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EFFECT OF SPRAYING WITH SPERMINE ON HEAT STRESS RELIEF IN SOME WHEAT CULTIVARS.

Abd El-Aziz, M. A.* and M. A. Attia
Plant production Department, Ecology and Dry Lands Agriculture Division, Desert Research Center, Egypt.
***E-mail- mahmoud75@drc.gov.eg**

ABSTRACT

The reaction of several bread wheat cultivars (*Triticum aestivum* L.) and spermine under new recovered sandy soil conditions was examined during the winters of 2021–22 and 2022–23 at Al-Dakhla – New Valley, Egypt. The experiment included 40 treatments, which were combinations of wheat cultivars Misr-1, Misr-2, Misr-3, Sakha-94, Sakha-1001, Sids14, Gemmeiza12 and Shandaweel1 and levels of spermine (0, 2, 4, 6 and 8 ml/ha^{-1}). The findings showed notable variations in all examined features between wheat cultivars. The Sakha-94 cultivar greatly outperformed other cultivars in both seasons for grain yield/ha. Wheat cultivar Misr-3 outperformed the others in terms of plant height and spike length. Sakha-1001 produced the No. of spike m-2. Application of either spermine 8 ml greatly improved all examined properties. The Sakha-94 wheat cultivar achieved the maximum grain yield (4190 kg/ha^{-1} in the first season and 4295 kg/ha^{-1} in the second one). However, this study recommends the importance of the Sakha-94 wheat cultivar with the application of Spermine 8 ml under Al-Dakhla – New Valley, conditions.

Key Words: Spermine, Wheat, Cultivar, Heat, Stress.

INTRODUCTION

The most important and staple food crop for the great majority of people is wheat (*Triticum aestivum* L.), and its straw is used as livestock feed. It is currently grown on nearly 226 million hectares worldwide, yielding 761 million ton, according to **(FAO, 2022)**. Wheat plays a vital role in Egypt's agricultural policies, with a total cultivated area of over 1.411 million hectares and an output volume of about 9 million ton **(Anonymous. 2016)**. While Egypt imports more than 45% of its annual wheat requirements. High temperature decreases winter wheat grain yield by reducing the grain number and grain weight. The effect of heat stress on spike grain distribution and weight of individual grains within spike and spikelets **(Mirosavljević *et al.*, 2021).** Heat stress significantly reduces seed germination and seedling growth, cell turgidity, and plant water-use efficiency, at a cellular level, heat stress disturbs cellular functions through generating excessive **(Akter and Islam, 2017).**

The newly restored soil in Al-Dakhla –New Valley is characterized by an increase in salt content in the soil or in irrigation water, this region suffers from high temperatures, and this is clear in meteorological data, and this causes heat stress to wheat, which affects productivity, which highlights the scope of the issue and the amount of work necessary to improve. It is well known that salinity and low soil fertility negatively affect the growth and yield of field crops, particularly wheat. It is demonstrated that under freshly recovered soil, wheat cultivars with yield potentialities ranging from 2.9 to 4.2 tons/ha^{-1} varied **(Inamullah *et al.,* 2011)**, 6.6 to 8.4 tons/ha^{-1} **(Kamal *et al.,* 2011)** and 3.2 to 5.7 tons/ha^{-1} **(Kandil *et al.,* 2016).** Therefore, given these conditions, it is essential for the production of wheat to select and cultivate a high yield cultivar. Tetraamine spermine aids in plant resilience to abiotic stress **(Igarashi & Kashiwagi 2019 and Talaat 2020)**. Spermine has the potential to be a strong plant defence activator when used exogenously **(Todorova *et al.,* 2016; Seifi and Shelp 2019 and Talaat *et al.,* 2022).** Exogenously applied spermine reduces the negative effects of salinity on plant development by scavenging radicals, defending the structure and function of the photosynthetic apparatus, maintaining cationic-anionic stability, lowering ethylene production, increasing protein content, altering endogenous phytohormone levels, and inducing the accumulation of organic solutes **(Nahar *et al.,*. 2016; Ahangera *et al.,* 2019 ; Xu *et al.,* 2020 and Geng *et al.,* 2021).** However, its prospective uses in saline environments are not fully understood. Wheat is a significant grain crop grown all over the world. It provides necessary sustenance for a sizeable portion of the world's population. Stress from salt reduces its production, compromising the security of the global food supply **(Talaat 2019)**. The most cost-effective strategy is thought to be increasing its capacity for surviving in salinity. Spermine innovative methods for improving plant tolerance to salt toxicity gain popularity; foliage application of bio stimulants like spermine is one of them. Plant growth and development are impacted in a variety of ways by environmental stress. The environment frequently puts plants under a variety of pressures in both rural and natural environments **(Radwan *et al.,* 2020),** and during the production of plant biomass, excessive stress frequently results in significant harm **(Ebeed *et al.,* 2017).** A lack of rainfall, salt, temperature extremes, intense light, evapotranspiration, and rhizosphere water storage capacity are just a few of the many factors that contribute to a lack of water for plants **(Devincentis, 2020)**. Premature leaf fall, yellowing, withering, and loss of leaf turgor are a few of the usual signs of dryness **(Corso *et al.,* 2020).** Reduced leaf expansion, excessive heat, and early leaf senescence are factors contributing to reduced photosynthesis **(Ebeed and El-Helely,**

