

# Effect of spraying salicylic acid and biostimulant (Biomagic) on productivity and quality of pomegranate under heat stress in Siwa Oasis

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**Abstract**— This study was implemented through the project (Sustainable development of fruit trees affected by some environmental stress in Matrouh governorate) funded by Regional Development Centers (RDC), Academy of Scientific Research and Technology (ASRT) (Call no. 2/2019/ASRT-RDC). It was carried out on 81 trees of Manfalouty pomegranate cv (*Punica granatum*) during the two successive seasons of 2020 and 2021 at the Khamisa research station of D.R.C. at Siwa Oasis-Matrouh Governorate-Egypt. The study aimed to investigate the influence of salicylic acid (SA) and the biostimulant biomagic to improve fruit productivity and the quality of pomegranate var. "Manfalouty." All the treatments were subjected to the same agricultural practice. The foliar treatments were used, tap water (T<sub>1</sub>), salicylic acid 100 ppm (T<sub>2</sub>), salicylic acid 200 ppm (T<sub>3</sub>), biomagic at 7.5 cm/l (T<sub>4</sub>), biomagic at 8.5 cm/l (T<sub>5</sub>), salicylic acid 100 ppm + biomagic 7.5 cm/l (T<sub>6</sub>), salicylic acid 100 ppm + biomagic 8.5cm/l (T<sub>7</sub>), salicylic acid 200 ppm. The obtained results showed that all the treatments were affected by spraying fruit trees with salicylic acid in combination with biomagic, followed by the solo concentrations of each treatment in both seasons. Meanwhile, T<sub>9</sub> gave the best vegetative growth, fruit physical, chemical properties, and gave the lowest total acidity, fruit cracking percentage, and sunburn percentage in the 1st and 2nd seasons, respectively.

**Keywords**— pomegranate, Biomagic, salicylic acid, heat stress, Siwa Oasis.

## I. INTRODUCTION

The pomegranate, (*Punica granatum*) L., is a member of the Punicaceae plant family and is primarily found in semi-arid, mild-temperate, and subtropical regions. Today, pomegranate orchards are planted all over the world, but they are most popular in the Mediterranean Basin, where the fruits are of the highest quality [Stover and Mercure, 2007; Holland et al., 2009]. One of the most significant pomegranate cultivars growing successfully in Egypt is known as Manfalouty. However, there are numerous issues with pomegranate production during the development of the trees and fruit production. Low fruit quality and cracking during maturity are the most typical issues (Abd El-all and Fouad, 2019).

The Siwa Oasis is located in the northern part of the Western Desert of Egypt, at the GPS (Global Positioning System) of 29.12\_N latitude and 25.29\_E longitude, with an elevation of 18 meters below sea level and 315 kilometers from the Mediterranean coast. It is characterized by very hot and dry climate conditions, especially during summer, and the main activity of Siwean people is agriculture, which depends on groundwater. Because that oasis is a desert closed area and has an irregular climate, and consequently heat stress during the summer season (temperatures can amount to 45 °C), almost all fruit productivity is negatively affected.

One of the most dangerous abiotic variables, heat stress reduces production and quality, which causes significant economic losses. The morphological,

anatomical, physiological, and biochemical alterations in the plant system are impacted by high temperatures. Due to inadequate understanding of heat stress at crucial periods for fruit crops, success in managing heat stress is restricted **Garcia et al. (2020)**. A pomegranate crop may suffer from heat stress and sunburn as a result of high temperatures and ultraviolet (UV) light, severely lowering the crop's commercial yield and eroding growers' profits.

The use of conventional chemicals, which have negative effects on people, animals, and the environment, is a common method used to improve the fruit quality in pomegranates. Unusual methods to improve pomegranate fruit quality are now urgently required to address the issues caused by people's careless usage of chemicals. Natural substances like salicylic acid (SA) are signaling molecules that are crucial for controlling plant growth and strengthening plants against biotic and abiotic stresses **(Hayat et al., 2010; War et al., 2012)**. They also influence the quality of fruits by improving plant strength under biotic and abiotic stresses **(Kondo, 2006; Elwan and El-Hamahmy, 2009; Marzouk and Kassem, 2011)**. These natural compounds are produced in the plant in low quantities that might not boost the plant to overcome the biotic and abiotic stress. For this reason, the exogenous applications of these compounds enhance plant activity **(Abd El-all and Fouad, 2019)**.

Salicylic acid (SA) participates in the regulation of numerous physiological processes in plants, including stomatal closure, photosynthesis, ion uptake, inhibition of ethylene biosynthesis, transpiration, and stress tolerance **(Khan et al., 2003; Simaei et al., 2012)**. SA is an endogenous growth regulator of phenolic nature and acts as a potential non-enzymatic antioxidant. It promotes flowering, lengthens the life of flowers, delays senescence, and speeds up cell metabolism **(Bhupinder and Usha, 2003)**. Plant development can be controlled by it **(Amanullah et al., 2010)**.

