-transpiration, while the interaction between salinity and the cutting season obtained the highest percentage of total carbohydrates (44.03%), with a salinity of 4000 ppm during spring. As for the interaction between the anti-transpiration agents, salinity, and the cutting season, the highest percentage of total carbohydrates (45.68%) was obtained from the treatment with 4000 ppm salinity and molasses during spring.

The results showed an increase ($P > 0.05$) in energy during spring (272.65 Kcal/g) compared to that in summer. There was also no significant difference between the salinity levels of 2000 ppm, 4000 ppm, and 6000 ppm (267.13, 270.10, and 266.05 Kcal/g) respectively, while the lowest percentage in energy was observed in the control (259.46 Kcal/g). Furthermore, there was no significant difference in anti-transpiration. Concerning the interaction between the cutting season and salinity, the energy percentage increased during spring compared to that during summer, while there was no significant difference between the salinity levels during spring. While the interaction between anti-transpiration and the cutting season, the results showed the highest energy during spring. As for the interaction between the anti-transpiration agents, salinity, and the cutting season, the highest energy (284.07 Kcal/g) was observed at 4000 ppm salinity level with molasses during spring.

Table 8. Average seasonal percentage of total carbohydrate and energy (Kcal/g) of *Panicum maximum* plants as affected by different salinity and anti-transpiration levels

Salinity	Anti-transpiration	Total Carbohydrate%			Energy/Kcal/g		
		Seasons			Seasons		
		Spring	Summer	mean	Spring	Summer	mean
S1	control	43.22^{abc}	39.10^{cd}	41.16^{a}	270.50^{abc}	243.07^{f}	256.79^{c}
	Kaolin	44.16^{ab}	40.97^{bcd}	42.57^{a}	273.26^{abc}	252.02^{def}	262.64^{bc}
	molasses	42.64^{abc}	37.92^{d}	40.28^{a}	268.89^{abc}	249.04^{ef}	258.97^{bc}
	mean	43.34^{a}	39.33^{c}	41.34^{A}	270.88^{ab}	248.04^{d}	259.46^{B}
S2	control	42.59^{abc}	39.49^{cd}	41.04^{a}	271.17^{abc}	$259.46^{b:e}$	265.32^{abc}
	Kaolin	42.45^{abc}	$41.52^{a:d}$	41.99^{a}	269.15^{abc}	267.94^{bc}	268.55^{ab}
	molasses	43.18^{abc}	40.42^{bcd}	41.80^{a}	272.47^{abc}	$262.60^{b:e}$	267.54^{abc}
	mean	42.74^{ab}	40.48^{bc}	41.61^{A}	270.93^{ab}	263.33^{bc}	267.13^{A}
S3	control	43.06^{abc}	$41.56^{a:d}$	42.31^{a}	270.57^{abc}	266.30^{bcd}	268.43^{ab}
	Kaolin	43.36^{abc}	40.67^{bcd}	42.02^{a}	272.63^{abc}	$260.39^{b:e}$	266.51^{abc}
	molasses	45.68^{a}	40.71^{bcd}	43.19^{a}	284.07^{a}	266.63^{bcd}	275.35^{a}
	mean	44.03^{a}	40.98^{bc}	42.51^{A}	275.75^{a}	264.44^{bc}	270.10^{A}
S4	control	$41.95^{a:d}$	39.63^{cd}	40.79^{a}	270.91^{abc}	$259.76^{b:e}$	265.33^{abc}
	Kaolin	43.23^{abc}	39.94^{bcd}	41.59^{a}	275.58^{ab}	257.60^{cde}	266.59^{abc}
	molasses	$42.19^{a:d}$	39.84^{bcd}	41.01^{a}	272.64^{abc}	$259.81^{b:e}$	266.22^{abc}
	mean	42.46^{ab}	39.80^{c}	41.13^{A}	273.04^{a}	259.05^{c}	266.05^{A}
Mean	control	42.71^{a}	39.95^{b}	41.33^{A}	270.79^{a}	257.15^{b}	263.97^{A}
	Kaolin	43.30^{a}	40.77^{b}	42.04^{A}	272.65^{a}	259.49^{b}	266.07^{A}
	molasses	43.42^{a}	39.72^{b}	41.57^{A}	274.52^{a}	259.52^{b}	267.02^{A}
	mean	43.14^{A}	40.15^{B}	41.65	272.65^{A}	258.72^{B}	265.68

S1 = well water (control), S2 = Well water + 2000 ppm, S3 = Well water + 4000 ppm, S4 = Well water + 6000 ppm
Small letters (a,b,c….) in the same column differ significantly between treatment at $p < 0.05$

4 Conclusion

To have the best results, it is recommended to cultivate *P. maximum* during the summer season by controlling the salinity and kaolin levels, as compared to its cultivation during spring under high salinity levels (6000 ppm), where the worst results were observed.

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