2021). Additionally, it has been discovered that plants under drought stress have far bigger root growth than shoot growth **(Hassan *et al.*, 2015 and Miranda *et al.*, 2021)**. Plants have developed their own defence systems to deal with drought stress. However, the plant type affects these systems **(Ebeed *et al.*, 2019 and Ebeed, 2021)**. The principal defence mechanism employed by plants against drought is to preserve cell homeostasis in conditions with low water availability by enhancing water entry into plant cells **(Hassan *et al.*, 2015)**. In this study, wheat cultivars were given exogenous spermine application to see how it affected the growth and yield of bread wheat grown in sandy soil with sprinkler in the Al-Dakhla –New Valley, Egypt, as well as to provide technical strategies for improving wheat production in the salinity conditions. This investigation looked at how spermine treatments affected the bread wheat cultivar yields in newly mended sandy soil.

MATERIALS AND METHODS

Wheat cultivars and spermine treatment.

Wheat cultivars from the Field Crops Research Institute at the Giza Agricultural Research Centre in Egypt, Misr-1 (V1), Misr-2 (V2), Misr-3 (V3), Sakha-94 (V4), Sakha-1001 (V5), Sids14 (V6), Gemmeiza12 (V7) and Shandaweel1 (V8), were utilized in this study. The trials included 40 treatments as combinations of wheat cultivars with the levels of spermine (0, 2, 4, 6 and 8 ml/ ha-1). They were conducted with four replicates and a split-split plot design. The spermine treatments served as the sub-plots, with wheat cultivars serving as the main.

The sub-plot area measured 10.5 m^2, 3.5 m^2, and 3 m^2 in length and width. Wheat seeds were sown at a rate of 143 kg/ha^{-1}. On November 30 of each season, the seeds (according to 1000-grain weight of each cultivar) were hand-drilled in rows that were 3.5 m long and 20 cm apart. Three dosages of salicylic acid were applied before irrigation, at intervals of 25, 50, and 75 days after plant germination. Irrigation with sprinkler every five days at a rate of 71 m^3/ha^{-1}.

Data recorded.

A. Morphological traits

After 120 days from sowing, ten guarded plants were chosen from each sub-sub plot and the following characters were estimated:

1- Flag leaf area (cm) was estimated using the allowing formula.

F. L. A.= flag leaf Length x maximum width x 0.75 according to **Watson (1952).**

2- Plant height (cm): was measured from soil surface to tip of spikes, excluding awns, as an average of ten readings.

3- Spike length (cm): as an average of ten random spikes.

B. Yield and its components

At harvest one square meter was randomly selected from each sub-sub plot and the following characters were estimated:

1- Number of spikes/m^2: was determined from a random sample of one square meter: taken from each plot.

2-Number of grains/spike: was recorded from a sample of ten main spikes collected from ten randomly selected plants in each sub-sub plot.

3-1000-grain weight (g): was obtained from the weight of 1000 kernels taken at random from each sub-sub plot.

4-Grain yield (kg/ha^{-1}): The obtained grains from each square meter of each sub-sub plot were air dried, then threshed and the grains at 13% moisture were weighed in kg and converted to kg/ha.

5- Straw yield (kg/ha^{-1}): It was estimated by weighting the straw yield (kg) from each square meter of each sub-sub plot and converted to kg/ha^{-1}.

6- Biological yield (kg/ha^{-1}): was determined by weighting all plants found in the chosen square meter and converted to kg/ha^{-1}.

7- Nitrogen content (%): Samples of grains representing each sub-sub plot were milled and subjected to the chemical analysis using the new kjeldahle method as outlined by the **A.O.A.C. (1980)**.

Protein content. (%): Protein content was estimated as follows: Nitrogen content multiplied by 6.25.

C- Economic assessment

1. Total gain (L.E/ha^{-1}) is equal to grain yield price plus straw yield price. The price of wheat grains was 10000 L.E/ton. Straw was 2000 L.E/ton.
2. Net return (L.E/ha^{-1}) is equal to total gain less costs.
3. The cost data included the price of all farm inputs, manpower, and farm machinery.

Total costs = 18600 L.E/ha^{-1}.