SA application influences a wide variety of plant processes and induces antioxidant synthesis **(Yordanova and Popova, 2007)**. It is a key signal molecule for the expression of multiple modes of plant stress resistance such as salinity and drought **(Chini et al., 2004)**, chilling **(Kang and Saltveit, 2002)**, heavy metal tolerance **(Freeman et al., 2005)**, heat **(Larkindale et al., 2005)**, and osmotic stress **(Borsani et al., 2001)**. SA plays a crucial role in the regulation of physiological and biochemical processes during the plant life cycle, by affecting a natural series of changes, such as growth, flowering, fruit ripening, and others **(Rivas and Plasencia, 2011; Koo et al., 2020)**. In addition, **Stuart et al. (2022)** said endogenous levels of SA, which are often associated with biotic and abiotic stress

responses, negatively affect pollen LTMH (tolerance (Long-Term Mild Heat Tolerance)). Reducing SA levels had distinct effects on anther and pollen physiology under LTMH, and found evidence for a role of JA signaling in the mechanism behind pollen thermo tolerance of the low-SA line. Sprayings salicylic induced a range of beneficial effects such as improvement in bioactive compounds, sugars, fruit size, and organic acids in fruit trees species such as apples **(Shaaban et al., 2011; Giannousis, 2012)**, pears **(Cao et al., 2006)**, sweet cherries **(Yao and Tian, 2005; Giménez et al., 2014, 2017; Valverde et al., 2015)**, oranges **(Champa et al., 2015; Oraei et al., 2019; García et al., 2020b)**, and plums **(Martínez et al., 2018)**

Bio-fertilization is the biological preparation containing primarily patented strains of micro-organisms in sufficient numbers. Bio-fertilizers are proven to sometimes eliminate the use of pesticides and rebalance the ratio of plant nutrients in soils. Bio-fertilizers are very safe for humans, animals, and the environment to reduce the great pollution that happens in the environment. **(Abd El-Hamied, 2019)**. They are easy and safe to handle with field applications that improve their efficiency in increasing crop yields and decreasing the costs of some agricultural practices. It is worthwhile to state that, biofertilizers do not replace mineral fertilizers, but significantly reduce their rate of application **(Saber, 1993)**. They are the most important for plant production and soil as they play an important role in increasing vegetative growth, yield, and fruit quality **(Soliman, 2001)** in guava and banana plants; and **(Osman et al., 2010)** in olive plants, **(Chokha et al., 2000; El-Geushy, 2011 and Bakry et al., 2013)** on sweet orange. In addition, **Shaban and Mohsen (2009)** showed that all bio-fertilizers were effective in improving the vegetative growth and nutritional status of sweet orange transplants. **Khamis et al., (2014)** indicated that leaf photosynthetic pigment content (chlorophyll A, B, and carotenoids) was improved by bio-fertilizers.

Biomagic product is a biological promoter of microbial origin and contains many biological products that affect plant growth. This product consists of amino acids (Amino acids are basic ingredients in the process of protein synthesis. Plants require amino acids for overall plant growth and development), vitamins (Vitamins are essential for plant growth; they assist plants in growing by providing essential nutrients), and macro and microelements are involved in all metabolic and cellular functions **(Suman et al., 2017)**. This, in turn, increases the vegetative growth, and period of production, enhancing photosynthesis and encouraging the absorption of water and nutrients from the soil, **(El-Sibaie, 1995)**. **Chokha et al. (2000)** stated that Volkamryana lemon and Mosambi sweet orange increased growth measurements using biomagic.

Therefore, The current study's goal is to investigate how salicylic acid and the biostimulant biomagic affect the productivity and quality of pomegranate var. "Manfalouty" fruit.

## II. MATERIAL AND METHODS

This study was implemented through the project (Sustainable development of fruit trees affected by some environmental stress in Matrouh Governorate) funded by Regional Development Centers (RDC), Academy of Scientific Research and Technology (ASRT) (Call no. 2/2019/ASRT-RDC). It was conducted during the two successive seasons of 2020 and 2021 at khamisa research station Desert Research Center (DRC) at Siwa Oasis – Matrouh Governorate – Egypt on 81 trees of Manfalouty pomegranate cv (*Punica granatum*) grown under saline and heat stress to study the effect of some biological compounds

