H

EGYPTIAN ACADEMIC JOURNAL OF
BIOLOGICAL SCIENCES
BOTANY

ISSN 2090-3812

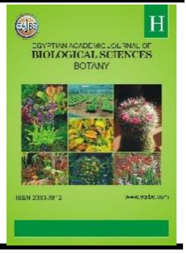
www.eajbs.com

Vol. 14 No.1 (2023)

Citation: Egypt. *Acad. J. Biolog. Sci.* (H. Botany) *Vol.14(1) pp43-54(2023)*
DOI: 10.21608/EAJBSH.2023.293954

Egypt. Acad. Journal Biology. Sci., 14(1):43-54(2023)

Egyptian Academic Journal of Biological Sciences
H. Botany
ISSN 2090-3812
www.eajbsh.journals.ekb.eg.



Response of Sugar Beet Growth to Soil Application of Humic Acid and Foliar Application of Some Biostimulators under Saline Soil Conditions

Mohamed A.A. Nassar[1]; Samia S.E. El-Magharby[2]; Nada S. M. Ibrahim[1] and Essam E. Kandil[1]

1-Plant Production Department, Faculty of Agriculture, Saba Basha, Alexandria University, Egypt.

2-Sugar crops Research Institute, Agriculture Research Center (ARC), Giza.

*****E-mail: nadasaad@alexu.edu.eg

ARTICLE INFO
Article History
Received:28/2/2023
Accepted:1/4/2023
Available:5/4/2023

***Keywords*:**
Sugar beet, growth, salicylic acid, fluvic acid, proline.

ABSTRACT

Two field experiments were conducted at the Experimental Farm, Abees Region, Faculty of Agriculture, Saba Basha, Alexandria University, Alexandria Governorate, Egypt, during 2021/2022 and 2022/2023 seasons to investigate the response of sugar beet (Karam) to humic acid and some Biositmulants substances under saline soil conditions. The experimental design was a split-plot design with three replicates, where three humic acids (HA) levels (0, 12 and 24 kg HA/ha) were allocated to the main plots, and 8 bio-stimulants treatments, randomly arranged within the sub-plot (Untreated (Zero control), Salicylic acid 100 mg / L, Fulvic acid 1.2 kg /ha, Hydroxyproline 1000 mg/L, Salicylic acid 100 mg / L + Fulvic acid 1.2 kg /ha, Salicylic acid 100 mg /L + Hydroxyproline 1000 mg/L), Fulvic acid 1.2 kg/ha + Hydroxyproline 1000 mg/L, and Salicylic acid 100 mg / L + Fulvic acid 1.2 kg /ha + Hydroxyproline 1000 mg/L). The results exposed that soil application of HA, spraying of bio stimulators and their interaction significantly affected the growth characteristics of sugar beet under salinity conditions, where to get the highest growth of sugar beet, it could be fertilized sugar beet with HA at a rate of 24 kg/ha as a soil application along with sprayed some of fluvic acid (FA), hydroxyproline.

INTRODUCTION

Sugar beet (*Beta vulgaris* subsp. *vulgaris*) is a biennial crop taxonomically affiliated with the *Amaranthaceae* family (Schwichtenberg *et al*., 2016; Mukherjee and Gantait 2023). it is regarded as a crucial industrial crop that substantially participates in the world's supply of sugar. On a global scale, sugar beet is the second main important sugar-producing crop after sugarcane, and is, therefore, it is regarded as a significant industrial crop. As a result of its short duration (5 to 6 months) and also has higher sucrose content (14–20%) than sugarcane (10–12%), high purity (85-90%), It also requires less irrigation, also could be a possible solution as a potential crop for newly reclaimed soils or for newly reclaimed soils, which are prevalent in tropical and subtropical areas (Subrahmanyeswari, and Gantait, 2022; Pathak *et al*., 2014; Abo-Elwafa *et al*.,2006; Nasr and Abd El-Razek,2008). Worldwide, the sugar beet sugar industry is well known in different nations

(Pathak *et al*., 2014). The total global cultivated acreage of about 4.4 Mt produces approximately 253 Mt of sugar beet roots that affords ~ 30% of the gross world's demand for white sugar (FAO2022). In Egypt, sugar beet production accounted for 67.7 % (1.8 million tons) of total sugar production. The total sugar beet cultivated area in Egypt reached 1.5 million ha with an average tonnage of 48.0 tons/ha (FAOStat 2021).