Soil characteristics and agronomic practices:

The experiments were carried out in Al-Dakhla –New Valley Government during the winter growing seasons of 2021/2022 and 2022/2023. It was located at (N25°32'31.07" E 29°08'16.14") coordinates, of Al-Dakhla –New Valley, Egypt.

As shown in Table (1) meteorological data and the high temperature that causes stress to the wheat plant and reduce the duration of branching and storage of dry matter, and thus the yield decreases.

As shown in Table (1), auger performed physical and chemical studies on soil samples that were taken at a depth of 0 to 30 cm prior to sowing. The experimental field was divided into experimental units with the aforementioned dimensions after being ploughed twice, compacted, and divided. Calcium superphosphate (15.5% P_2O_5) was administered to the soil at a rate of 74 kg P P_2O_5/ha^{-1} during soil preparation. Prior to sowing, potassium sulphate (48% k_2O) was broadcast at a rate of 115 kg/ha^{-1}. Ammonium sulphate (20.6% N) was broadcast at a rate of 150 kg N/ha^{-1} prior to sowing, and ammonium nitrate (33.5% N) was administered in three equal doses at a rate of 250 kg N/ha^{-1} at 25, 50, and 75 days following sowing (a total of 750 kg. The Ministry of Agriculture's recommendations for the cultivation of wheat were followed. The irrigation water was examined for pH, EC, captions, and anions during the course of three seasons, as shown in Table (2).

Table (1): Meteorological data of the two growing seasons in Al-Dakhla location.

Month	(T) Mean temperature (°C)	(TM) Maximum temperature (°C)	(Tm) Minimum temperature (°C)	(H) Mean humidity (%)	(PP) Precipitation amount (mm)	(V) Mean wind speed (m/s)
			2021-2022			
Oct	25.6	33.5	18.8	31.5	00.00	1.92
Nov	25.6	33.5	18.8	31.5	00.00	1.92
Dec	15.5	23.3	9.4	45.5	00.07	2.17
Janu	10.3	17.7	4.3	52.9	01.46	2.39
Feb,	13.0	20.5	6.6	46.3	26.46	2.36
Mar	18.0	26.4	10.6	34.3	00.13	2.94
Apr	22.0	30.1	14.2	26.3	00.00	2.53
Jun	27.4	35.4	19.60	21.30	00.00	25.0
			2022-2023			
Oct	29.56	37.09	21.14	31.00	00.00	9.34
Nov	20.45	27.07	13.09	49.07	00.00	6.63
Dec	18.12	25.47	9.92	43.94	00.07	6.51
Janu	13.83	21.36	5.83	46.31	01.46	5.24
Feb,	15.69	23.81	6.29	45.33	26.46	5.87
Mar	20.72	28.79	11.63	34.25	00.13	10.57
Apr	23.59	30.67	15.58	28.27	00.00	7.57
Jun	30.16	37.50	20.65	22.25	00.00	8.83

Table (2): The typical chemical and physical characteristics of representative soil samples (0–30 cm in depth) taken from the experiment location before sowing, as well as the irrigation water used during the two growing seasons.

Parameter	Water	Parameter	Soil
pH	6.78	Ph	7.75
Electrical conductivity (EC), µS/cm	1221	Electrical conductivity (EC), dS/m	1.718
Total dissolved solids (TDS), mg/l mg/l	793	Total dissolved solids (TDS), mg/l	1006
Calcium, mg/l	365.6	Calcium, meq/l	7.68
Magnesium, mg/l	290.6	Magnesium, meq /l	5.40
Sodium, mg/l	1050.0	Sodium, meq /l	5.21
Potassium, mg/l	20.0	Potassium meq /l	0.53
Carbonate, mg/l	Nil	Carbonate, meq /l	Nil
Bicarbonate, mg/l	24.4	Bicarbonate, meq /l	4.59
Sulphate, mg/l	203.5	Sulphate, meq /l	8.86
Chloride, mg/l	326.0	Chloride, meq /l	5.07

Yield traits determination

During harvest, one square meter from each sub-sub plot was randomly selected to investigate the associated features. To assess grain, straw, and biological yields, each sub-plot was used. To estimate all wheat yield metrics, 10 guarded plants were chosen at random from each sub-plot at harvest.