(salicylic acid and biomagic) on improving quality and productivity. The selected trees were 15 years old, planted at 3X 5 m grown in sandy soil under a drip irrigation system. All are almost uniform in shape and received the common horticultural practices. Physical and chemical analysis of the experimental soil and water irrigation is shown in Table 1. Nine treatments of foliar applications, (T<sub>1</sub>): tap water, (T<sub>2</sub>): salicylic acid 100 ppm, (T<sub>3</sub>): salicylic acid 200 ppm, (T<sub>4</sub>): biomagic at 7.5cm/l, (T<sub>5</sub>): biomagic at 8.5cm/l, (T<sub>6</sub>): salicylic acid 100 ppm + biomagic 7.5cm/l, (T<sub>7</sub>): salicylic acid 100 ppm + biomagic 8.5 cm/l, (T<sub>8</sub>): salicylic acid 200 ppm + biomagic 7.5cm/l, and (T<sub>9</sub>): salicylic acid 200 ppm + biomagic 8.5 cm/l, sprayed once every two months starting from January until the harvest time. The experiment was designed as a complete block randomized design each treatment represented by 3 replicates of 3 trees each. The analysis of the biomagic is shown in table 3. **El Massiry, (2009)**

Table 1: Some physical and chemical analyses of the experiment soil and irrigation water at khamisa research station Siwa oasis.

Particle size distribution%		Sand	Silt	Clay	Some chemical analysis of irrigation water
		81.2	8.57	10.23	
Texture soil		Sand loamy			
Ec ds/m1		9.05			6.78
pH		7.7			7.7
Units		meq/l			
Soluble captions	Ca <sup>++</sup>	25			21.8
	Mg <sup>++</sup>	12.1			9.7
	Na <sup>+</sup>	52.1			35.95
	K <sup>+</sup>	1.3			0.35
Soluble anions	CO <sub>3</sub> <sup>-</sup>	0.0			0.00
	HCO <sub>3</sub> <sup>-</sup>	2.8			9.5
	SO <sub>4</sub> <sup>-</sup>	26.2			10.8
	Cl <sup>-</sup>	61.5			47.5

Table 2: The analysis of biomagic

Biomagic			
Amino acids(2.07%)	Vitamins(0.04 %)	Ma.E( in mg/l)	M i. E(3.7 % in mg/l)
Arginine	thiamine	1125 N	45 Mg
cysteine	Biotene	550 P2 O5	160 Fe
glycine	choline	625 k2O	124 Zn
histidine	folic acid		100 Mn
leucine	niacin		45 Cu
lysine	pantothenic		14 B
phenylalanine	pyridoxine		12 Mo
threonine	riboflavin		8 Co
tryptophan			
tyrosine			
valine			

The following parameters were measured:

- 1. Shoot length and Leaves number /shoot:** at the end of each current season (first week of October).
- 2. Leaf area (cm<sup>2</sup>):** was determined by using the leaf area meter CL203.
- 3- Total chlorophyll contents in leaf:** measured using Minolta chlorophyll meter SPAD-502 was estimated on the selected branches
- 4- Yield per tree:** At harvest time, the number of fruits per each treated tree was counted and reported then the yield (kg) per tree was weighed and recorded.
- 5- Fruit parameters (fruit physical characteristics):** Fruits samples were taken at the harvest time to be used for determining the physical properties (i.e., fruit weight (g), fruit height (cm) , and fruit diameter (cm)).
- 6- Fruit quality (fruit chemical characteristics):** a sample of 10 mature fruits of each tree was taken at the harvest time to be used for determining the chemical properties (i.e., the total soluble solids percentage (T.S.S. %) that were measured using a hand

refractometer, and the fruit juice is used to determine total acidity by titration against standard sodium hydroxide solution (0.1 N) using phenolphthalein as an indicator). Total sugars and vitamin C content were determined according to A.O.A.C (1985).

### 7- Statistical Analysis

The obtained data were subjected to analysis of variance according to **Clarke and Kempson (1997)**. Means were differentiated using the Range test at the 0.05 level (**Duncan, 1955**).

## III. RESULTS AND DISCUSSIONS

### Shoot length (cm), leaves number /shoot

Data in table (3), clear that shoot length and leaves number were significantly affected by all treatments in both seasons. However, T<sub>9</sub> gave the best shoot length (31.44 (cm) in first season, 30.17(cm) in second season) and leaves number (30.23 and 29.87) in both seasons. On the other side, T<sub>1</sub> gave the lowest shoot length and leaves number in both seasons.

Table.3: Effect of spraying salicylic acid and Biomagic on shoot length(cm) and leaves number of "Manfalouty" pomegranate trees during 2020 and 2021 seasons.