Salinity is the excessive accretion of salts in soil that interferes with the normal growth of plants (El Sabagh *et al*., 2020). Saline soil and irrigation water are defined as having an electrical conductivity of 4 dSm-1 or greater (Misra *et al*.,2020). More than 20% of agricultural land is affected by salinity, spoiling around 954 million hectares of the total land area all over the globe (Saddiq *et al.*, 2021). It is anticipated to increase up to 50% by 2050 (Das and Tzudir,2021). The first effect of salinity on plants is the closure of stomata and the suppression of leaf development via increasing the osmotic potential in the rhizosphere. (Munns, and Termaat 1986; Cernusak2020). The second effect is that the ions hook up to toxic levels for a longer period and pile up, mostly in mature leaves, and cause the early aging of the leaves, resulting in a decrease in yield and the death of the plant (Munns and Tester,2008). The high concentration of Na ions has a toxic effect on cell metabolism and inhibition of enzyme activity, cell division and expansion, causing irregularities in membrane and osmotic imbalance and preventing growth. Salt stress also causes the production of reactive oxygen species (ROS) and reduced photosynthesis (Joshi *et al*.,2022; Tuteja, 2007) Salt stress affects All crucial plant functions, including germination, growth, water relationship, nutrient imbalance, photosynthesis, and yield (Munns and Tester,2008; Parida, and Das, 2005).

Natural biostimulants substances like humic acid (HA), Salicylic (SA), fulvic acid (FA), and hydroxyproline (HP), are nearer to bringing plant-growing techniques up to date. Many biostimulants substances have been known, that allow plants to preserve their improvement in the face of environmental stress by regulating a wide range of physio-biochemical processes (Malik *et al*., 2020).

Potassium (K) is an essential nutrient that influences the majority of the biochemical and physiological processes that affect plant metabolism and development. Additionally, it supports plants surviving in a variety of biotic and abiotic conditions (Wang *et al*., 2013). K plays a crucial involvement in a diversity of regulatory functions in plants. Nearly all processes essential for plant growth and reproduction depend on it, including photosynthesis, translocation of photosynthesis products, protein synthesis, control of the ionic balance, regulation of plant stomata, maintenance of turgor, stress tolerance, water use, enzyme activation, and many other processes (Cakmak 2005).In addition to improving root permeability and water uptake, K also controls guard cells and contributes to developed water use efficiency (Zekri and Obreza, 2003).

The humic acid level of sugar beets can be adjusted to increase sugar beet production (Kiymaz and Ertek, 2015), it enhances soil structure, improvements fertilizer efficiency, exchanging cations, and increases water-holding, root development and encourages plant growth (Hartwigsen and Evans 2000). Potassium humate increases production and quality by promoting plant growth. By boosting metabolic activity and the seed membrane, it hastens germination. Improve the root's ability to absorb nutrients (N, P, K + Fe, Zn and other trace elements), as these elements are transformed into forms that are more readily available to plants. As soil supplements, HA and FA are frequently used in agriculture to enrich the soil, minimise abiotic stress, and enhance the development and production of numerous crops (*Mosaad et al*., 2022).

Biostimulators are one of the most talented alternatives nowadays to cope with yield losses caused by plant stress, which are strengthened by climate change. (García-García *et al*., 2020). The global market for biostimulants substances reached $2.19 billion in 2018 and it is predicted to increase at a rate of 12.5% annually from 2019 to 2024 (Dubey *et al*., 2020).

The recent definition of plant BSs is “A product that stimulates plant nutrition processes independently of the product’s nutrient content, with the sole aim of enhancing one or more of the next characteristics of the plant or the plant rhizosphere: (a) nutrient use efficiency; (b) tolerance to abiotic stress; (c) quality traits; or (d) availability of confined nutrients in the soil or rhizosphere (Li *et al*.,2022; Franzoni *et al*., 2022; Monteiro *et al*.,2022; Deolu-Ajayi *et al*., 2022).

Fulvic acid (FA) increases the ability of plants to buffer against available soil salts and soil acidity is increased by fulvic acid, which helps plants deal with salt stress (Gezgin and Sanal,2012). foliar spray of fulvic acid improves plant oxygen intake, which is directly related to enhanced chlorophyll content, membrane stability under abiotic stress conditions, and nutrition uptake by the roots (Hasanuzzaman *et al*., 2020). Spraying twice with K-fulvate (5 cm^3 /liter water) after 50 and 70 days from sowing resulted in the highest values of gross sucrose, quality index, and extractable white sugar percentages in the juice of roots, root, top, and extracted sugar yields/fed at the same manner the lowest values of Na, K, -Amino-N, impurity, Othman and El-Moursy (2020).