Statistical analysis

According to **Gomez and Gomez's. (1984)** description, the gathered data were statistically analyzed using the split design and analysis of variance (ANOVA). The MSTAT statistical package was used in conjunction with MGRAPH version 2.10 in this study. The difference between treatment means was determined using the least significant difference (LSD) method at a 5% level of probability, according to **Snedecor and Cochran (1980).**

RESULTS AND DISCUSSION

Effect of wheat cultivars:

After 150 days from planting, conclusions in the effects of wheat cultivars on plant height (cm) were significant in the two seasons (Table 3). The highest values of plant height were significantly obtained from planting Misr-3 cultivar with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to cultivation Misr-3 were 21.49 and 15.69 % for the two seasons, respectively compared with Sakha-1001cultivar.The results in showed that spike length were significantly affected by using different wheat cultivars. The maximum values were significantly obtained by planting Misr-3 cultivars in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them. The effects of wheat cultivars on no. of spike m^2 were significant in the two seasons. The highest values of no. of spike were significantly obtained from planting Sids14 cultivar with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to cultivation Sids14were 15.84 and 13.04 % for the two seasons, respectively compared with Misr-1 cultivar. The results in showed that flag leaf were significantly affected by using different wheat cultivars. The maximum values were significantly obtained by planting Gemmeiza-12 cultivars in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them.

1000-grain varied from 26 (Misr-2) to 37 (Sids14); in the first season, it varied from 29 (Misr-2) to 40 (Sids14); in the second. Harmonic outcomes were observed by **Kandil *et al.*, (2012); Sabbour *et al.*, (2016) and Kandil *et al.*, (2017).** It is clear from these results that wheat varieties differ in their degree of response to heat stress.

Table (3): Plant height, spike length, No. of spike, flag leaf and 1000-grain of wheat as affected by the wheat cultivars during the both seasons of the study.

Cultivars	Plant height		Spike length		No. of spike m^2		Flag leaf		1000-grain	
	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23
Misr-1	76.80E	81.20E	9.54E	10.18CD	180.6F	199.4G	30.20F	31.60H	31.00F	32.60F
Misr-2	80.40D	83.80D	9.74C	10.22C	189.20E	209.2E	31.00E	33.60F	26.00H	29.20H
Misr-3	84.80A	87.00A	10.76A	11.14A	205.60B	224.4A	31.60D	35.20E	33.60D	36.20D
Sakha-94	72.80F	76.80F	9.70CD	10.14DE	203.00C	222.8B	32.60C	37.20C	36.20B	38.80B
Sakha-1001	69.80G	75.20G	9.58E	9.96F	196.20D	211.4D	31.60D	36.20D	35.20C	37.20C
Sids14	72.80F	76.80F	9.66D	10.12DE	209.20A	225.4A	33.60B	37.80B	37.20A	40.40A
Gemmeiza12	83.00B	86.00B	10.30B	10.82B	180.60F	201.2F	34.60A	39.40A	28.20G	33.60F
Shandaweel1	82.20C	84.80C	9.68CD	10.08E	204.60B	220.2C	31.20F	32.60G	32.60E	35.20E
LSD. 0.05	0.6807	0.6341	0.0658	0.0716	1.3786	1.2950	0.2972	0.3603	0.5321	0.4842

Conclusions in during the first season, the effects of wheat cultivars on no. of grains/spike were significant in the two seasons (Table 4). The highest values of no. of grains/spike were significantly obtained from planting Sakha-94 cultivar with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to cultivation Sakha-94 were 39.27 and 37.97 % for the two seasons, respectively compared with Gemmeiza12 cultivar, grain yield (kg/ha^{-1}) of the various wheat cultivars ranged from 3108 (Misr-2) to 4190 (Sakha-94), in the first season, ranged from 3265 (Misr-2) to 4295 (Sakha-94), in the second, the results showed that straw yield (kg/ha^{-1}) were significantly affected by using different wheat cultivars. The maximum values were significantly obtained by planting Sakha-94 cultivars in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them. The effects of wheat cultivars on biological yield (kg/ha^{-1}) were significant in the two seasons. The highest values of biological yield were significantly obtained from planting Sakha-94 cultivar with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to cultivation Sakha-94 were 33.96 and 35.37 % for the two seasons, respectively compared with Misr-2 cultivar. Grain yield (L.E /ha^{-1}) varied from 31080 (Misr-2) to 41898 (Sakha-94), in the first season, ranged from 32646 (Misr-2) to 42948 (Sakha-94), in the second. These results exhibit a similar trend to those acquired by **Bakry *et al.*, (2015) and Abd El-Aziz, *et al.*, (2018).** It is clear from these results that wheat varieties differ in their degree of response to heat stress.

Table (4): No. of grains/spike, grain yield (kg/ha^{-1}), straw yield (kg/ha^{-1}), biological yield (kg/ha^{-1}) and grain (L.E /ha^{-1}) of wheat cultivars during the both seasons of the study.