Parameters Treatments	Shoot length (cm)		Leaves number	
	Season 2020	Season 2021	Season 2020	Season 2021
T <sub>1</sub>	17.19h	18.01h	17.13i	17.58i
T <sub>2</sub>	20.56g	20.83g	18.39h	19.54h
T <sub>3</sub>	22.19f	22.52f	20.11g	20.93g
T <sub>4</sub>	24.17e	23.72e	22.71f	21.82f
T <sub>5</sub>	24.75e	24.77d	24.55e	22.32e
T <sub>6</sub>	24.63d	25.09d	25.59d	23.96d
T <sub>7</sub>	26.80c	26.80c	27.39c	26.12c
T <sub>8</sub>	28.66b	28.80b	28.45b	28.79b
T <sub>9</sub>	31.44a	30.17a	30.23a	29.87a

Means having the same letter (s) in each column is not significantly different at 5% level. \* (T<sub>1</sub>): tap water:, (T<sub>2</sub>): salicylic acid 100 ppm, (T<sub>3</sub>): salicylic acid 200ppm, (T<sub>4</sub>): biomagic at 7.5%, (T<sub>5</sub>): biomagic at 8.5%, (T<sub>6</sub>): salicylic acid 100 ppm+ biomagic 7.5cm/l, (T<sub>7</sub>): salicylic acid 100 ppm+ biomagic 8.5cm/l, (T<sub>8</sub>): salicylic acid 200ppm+biomagic 7.5cm/l and (T<sub>9</sub>): salicylic acid 200ppm+biomagic 8.5cm/l

### Leaf area (cm<sup>2</sup>) and leaf total chlorophyll (SPAD)

It could be noticed from table (4) that all treatments were significantly affected in leaf area and leaf total chlorophyll in both seasons. However, T<sub>9</sub> gave the best

leaf area(5.96 cm<sup>2</sup> and 6.13 cm<sup>2</sup>) and leaf total chlorophyll (58.43 and 60.92) in both seasons respectively. On the contrary, untreated trees T<sub>1</sub> gave the lowest leaf area (2.56

cm<sup>2</sup> and 2.25 cm<sup>2</sup>) and leaf total chlorophyll (36.22 and 37.95) in both seasons.

The positive effect of salicylic acid on growth may be due to its effect on plant hormones (Shakirova, 2007). Salicylic acid increased leaf chlorophyll content (Abdel Aziz et al., 2017). Additionally, it can influence stomatal movement, photosynthesis, ethylene production, plant water relations, and the ability of ABA to reverse the effects of leaf abscission (Arfan et al., 2007). Abd El-Naby et al. (2020) spraying SA at a high concentration shows a positive effect on vegetative growth characteristics of the navel orange. Mokhtar et al. (2011) observed varying concentrations of SA (50 to 400 ppm) and frequencies (1, 2, 3, or 4 times) with a gradual promotion in the leaf area. Hamdy et al. (2019) Spraying SA at 50 to 200 ppm improved all vegetative growth aspects, leaf chlorophyll contents on fig trees. Ahmed et al. (2015) showed that using salicylic acid at 50 to 200 ppm enhanced shoot length, leaf area, and total chlorophylls on mango, these lead to

more carbohydrate production and this is reflected in fruit quality.

It is also could be due to the biomagic contents of proteins, amino acids, vitamins, and hormones, as well as some micronutrients, growth regulators, and vitamins which enhanced cell division, metabolism, and other biological reactions. In addition to the activation effect of these components on photosynthesis and promoting protoplasm formation including RNA and DNA that are important for cell division, All of these materials lead to reducing the impact of stress on the plant (El Massiry, 2009; Ibrahim, 2009; El-Hifny and El-Sayed, 2011 and Hashem, 2016).

The obtained results regarding the effect of salicylic acid on fruit quality go in line with the findings of (Abdel Aziz et al., 2017 and Amro et al., 2020) on pomegranate fruits. (Khedr and Farid, 2000; El Massiry, 2009, and Ibrahim, 2009) who reported that biomagic improved growth. In addition, Abd El-Hamied (2014a&b) stated that the addition of bio-fertilizers increased vegetative growth measurements of mango.

Table.4: Effect of spraying salicylic acid and Biomagic on leaf area and leaf total chlorophyll (SPAD) of "Manfalouty" pomegranate trees during 2020 and 2021 seasons.

Parameters Treatments	Leaf area cm <sup>2</sup>		leaf total chlorophyll (SPAD)	
	Season 2020	Season 2021	Season 2020	Season 2021
T <sub>1</sub>	2.56i	2.25i	36.22i	37.95i
T <sub>2</sub>	2.47h	2.61h	38.57h	40.01h
T <sub>3</sub>	3.06g	2.97g	41.53g	42.36g
T <sub>4</sub>	3.54f	3.35f	44.49f	44.01f
T <sub>5</sub>	3.93e	3.83e	47.87e	48.15e
T <sub>6</sub>	4.37d	4.29d	50.16d	49.71d
T <sub>7</sub>	4.57c	4.93c	53.51c	54.43c
T <sub>8</sub>	5.28b	5.6b	56.61b	57.31b
T <sub>9</sub>	5.96a	6.13a	58.43a	60.92a

Means having the same letter (s) in each column is not significantly different at 5% level.