Salicylic acid (SA), and hydroxyproline (HP) encourage crop growth while minimising the negative effects of agriculture on the environment and human health (Ayed *et al*., 2022). Salicylic acid (SA), a substitute ecological and acceptable chemical regulator, assists them in better tolerating abiotic stress tolerance troubles in many horticultural crops (Chen *et al*.,.2023).

Proline is an essential amino acid that is known as an osmo-regulator, because it mitigates the negative impacts of environmental factors like drought and improves growth and physiological characteristics (AlKahtani *et al*., 2021). The Proline performs a crucial role in a plant's capacity to tolerate environmental stresses. It prevents protein oxidation, reduces lipid peroxidation, and safeguards cell membranes and structures. Proline is a source of nitrogen and energy as well (Claussen, 2005). Proline plays a substantial impact in reducing salt stress in plants. It is a crucial plant hormone that promotes plant growth and development when exposed to salt stress. The quality, yield, and morphological characteristics of sugar beet were all improved by proline application. White sugar yields were also raised (Altaf, 2023).

The aim of this investigation is to study the response of sugar beet growth to soil application of humic acid and foliar application of some bio-stimulants and their interaction under soil salinity.

MATERIALS AND METHODS

Field experiments were conducted at the Experimental Farm, Abees Region, Faculty of Agriculture, Saba Basha, Alexandria University, Alexandria Governorate, Egypt, during the seasons of 2021/2022 and 2022/2023 to study the response of sugar beet cv (Karam) to potassium and some bio-stimulants under salt-affected soil.

Before planting, soil samples were randomly taken from the experimental site at a depth of 0 to 60 cm from the soil surface and prepared for chemical analysis according to the method described by (Chapman and Pratt, 1978). The results of the physical and chemical analysis of the experimental soil are presented in (Table 1).

The preceding crop was maize (*Zea mays L*.) in both seasons. The experimental design was a split-plot design with three replicates. Each experiment included 24 treatments, which were, the combination of three humic acids (HA) levels (0, 12 and 24 kg HA/ha) assigned to the main plots, and 8 bio-stimulants treatments, randomly arranged within the sub-plot (1- water (control), 2- Salicylic acid 100 mg / L, 3- Fulvic acid 1.2 kg /ha, 4- Hydroxyproline 1000 mg/L, 5-Salicylic acid 100 mg / L + Fulvic acid 1.2 kg /ha, 6- Salicylic acid 100 mg /L + Hydroxyproline 1000 mg/L), 7- Fulvic acid 1.2 kg/ha + Hydroxyproline

1000 mg/L, and 8- Salicylic acid 100 mg / L + Fulvic acid 1.2 kg /ha + Hydroxyproline 1000 mg/L). The area of each sub-plot was 10.5 m2 as 3.5 meters long and 3.0 m wide (6 ridges width 50 cm), and plant spacing was 20 cm.

Table (1). Physical and chemical characteristics of the soil at the test sites in both seasons.

Soil properties	Seasons	
	2020/ 2021	2021/2022
A- Mechanical analysis		
Sand	14.50	14.70
Silt	42.10	42.10
Clay	43.40	43.20
Soil texture	Clay loam	Clay loam
B- Chemical properties		
p^H (1:1)	8.10	8.20
EC (1:1) dS/m	4.50	4.60
1- Soluble cations (1:2)		
K^+	1.40	1.45
Ca^{++}	14.20	14.40
Mg^{++}	11.50	10.50
Na^+	13.60	13.80
2- Soluble anions (1:2)		
CO^-_3+ HCO^-_3	2.80	2.90
CL^-	21.50	21.50
SO^-_4	16.40	16.00
Calcium carbonate (%)	6.70	6.90
Total nitrogen (%)	1.10	1.20
Available P (mg/kg)	3.70	3.60
Organic matter (%)	1.50	1.60

The soil was well prepared through two ploughings and leveling. Sugar beet cultivar poly germ (cv. Karam) obtained from Sugar Factory El Nile Company (Brand KWS – Type N – Resistance C). Seed balls were mechanized sown as usual on one side of the ridge in hills 20 cm apart at the rate of 3-4 seed balls per hill, sown on the 15th of August 2021/2022 and 2022/2023 seasons. The plants were thinned once at 35 days from sowing to one plant.

Mono calcium super phosphate (P_2O_5, 12.5 %) was applied at the rate of 60 kg P2O5/ha with soil preparation. Nitrogen fertilizer was added in the form of ammonium nitrate (33.5%N) as a side- dress at the rate of 168 kg N/ha, in two equal doses on half after thinning (before the first irrigation) and the other half before the second irrigation. Weed control by emergency herbicide (Gardo, 96 %; S-metolachlor) at the rate of 720 cm^3/ha before weed and plants emergency and after sowing, also manually controlled by hand hoeing one time. Other agricultural practices for growing sugar beet were followed, according to the recommendations of the Ministry of Agriculture and Land Reclamation.