Cultivars	No. of grains/spike		Grain yield (kg/ /ha^{-1})		Straw yield (kg/ha^{-1})		Biological yield (kg/ha^{-1})		Grain (L.E /ha^{-1})	
	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23
Misr-1	55.00C	57.80C	3147.4G	3201.1G	4734.0E	5025.2D	7881.0E	8334E	31474G	33084F
Misr-2	54.40C	56.20D	3108.0G	3160.2G	4723.2E	4929.8D	7831.0E	8194E	31080G	32646G
Misr-3	56.80B	59.40B	3405.4F	3489.5F	5491.8D	5781.2C	8897.0D	9438D	34054F	36576E
Sakha-94	61.00A	65.40A	4189.8A	4224.8A	6457.6A	6797.4A	10647.0A	11092A	41898A	42948A
Sakha-1001	54.40C	57.80C	3791.8B	3858.3B	6160.0B	6484.0AB	9952.0B	10475B	37918B	39912B
Sids14	52.40D	55.00E	3716.2C	3778.7C	5587.2CD	5880.8C	9303.0C	9785CD	37162C	39036C
Gemmeiza12	43.80F	47.40G	3482.2E	3552.7E	5429.2D	5757.0C	8911.0D	9451D	34822E	36936E
Shandaweel1	47.40E	49.80F	3587.0D	3647.5D	5761.0C	6337.8B	9348.0C	10106C	35870D	37686D
LSD. 0.05	0.6592	0.7464	42.661	49.286	252.55	352.01	270.46	365.41	426.61	412.65

Conclusions in Table (5) during the first season, the effects of wheat cultivars on straw yield (L.E /ha^{-1}) were significant in the two seasons. The highest values of straw yield were significantly obtained from planting Sakha-94 cultivar with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to cultivation Sakha-94 were 35.72 and 37.88 % for the two seasons, respectively compared with Misr-2 cultivar. The results in Table (4) showed that Total gain (L.E /ha^{-1}) were significantly affected by using different wheat cultivars. The maximum values were significantly obtained by planting Sakha-94 cultivars in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them. Net gain (L.E /ha^{-1}) varied from 21926 (Misr-2) to 36213 (Sakha-94); during the second and third seasons, it varied from 23906 (Misr-2) to 37943 (Sakha-94); in the second. The effects of wheat cultivars on Protein (%) were significant in the two seasons (Table 4). The highest values of Protein (%) were significantly obtained from planting Misr-1cultivar with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to cultivation Misr-1were 16.56 and 15.51 % for the two seasons, respectively compared with Shandaweel1cultivar. Harmonic outcomes were observed by **Abd El-Aziz and Attia. (2022); Attia *et al.*(2022) and El-Metwally *et al.* 2010).** It is clear from these results that wheat varieties differ in their degree of response to heat stress.

Table (5): Straw Yield (L.E /ha^{-1}), total gain (L.E /ha^{-1}), net gain (L.E /ha^{-1}) and protein (%) of wheat cultivars during the both seasons of the study.

Cultivars	Straw yield (L.E /ha^{-1})		Total gain (L.E /ha^{-1})		Net gain (L.E /ha^{-1})		Protein %	
	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23
Misr-1	9468E	10050D	40942F	43134E	22342F	24534E	11.078A	11.156A
Misr-2	9446E	9860D	40526F	42506E	21926F	23906E	10.268E	10.310E
Misr-3	10984D	11562C	45038E	48138D	26438E	29538D	10.622C	10.734C
Sakha-94	12915A	13595A	54813A	56543A	36213A	37943A	10.388D	10.518D
Sakha-1001	12320B	12968AB	50238B	52880B	31638B	34280B	9.934F	10.046F
Sids14	11174CD	11762C	48336C	50798C	29736C	32198C	9.786G	9.942G
Gemmeiza12	10858D	11514C	45680E	48450D	27080E	29850D	10.698B	10.816B
Shandaweel1	11522C	12676B	47392D	50362C	28792D	31762C	9.504H	9.658H
LSD. 0.05	505.10	704.01	766.84	907.85	766.84	907.85	0.0625	0.0592

Effects of spermine on yield traits of wheat:

The results in Table (6) showed that plant height (cm) was significantly affected by using different spermine. The maximum values were significantly obtained by applications spermine 8 ml in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them. Spike length (cm) ranged from 8.5 cm (water) to 11.5 cm (spermine 8 ml); during the second and third seasons, it varied from 8.9 cm (water) to 12 cm (spermine 8 ml); in the second. The results showed that no. of spike m^2 was significantly affected by using different spermine. The maximum values were significantly obtained by applications spermine 8 ml in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them. The effects of spermine on flag leaf were significant in the two seasons. The highest values of flag leaf were significantly obtained from planting spermine 8 ml with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to spermine 8 ml were 35.12 and 34.82 % for the two seasons, respectively compared with spermine 0 ml. 1000-grain varied from 28 (water) to 38 (spermine 8 ml); during the second and third seasons, it varied from 30 (water) to 41 (spermine 8 ml); in the second. Harmonic outcomes were observed by **Aldesuquy *et al.* (2014).** It is clear from these results that increasing the concentration of spermine increases the resistance of wheat plants in terms of their response to heat stress.