(T<sub>1</sub>): tap water:, (T<sub>2</sub>): salicylic acid 100 ppm, (T<sub>3</sub>): salicylic acid 200ppm, (T<sub>4</sub>): biomagic at 7.5%, (T<sub>5</sub>): biomagic at 8.5%, (T<sub>6</sub>): salicylic acid 100 ppm+ biomagic 7.5cm/l, (T<sub>7</sub>): salicylic acid 100 ppm+ biomagic 8.5cm/l, (T<sub>8</sub>): salicylic acid 200ppm+biomagic 7.5cm/l and (T<sub>9</sub>): salicylic acid 200ppm+biomagic 8.5cm/l.

#### Fruit length (cm), fruit diameter (cm), and fruit weight (g)

Data in table (5), shows that fruit length, fruit diameter, and fruit weight were significantly affected by all

treatments in both seasons. However, T<sub>9</sub> gave the highest fruit length, fruit diameter, and fruit weight in the 1st and the 2nd seasons. On the other hand, the untreated trees T<sub>1</sub> gave the lowest fruit length, fruit diameter, and fruit weight in both seasons.



Table.5.:Effect of spraying salicylic acid and Biomagic on fruit length(cm) ,fruit diameter(cm) and fruit weight(g) of “Manfalouty” pomegranate trees during 2020 and 2021 seasons.

Parameters Treatments	Fruit length (cm)		Fruit diameter (cm)		fruit weight (g)	
	Season 2020	Season 2021	Season 2020	Season 2021	Season 2020	Season 2021
T <sub>1</sub>	7.51 e	7.57 e	7.40 f	7.52 g	349.22 g	351.84 g
T <sub>2</sub>	7.61 de	7.69 d	7.58 f	7.73 f	355.88 f	357.29 f
T <sub>3</sub>	7.73 cde	7.77 cd	7.89 e	7.92 e	362.12 e	364.44 e
T <sub>4</sub>	7.75 bcd	7.79 cd	7.94 de	8.02 e	367.61 d	368.07 e
T <sub>5</sub>	7.79 abc	7.83 c	8.10 d	8.20 d	373.14 c	375.45 d
T <sub>6</sub>	7.81 ab	7.88 c	8.32 c	8.48 c	376.67 b	377.45 cd
T <sub>7</sub>	7.89 ab	8.02 b	8.54 b	8.67 b	379.33 a	381.54 bc
T <sub>8</sub>	7.92 a	8.13 b	8.76 a	8.72 b	380.15 a	385.05 b
T <sub>9</sub>	7.94 a	8.33 a	8.80 a	8.96 a	380.99 a	400.11 a

Means having the same letter (s) in each column is not significantly different at 5% level.

(T<sub>1</sub>): tap water:, (T<sub>2</sub>): salicylic acid 100 ppm, (T<sub>3</sub>): salicylic acid 200ppm, (T<sub>4</sub>): biomagic at 7.5%, (T<sub>5</sub>): biomagic at 8.5%, (T<sub>6</sub>): salicylic acid 100 ppm+ biomagic 7.5cm/l, (T<sub>7</sub>): salicylic acid 100 ppm+ biomagic 8.5cm/l, (T<sub>8</sub>): salicylic acid 200ppm+biomagic 7.5cm/l and (T<sub>9</sub>): salicylic acid 200ppm+biomagic 8.5cm/l

#### Fruit grains weight (g) and grains/fruit weight percentage

Concerning the results in Table 6, fruit grains weight (g), and grains/fruit weight % were significantly affected by all treatments in both seasons. However, T<sub>9</sub> gave

the best fruit grains weight (g) (303.13 and 311.33 (g) and grains/fruit weight percentage (79.56 and 77.81%) in 1<sup>st</sup> and 2<sup>nd</sup> season respectively. On the other side, T<sub>1</sub> gave the lowest fruit grains weight (g) and grains/fruit weight percentage in both seasons.

Table.6: Effect of spraying salicylic acid and Biomagic on fruit grains weight(g)and grains/fruit weight %of “Manfalouty” pomegranate trees during 2020 and 2021 seasons.