Humic acid from Setra Company, Tanta, Egypt, whose commercial name is HABICAR HUMICO WSP, is used as soil application and the doses are 0, 12 and 24 kg/ha after 50 days from sowing.

The commercial SA from Oasis For I.E.T Company – Egypt Alexandria Desert Road – Egypt, whose commercial name is Anti-free, was prepared at a rate of 100 mg/L and sprayed two times during the 65, and 90 days after sowing. At the same time, the control was sprayed with tap water.

The commercial fulvic acid (FA) is from Setra Company, Egypt whose commercial name is Free Fulvic (70 %), which sprayed twice at a rate of 1.2 kg/ha after-65, and 90 days after sowing, at the same times, control was sprayed with tap water.

The Industrial hydroxyproline from SAMA Company—Egypt, Alexandria Desert Road, Egypt, was prepared at the rate of 1000 mg/L and sprayed two times after-65, and 90 days after sowing. At the same time, the control was sprayed with tap water.

Three samples were collected at 120, 150, and 180 days after seeding to evaluate growth characteristics on five guarded plants for each sampling data. In the meantime, the border effects were avoided in the subsequent samples. Each sample was randomly selected from the ridges, to see how humic acid, SA, FA, and hydroxyproline affect the following physiological parameters:

1. **Number of leaves/plants**.
2. **Crop growth rate (CGR) (g/m^2/day)** according to the formula suggested by Radford (1967).

$$CGR\ (g/m^2/day) = (W2-W1) / SA\ (T2-T1)$$

Where: W1 and W2 refer to the dry weight of the plant at sampling time T1 (120 DAS) and T2 (150 DAS), respectively and SA: Soil area occupied by plants for each sample, according to (Charles, 1982).

3. **Relative growth rate (RGR) in g/g/day** was determined according to Radford (1967), using the following equation:

RGR = (log W2 – log W1)/ (t2 – t1), where W1 and W2 are plant dry weights at times t1 and t2.

All collected data were statistically evaluated using the analysis of variance (ANOVA) method for the split-plot design as described in (Gomez and Gomez, 1984). The differences between the treatment means were tested using the Least Significant Difference (LSD) method at the 5% level of probability. Application of (CoStat, 2005) for Windows was used to perform all data analysis.

RESULTS AND DISCUSSION

A) Analysis of Variances:

The results in Table (2) present the variance analysis for Growth and Physiological characteristics in the seasons of 2021–2022 and 2022–2023. Substantial K-humate, foliar spray, some bio-stimulators, and their interaction. These results show that K-humate application rates, foliar application of biostimulants substances like salicylic acid (SA), fulvic acid (FA), and hydroxyproline (HP), and their interaction in both study seasons significantly affected sugar beet growth characteristics such as the number of leaves/plants, crop growth rate (CGR) (g/m2/day), and relative growth rate (RGR).

Table 2: Mean square of sugar beet growth characters as affected by Humic acid, foliar application and their interaction during 2021/2022 and 2022/2023 seasons.

SOV	df	Number of leaves/plants		Crop growth rate (CGR) ($g/m^2/day$)				Relative growth rate (RGR)			
		1st seasons	2nd season	1st seasons		2nd season		1st seasons		2nd season	
				Days after sowing (DAS)							
				120-150	150-180	120-150	150-180	120-150	150-180	120-150	150-180
Block	2	4.18 ns	1.96 ns	0.11ns	0.19ns	0.20ns	0.04ns	0.001ns	0.001ns	0.002ns	0.009ns
Humic acid (A)	2	210.88**	173.10**	25.12**	58.18**	26.91**	59.09**	8.50**	3.91**	8.72**	3.61 **
Ea	4	2.74	7.04	0.04	0.22	0.07	0.46	7.30	3.51	0.002	0.015
Foliar application (B)	7	280.22 **	278.55 **	6.70**	2.49**	6.93**	3.25**	1.14**	0.64 **	1.11**	0.69**
Interaction (A x B)	14	93.65**	100.26**	0.91**	1.77**	0.94**	1.51*	0.26	0.17	0.26**	0.16 **
Eb	42	1.07	5.01	0.07	0.79	0.08	0.82	8.26	9.59	0.002	0.012
Total	71										

ns, *, and **: Not significant, Significant and highly significant differences at 0.05 and 0.01 levels of probability respectively.

B) Effect of Humic Acid and Bio Stimulators:

1- Number of Leaves/Plants:

The results in Table (3) show a significant relationship between humic acid (HA) levels, foliar bio stimulator application, and their interaction on the number of leaves/plants in salinity-affected soil in both the 2021–2022 and 2022–2023 growing seasons.