Table (6): Plant height, spike length, no. of spike, flag leaf and 1000-grain of wheat as affected by the season during the both seasons of the study.

Spermine	Plant height		Spike length		No. of spike m^2		flag leaf		1000-grain	
Season	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23
water	67.13E	70.13E	8.51E	8.90E	168.75E	184.37E	27.63A	30.50E	27.88C	30.38D
Spermine 2 ml	71.63D	75.00D	9.08D	9.50D	180.13D	196.75D	29.50D	32.50D	29.75CD	32.50CD
Spermine 4 ml	77.00C	80.50C	9.76C	10.24C	194.00C	211.87C	31.63C	35.00C	32.25BC	35.13C
Spermine 6 ml	83.38B	87.25B	10.54B	11.03B	209.75B	229.13B	34.25B	38.00B	34.88AB	37.88B
Spermine 8 ml	90.00A	94.38A	11.46A	12.00A	228.00A	249.12A	37.25A	41.25A	37.75A	41.13A
LSD. 0.05	3.8165	3.1337	0.3354	0.3251	8.5057	7.6848	0.9658	1.6895	2.9805	2.6667

The results in Table (7) showed that no. of grains/spike was significantly affected by using different spermine. The maximum values were significantly obtained by applications spermine 8 ml in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them. Grain yield (kg/ha^{-1}) ranged from 3058 (water) to 4132 (spermine 8 ml); during the second and third seasons, it varied from 3214 (water) to 4343 (spermine 8 ml); the effects of spermine on straw yield (kg/ha^{-1}) were significant in the two seasons. The highest values of straw yield were significantly obtained from planting spermine 8 ml with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to spermine 8 ml were 34.26 and 32.97 % for the two seasons, respectively compared with spermine 0 ml. The results showed that biological yield (kg/ha) was significantly affected by using different spermine. The maximum values were significantly obtained by applications spermine 8 ml in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them. Grain (L.E /ha^{-1}) varied from 30576 (water) to 41320 (spermine 8 ml); during the second and third seasons, it varied from 3109.8 (water) to 4202.5 (spermine 8 ml); in the second. These results exhibit a similar trend to those acquired by **Liang *et al*. (2021).** It is clear from these results that increasing the concentration of spermine increases the resistance of wheat plants in terms of their response to heat stress.

Table (7): No. of grains/spike, grain yield (kg/ha^{-1}), straw yield (kg/ha^{-1}), biological yield (kg/ha^{-1}) and grain (L.E /ha^{-1}) of season during the both seasons of the study.

Spermine	No. of grains/spike		Grain yield (kg//ha^{-1})		Straw yield (kg//ha^{-1})		Biological yield (kg/ha^{-1})		Grain (L.E /ha^{-1})	
Season	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23
water	45.87D	48.25D	3057.6D	3109.8D	4775.1E	5026.1D	7833.0D	8240C	30576D	32141D
Spermine 2 ml	48.750D	51.63D	3264.2D	3319.9D	5187.8D	5566.0C	8452.0CD	8997B	32643D	34313D
Spermine 4 ml	52.500C	55.50C	3512.3C	3572.2C	5498.0C	5813.6C	9010.0BC	9506B	35123C	36920C
Spermine 6 ml	56.875B	60.00B	3801.3B	3866.1B	5842.8B	6281.9B	9644.0B	10278A	38013B	39958B
Spermine 8 ml	61.750A	65.13A	4132.0A	4202.5A	6411.4A	6683.1A	10543.0A	11026A	41320A	43434A
LSD. 0.05	3.5016	3.6924	246.39	231.18	179.25	249.84	191.96	754.4	2463.9	2311.8

Conclusions in table (8) during the first season, straw yield (L.E /ha^{-1}) varied from 9550 (water) to 12823 (spermine 8 ml); during the second and third seasons, it varied from 10052 (water) to 13366 (spermine 8 ml); and during the fourth season. Revealed a distinct difference of the various wheat cultivars. The effects of spermine on total gain (L.E /ha^{-1}) were significant in the two seasons. The highest values of total gain were significantly obtained from planting spermine 8 ml with significant differences between them in the two seasons. Moreover, the results showed that the relative increase percentages due to spermine 8 ml were 32.97 and 34.93 % for the two seasons, respectively compared with spermine 0 ml. Net gain (L.E /ha^{-1}) varied from 21527 (water) to 35543 (spermine 8 ml); during the second and third seasons, it varied from 23594 (water) to 38200 (spermine 8 ml); in the second. The results showed that protein (%) was significantly affected by using different spermine. The maximum values were significantly obtained by applications spermine 8 ml in the 2021/2022 and 2022/2023 seasons in respectively, with significant differences among them. It is clear from these results that increasing the concentration of spermine increases the resistance of wheat plants in terms of their response to heat stress.