Parameters Treatments	Fruit grains weight (g)		Grains/fruit weight %	
	Season 2020	Season 2021	Season 2020	Season 2021
T <sub>1</sub>	219.44 i	221.81 h	62.84 i	63.04 i
T <sub>2</sub>	227.78 h	231.26 g	64.00 h	64.73 h
T <sub>3</sub>	238.25 g	246.42 f	65.79 g	67.62 g
T <sub>4</sub>	256.77 f	259.59 e	69.85 f	70.53 f
T <sub>5</sub>	264.11 e	268.37 d	70.78 e	71.48e
T <sub>6</sub>	276.46 d	280.67 c	73.40 d	74.36d
T <sub>7</sub>	285.33 c	289.11 b	75.22 c	75.77c
T <sub>8</sub>	291.48 b	295.83 b	76.67 b	76.83b
T <sub>9</sub>	303.13 a	311.33 a	79.56 a	77.81a

Means having the same letter (s) in each column is not significantly different at 5% level.

(T<sub>1</sub>): tap water:, (T<sub>2</sub>): salicylic acid 100 ppm, (T<sub>3</sub>): salicylic acid 200ppm, (T<sub>4</sub>): biomagic at 7.5%, (T<sub>5</sub>): biomagic at 8.5%, (T<sub>6</sub>): salicylic acid 100 ppm+ biomagic 7.5cm/l, (T<sub>7</sub>): salicylic acid 100 ppm+ biomagic 8.5cm/l, (T<sub>8</sub>): salicylic acid 200ppm+biomagic 7.5cm/l and (T<sub>9</sub>): salicylic acid 200ppm+biomagic 8.5cm/l

### Number of fruits/tree and total yield/tree (Kg)

It is shown from the data in table (7) that the number of fruits /tree and total yield /tree (kg) were significantly affected by all treatments in both seasons. In addition, T<sub>9</sub> gave the best number of fruits and the total yield in both seasons respectively. On the other hand, T<sub>1</sub> gave the lowest number of fruits and total yield in both seasons.

The number of fruits and total yield were affected significantly by spraying trees with salicylic acid in combination with biomagic in both seasons. It is observed that spraying the solo concentrations of salicylic acid and biomagic recorded less number of fruits and total yield (kg) in the 1<sup>st</sup> and the 2<sup>nd</sup> season respectively.

The increase in the number of fruits by salicylate treatments could be due to: an increased flowering rate, set fruits, or a decrease in fruit abscission. An increase in plum tree yield has been recently reported as a consequence of salicylate treatments, although it was due to increased fruit mass but not the number of fruits. (Martínez et al., 2018). SA activates growth and the nutritional state of trees due to an increase in fresh and dry weight and chlorophyll, carotenoid, and sugar concentration in leaves, which illustrates an enhancement of net photosynthesis on trees (Helaly et al., 2018). The positive effect of SA on yield may be due to its effect on plant hormones (Shakirova, 2007). Hamdy et al., (2019) found that different concentrations of SA represented varying effects on the yield of fig tree.

These results were in agreement with Amro et al. (2020) found that salicylic treatments enhanced the yield of pomegranate var "wonderful". Mokhtar et al (2011) sprayed Anna apple trees with salicylic acid at 200 ppm three times (at growth start, just after fruit set, and at 14 days later) giving an economical yield. In addition, using salicylic acid was very effective to improve the yield of fruits (Ahmed and Abd El-Hameed, 2004; Ibrahim-, 2006; Imran et al., 2007; Abd El-Kariem, 2008 and Ahmed et al., 2010). Abd El-all and Fouad (2019) said that SA improved yield (kg/tree) , and number of fruits/tree. Ying-Ning et al. (2014) revealed that the applications of SA decreased the flower dropping percentage and increased the fruit setting percentage on citrus. Ahmed et al (2015) said that Sukkary mango trees' yield was increased by two sprays of salicylic acid at 100 ppm at the beginning of growth and after fruit set. Helaly et al., (2018) they found a higher percentage of fruit retention and crop yield on two mango cultivars using SA treatments. In addition, Bio-fertilizers are the most important for plant production, they play an important role in increasing yield (Soliman, 2001) on guava and banana plants and (Osman et al., 2010) on olive plants, (Chokha et al., 2000; El-Geuoshy, 2011 and Bakry et al., 2013) on sweet orange. Abd El-Hamied (2019) proved that biomagic was very effective on yield (number of fruits and fruit weights) for the final crop.

Table.7: Effect of spraying salicylic acid and Biomagic on No of fruits/tree and total yield /tree(kg) of "Manfalouty" pomegranate trees during 2020 and 2021 seasons.