Table (8): Straw yield (L.E /ha^{-1}), total gain (L.E /ha^{-1}), net gain (L.E /ha^{-1}) and protein (%) of wheat cultivars during the both seasons of the study.

Spermine	Straw yield (L.E /ha^{-1})		Total gain (L.E /ha^{-1})		Net gain (L.E /ha^{-1})		Protein %	
Season	21/22	22/23	21/22	22/23	21/22	22/23	21/22	22/23
water	9550D	10052D	40127E	42194E	21526D	23594D	8.851E	8.947E
Spermine 2 ml	10376CD	11132CD	43018D	45445D	24418CD	26845CD	9.447D	9.550D
Spermine 4 ml	10996BC	11627BC	46118C	48547C	27518C	29947C	10.165C	10.278C
Spermine 6 ml	11685B	12564AB	49698B	52521B	31098B	33921B	11.001B	11.122B
Spermine 8 ml	12823A	13366A	54143A	56800A	35543A	38200A	11.959A	12.090A
LSD. 0.05	935.72	1101.4	544.27	644.35	3303.4	3287.2	0.4442	0.432

Effects of interactions wheat cultivars and spermine treatments.

The findings in Table (9) showed that the use of interactions between wheat cultivars and spermine enhanced wheat yield and its constituent parts significantly. Application of interaction wheat cultivars and applications spermine was scored 48720 and 49940 L.E /ha^{-1}as well as (Sakha-94 and spermine 8 ml) for grain yield (L.E /ha^{-1}) trait in the 2021/2022 and 2022/2023 seasons in respectively.

Table (9): Grain yield (L.E /ha^{-1}), straw yield (L.E /ha^{-1}), total gain (L.E /ha^{-1}) and net gain of wheat as affected by the interaction between wheat cultivars, spermine during the both seasons of the study.

Cultivars	Spermine	Grain yield (L.E /ha^{-1})		Straw yield (L.E /ha^{-1})		Total gain (L.E /ha^{-1})		Net gain (L.E //ha^{-1})	
	Season	21/22	21/22	22/23	21/22	21/22	22/23	21/22	22/23
Misr-1	water	27080	28470	7960	8378	35040	36848	16440	18248
	Spermine 2 ml	28910	30390	8780	9242	37690	39632	19090	21032
	Spermine 4 ml	31110	32700	9954	10478	41064	43178	22464	24578
	Spermine 6 ml	33670	35390	9892	11886	43562	47276	24962	28676
	Spermine 8 ml	36600	38470	10754	10268	47354	48738	28754	30138
Misr-2	water	26740	28090	8788	9250	35528	37340	16928	18740
	Spermine 2 ml	28550	29990	8416	8438	36966	38428	18366	19828
	Spermine 4 ml	30720	32270	8912	9382	39632	41652	21032	23052
	Spermine 6 ml	33250	34920	9960	10484	43210	45404	24610	26804
	Spermine 8 ml	36140	37960	11156	11744	47296	49704	28696	31104
Misr-3	water	29300	31470	9216	9700	38516	41170	19916	22570
	Spermine 2 ml	31280	33600	10094	10626	41374	44226	22774	25626
	Spermine 4 ml	33660	36150	11150	11736	44810	47886	26210	29286
	Spermine 6 ml	36430	39130	12380	13032	48810	52162	30210	33562
	Spermine 8 ml	39600	42530	12078	12714	51678	55244	33078	36644
Sakha-94	water	36050	36960	11294	11888	47344	48848	28744	30248
	Spermine 2 ml	38490	39450	12176	12816	50666	52266	32066	33666
	Spermine 4 ml	41410	42450	12512	13170	53922	55620	35322	37020
	Spermine 6 ml	44820	45940	12870	13548	57690	59488	39090	40888
	Spermine 8 ml	48720	49940	15724	16552	64444	66492	45844	47892
Sakha-1001	water	32630	34340	10660	11220	43290	45560	24690	26960
	Spermine 2 ml	34830	36660	11446	12048	46276	48708	27676	30108
	Spermine 4 ml	37480	39450	12238	12882	49718	52332	31118	33732
	Spermine 6 ml	40560	42700	13416	14122	53976	56822	35376	38222
	Spermine 8 ml	44090	46410	13840	14568	57930	60978	39330	42378
Sids14	water	31980	33590	9280	9768	41260	43358	22660	24758
	Spermine 2 ml	34140	35860	11178	11766	45318	47626	26718	29026
	Spermine 4 ml	36730	38580	10414	10962	47144	49542	28544	30942
	Spermine 6 ml	39750	41760	11742	12360	51492	54120	32892	35520
	Spermine 8 ml	43210	45390	13258	13956	56468	59346	37868	40746
Gemmeiza12	water	29960	31780	9536	10038	39496	41818	20896	23218
	Spermine 2 ml	31990	33930	10436	10986	42426	44916	23826	26316
	Spermine 4 ml	34420	36510	11118	12124	45538	48634	26938	30034
	Spermine 6 ml	37250	39510	10880	11452	48130	50962	29530	32362
	Spermine 8 ml	40490	42950	12322	12970	52812	55920	34212	37320
Shandaweel1	water	30870	32430	9668	10176	40538	42606	21938	24006
	Spermine 2 ml	32950	34620	10478	13134	43428	47754	24828	29154
	Spermine 4 ml	35450	37250	11670	12284	47120	49534	28520	30934
	Spermine 6 ml	38370	40310	12344	13626	50714	53936	32114	35336
	Spermine 8 ml	41710	43820	13450	14158	55160	57978	36560	39378
	LSD. 0.05	10085	9462.1	3829.9	4507.9	13521	13454	13521	13454

Application of interaction wheat cultivars and applications spermine was scored 15724 and 16552 L.E /ha^{-1}as well as (Sakha-94 and spermine 8 ml) for straw yield (L.E /ha^{-1}) trait in the 2021/2022 and 2022/2023 seasons in respectively. These results exhibit a similar trend to those acquired by **Bakry *et al.*, (2013) ; Bakry *et al.*, (2015) and Abd El-Aziz, *et al.*, (2017).** Application of interaction wheat cultivars and applications spermine was scored 64444 and 66492 L.E /ha^{-1} as well as (Sakha-94 and spermine 8 ml) for total gain (L.E/ha^{-1}) trait in the 2021/2022 and 2022/2023 seasons in respectively. Net gain (L.E /ha^{-1}) varied from ranged from 16440 L.E /ha^{-1} (Misr-1 and water) to 45844 L.E /ha^{-1} (Sakha-94 and spermine 8 ml) in the first season, 18248 L.E /ha^{-1} (Misr-1 and water) to 47892 L.E /ha^{-1} (Sakha-94 and spermine 8 ml) in the second one. Harmonic outcomes were observed by **Abd El-Aziz & El Sahed. (2021) and El-Metwally *et al.*, (2010).**

CONCLUSION

It can be concluded that planting the wheat variety Sakha-94 showed high resistance to high temperatures, and increasing the addition of spermine to increase the resistance of wheat varieties to heat stress up to a concentration of 8 ml has produced the most economical production of bread wheat under the new reclaimed sandy soil in Al-Dakhla – New Valley, Egypt.

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تأثير الرش بالسبيرمين على تخفيف الإجهاد الحراري فى بعض أصناف القمح

محمود عبد السلام عبد العزيز – محمد عبدالحميد عطية

قسم الانتاج النباتى– شعبة البيئة وزراعات المناطق الجافة– مركز بحوث الصحراء.

أجريت تجربتين حقليتين تحت ظروف الزراعة فى الأراضي حديثة الاستصلاح بمنطقة الداخلة – محافظة الوادى الجديد خلال موسمي 2022/2021 و 2023/2022 على التوالي. وذلك بهدف دراسة تأثير السبيرمين على بعض اصناف القمح. وكانت معاملات الدراسة كما يلى:

العامل الاول: الاصناف:-

(مصر 1 – مصر 2 – مصر 3 – سخا 94 – سخا1001 – سدس 14 – جميزة 12– شندويل 1).

العامل الثانى: الرش (السبيرمين) :

أ– الرش بالماء فقط ب– السبيرمين 0.2 ملى ج– السبيرمين 0.4 ملى

د– السبيرمين 0.6 ملى هـ– السبيرمين 0.8 ملى

أظهرت النتائج ما يلى :

- وجود اختلافات معنوية بين اصناف قمح الخبز فى كلا من الموسمين. وقد أعطى الصنف سخا 94 أعلى انتاجية لغلة المحصول فى كلا الموسمين، بينما سجل الصنف مصر–3 أقل قيم للمحصول ومكوناته خلال موسمى الدراسة.

  أظهرت معاملات الرش بالسبيرمين 0.8 ملى تفوقا معنويا حيث أعطت أعلى انتاجية لمحصول قمح الخبز وبعض مكوناته.
- سجل الصنف سخا 94 أعلى إنتاج للحبوب (4190 كجم/هكتار في الموسم الأول و 4295 كجم/هكتار في الموسم الثاني) لذلك.
- توصى هذه الدراسة أهمية الصنف سخا 94 عند الرش بالسبيرمين 0.8 ملى بمنطقة الداخلة – محافظة الوادى الجديد في مصر.