Parameters Treatments	No of fruits/tree		Total yield /tree (kg)	
	Season 2020	Season 2021	Season 2020	Season 2021
T <sub>1</sub>	37.80 f	39.11 e	13.21 g	13.76 f
T <sub>2</sub>	39.06 ef	39.66 e	13.93 f	14.17 f
T <sub>3</sub>	39.21 ef	40.53 de	14.22 f	14.77 e
T <sub>4</sub>	40.80 de	41.57 cd	15.00 e	15.30 d
T <sub>5</sub>	41.81 cd	42.80 bc	15.62 d	16.07 c
T <sub>6</sub>	41.68 cd	44.43 ab	15.74 d	16.77 b
T <sub>7</sub>	42.71 bc	44.03 ab	16.20 c	16.80 b
T <sub>8</sub>	44.19 ab	44.59 ab	16.81 b	17.17 b
T <sub>9</sub>	45.41 a	45.41 a	17.32 a	18.17 a

Means having the same letter (s) in each column is not significantly different at 5% level.

(T<sub>1</sub>): tap water:, (T<sub>2</sub>): salicylic acid 100 ppm, (T<sub>3</sub>): salicylic acid 200ppm, (T<sub>4</sub>): biomagic at 7.5%, (T<sub>5</sub>): biomagic at 8.5%, (T<sub>6</sub>): salicylic acid 100 ppm+ biomagic 7.5cm/l, (T<sub>7</sub>): salicylic acid 100 ppm+ biomagic 8.5cm/l, (T<sub>8</sub>): salicylic acid 200ppm+biomagic 7.5cm/l and (T<sub>9</sub>): salicylic acid 200ppm+biomagic 8.5cm/l

### Total soluble solids percenrage(T.S.S.%), total sugar%, vitamin C (mg/100g pulp) and total acidity%

Data in table (8), showed, that total soluble solids percentage(T.S.S.%), total sugar%, vitamin C and total acidity% were significantly affected by all treatments in both seasons. However, T<sub>9</sub> gave the highest total soluble solids, total sugar%, vitamin C and the lowest total acidity%. On the other hand, the T<sub>1</sub> treatment gave the lowest T.S.S%, total sugar%, vitamin C and the highest total acidity % in both seasons.

The obtained results regarding the effect of salicylic acid on fruit quality go in line with the findings of **Abdel Aziz et al.(2017)** on pomegranate fruits. **Hamdy et al. (2019)** Increasing SA concentration resulted in a gradual and significant promotion in T.S.S. %, increasing sugars %, and decreasing total acidity % in fig tree, the frequency of application of SA from one to three times improve the fruits' physical properties. **Ahmed et al. (2015)** proved that fruit quality of Sukkary mango trees was improved by two sprays of salicylic acid at 100 ppm at the beginning of growth and

after fruit set. In addition **.Amro et al. (2020)** found that salicylic treatments enhanced fruit quality traits of pomegranate "wonderful". Salicylic acid was very effective in improving the physical characteristics of fruits in different fruit crops (**Ahmed and Abd El-Hameed, 2004; Ibrahim, 2006; Imran et al., 2007; Abd El-Kariem, 2008** and **Ahmed et al., 2010**). **Mirdehghan, et al. (2012)** and (**Zhang et al., 2003**) found that spraying salicylic acid reduces the total acidity% and increases TSS of pomegranates. **Abd El-all and Fouad (2019)** SA improved yield (kg/tree), fruit weight (g), number of fruits/tree, T.S.S., TSS /acid % ratio, and reduced acidity %. Furthermore, Bio-fertilizers are the most important for plant production and soil as they play an important role in increasing fruit quality (**Soliman,2001**) in guava and banana plants and (**Osman et al., 2010**) in olive plants, (**Chokha et al., 2000; El-Geushy, 2011 and Bakry et al., 2013**) on sweet orange. **Abd El-Hamied (2019)** proved that biomagic was very effective on fruit chemical characteristics of fig tree.

Table.8: Effect of spraying salicylic acid and Biomagic on fruit Total soluble solids percentage(T.S.S%), total sugar%, vitamin C(mg/100g pulp) and total acidity% of "Manfalouty" pomegranate trees during 2020 and 2021 seasons.

Parameters Treatments	T.S.S.%		Total sugar%		Vitamin C (mg/100g pulp)		Total acidity %	
	Season 2020	Season 2021	Season 2020	Season 2021	Season 2020	Season 2020	Season 2020	Season 2021
T <sub>1</sub>	14.12 h	14.28 h	12.10 f	12.40 f	14.41i	14.41i	0.42 a	0.43 a
T <sub>2</sub>	14.33 g	14.63 g	12.21 f	12.65 ef	14.74h	14.74h	0.41 ab	0.41 ab
T <sub>3</sub>	14.75 f	14.96 f	12.45 e	12.83 e	15.08g	15.08g	0.40 abc	0.38 abc
T <sub>4</sub>	15.42 e	15.51 e	12.99 d	13.15 d	15.28f	15.28f	0.39 abc	0.37 bc0
T <sub>5</sub>	15.73 d	15.78 d	13.01 d	13.29 d	15.42e	15.42e	0.38 abc	0.37 bc0
T <sub>6</sub>	15.97 c	16.17 c	13.58 c	13.77 c	15.62d	15.62d	0.37 abc	0.35 cd
T <sub>7</sub>	16.21 b	16.27 bc	14.05 b	14.23 b	15.86c	15.86c	0.36 bc	0.34 cde
T <sub>8</sub>	16.35 ab	16.48 b	14.28 a	14.44 b	15.97b	15.97b	0.35 c	0.32 de
T <sub>9</sub>	16.49a	16.78 a	14.24 a	14.81 a	16.65a	16.65a	0.35 c	0.30 e

Means having the same letter (s) in each column is not significantly different at 5% level.

(T<sub>1</sub>): tap water:, (T<sub>2</sub>): salicylic acid 100 ppm, (T<sub>3</sub>): salicylic acid 200ppm, (T<sub>4</sub>): biomagic at 7.5%, (T<sub>5</sub>): biomagic at 8.5%,(T<sub>6</sub>): salicylic acid 100 ppm+ biomagic 7.5cm/l, (T<sub>7</sub>): salicylic acid 100 ppm+ biomagic 8.5cm/l, (T<sub>8</sub>): salicylic acid 200ppm+biomagic 7.5cm/l and (T<sub>9</sub>): salicylic acid 200ppm+biomagic 8.5cm/l.

### Fruit cracking % and Sunburned fruit (%)

Table 9, cleared that cracking and sunburn percentage of fruits were significantly affected by all treatments in both seasons. However, T<sub>9</sub> treatment gave the lowest cracking (14.17 % and 13.7%) and sunburn (9.00% and 7.87%) in

both seasons respectively. On the other hand, T<sub>1</sub> gave the highest cracking (30.30 % and 28.46%) and sunburn (18.40% and 16.40%) in both seasons.

The positive effect of salicylic acid in reducing cracked and sunburned fruits may be attributed to salicylic



acid playing a crucial role in keeping cells from ageing and stopping free radicals from oxidizing lipids, which make up the plasma membrane, which may explain why it has a favorable impact on reducing cracked and sunburned fruit. Salicylic acid helps the body's antioxidant system, which also helps with stress management. It is in charge of boosting naturally occurring hormones that are essential for controlling plant growth and development, as well as the production of IAA, and limiting the detrimental effects of various stresses on plant development. (Senarataa et al.,

2004). Salicylic acid has a significant role in plant water relations, photosynthesis, and growth in plants (Arfan et al., 2007), and this is reflected on reducing cracked and sunburned fruits.

The obtained results regarding the effect of salicylic acid on fruit disorders go in line with the findings of Ahmed et al. (2014) on pomegranate, Abdel Aziz et al. (2017) on pomegranate and Amro et al. (2020) on pomegranate.

Table.9: Effect of spraying salicylic acid and Biomagic on fruit cracking% and sunburned fruit% of “Manfalouty” pomegranate trees during 2020 and 2021 seasons.

Parameters Treatments	Fruit Cracking%		Sunburned fruit (%)	
	Season 2020	Season 2021	Season 2020	Season 2021
T1	30.30a	28.46a	18.40a	16.40a
T2	27.30b	26.37b	17.33b	15.37b
T3	25.50c	24.47c	15.63c	14.7c
T4	24.43c	23.23d	14.53d	13.20d
T5	22.47d	21.57e	13.43e	12.4e
T6	20.40e	19.63f	12.53f	11.37f
T7	18.60f	22.80g	11.00g	10.60g
T8	16.67g	17.477h	10.33h	9.30h
T9	14.17h	13.7i	9.00i	7.87i

Means having the same letter (s) in each column is not significantly different at 5% level.

(T<sub>1</sub>): tap water:, (T<sub>2</sub>): salicylic acid 100 ppm, (T<sub>3</sub>): salicylic acid 200ppm, (T<sub>4</sub>): biomagic at 7.5%, (T<sub>5</sub>): biomagic at 8.5%, (T<sub>6</sub>): salicylic acid 100 ppm+ biomagic 7.5cm/l, (T<sub>7</sub>): salicylic acid 100 ppm+ biomagic 8.5cm/l, (T<sub>8</sub>): salicylic acid 200ppm+biomagic 7.5cm/l and (T<sub>9</sub>): salicylic acid 200ppm+biomagic 8.5cm/l.

#### IV. CONCLUSION

It could be concluded that spraying pomegranate with salicylic acid 200 ppm + biomagic 8.5cm/l gave the best vegetative growth, fruit physical, chemical properties, and gave the lowest total acidity, fruit cracking percentage, and sunburn percentage under heat stress in Siwa oasis.

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