The obtained results in the same Table (3) made it evident that applying humic acid at a rate of 24 kg/ha resulted in the largest number of leaves/plants and that applying 0 kg HA/ha resulted in the lowest values over the course of two seasons.

Also, the results in Table (3) also showed that SA + FA and HP produced the most leaves/plants, whereas water application produced the fewest in both seasons. El-Kady *et al*. (2021); Anjum *et al*. (2011); Malan (2015) revealed that HA and FA had a significant effect on leaf functions. In the same way, El-Safy and Abo-Marzoka (2021); Abdelaal *et al*. (2020); Abido *et al*. (2015). Likewise, Abdelaal *et al.* (2020); Abido and Ibrahim, (2017); El-Safy and Abo-Marzoka (2021) showed that the application of SA increased the growth parameters of many crops. On the otherwise, pro-improved growth and physiological characteristics, according to Ashraf *et al*. (2010); Ali *et al.* (2019); AlKahtani *et al.* (2021); Ghaffari *et al.* (2021) On the other hand, Yang and Antonietti (2020) that the use of FA accelerated plant development under stress.

2- Crop Growth Rate (CGR) ($g/m^2/day$):

The obtained results in Table (3) show the considerable impact of humic acid (HA) levels, foliar application of biostimulants substances, and their interaction on crop growth rate (CGR) during the two growth periods (120-150 and 150-180 DAS) in salinity-affected soil in the 2021/2022 and 2022/2023 seasons.

Also, Table (3) intervals were observed when humic acid was applied to the soil at a rate of 24 kg/ha, followed by an application of HA at a rate of 12 kg/ha, while the application of 0 kg/ha of HA produced the lowest value of this feature. This might be because humic chemicals added to the soil encourage plant growth and nutrient uptake by altering membrane permeability. These findings are supported by research from; Nardi *et al*. (2002); Badawi *et al*. (2013); Dawood *et al*. (2019); Abido and Ibrahim, (2017) who found that humic compounds promoted sugar beet development.

Table (3) found that the foliar application of SA + HP at the first growth stage in both seasons produced the highest CGR, but HP or FA + HP or SA + HP at the second stage in both seasons produced the lowest CGR when compared to the other treatments, while water application produced the highest CGR. In the same way, El-Safy and Abo-Marzoka (2021);

Gilani (2022) also demonstrated that applying SA improved various crops' growth metrics. However, Monreal *et al*. (2007); Ali *et al.* (2019); AlKahtani *et al.* (2021) reported that utilizing Pro improved growth and physiological characteristics. On the other hand, Yang and Antonietti (2020) claimed that humus components promoted growth. Also, Anjum *et al*. (2011); Wilczewski *et al*. (2017); Van Oosten *et al.* (2017); Mosaad *et al*. (2022) reported that the use of FA accelerated plant development under stress.

3- Relative Growth Rate (RGR):

The obtained data in Table (3) show a substantial relationship between humic acid (HA) levels, foliar biostimulant treatment, and relative growth rate (RGR) at the two growth periods (120-150 and 150-180 DAS) in salinity-affected soil in the 2021/2022 and 2022/2023 seasons.

Moreover, Table (3) demonstrated that humic acid treatment to the soil at a rate of 24 kg/ha resulted in the maximum relative growth rate (RGR) during the two-growth period, while application of 0 kg HA/ha resulted in the lowest RGR during both seasons.

The reachable results in Table (3) regarding the foliar application of some bio-stimulants showed that the application of SA + HP produced the highest RGR at the first and second growth stages in both seasons when compared to the other treatments, while water application produced the lowest RGR values in both.

This pattern, El-Safy and Abo-Marzoka (2021); Ali *et al.* (2020) showed that the application of SA increased the growth parameters of many crops. Otherwise, Ghaffari *et al.* (2021); Ali *et al.* (2019); AlKahtani *et al.* (2021) indicated that using Pro enhanced growth and physiological characteristics. On the other hand, Yang and Antonietti (2020) stated that humus compounds promoted development under stress.

Table 3: Number of leaves/plant, Crop growth rate (CGR) and Relative growth rate (RGR) of sugar beet as affected by Humic acid, foliar application of biostimulants substances and their interaction in both seasons.

Treatment	No. of leaves/plant		CGR (g/m²/day)				RGR0.96			
	Seasons									
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
			Days after sowing (DAS)							
			120 - 150	150 - 180	120 - 150	150 - 180	120 - 150	150 - 180	120 - 150	150 - 180
A) Humic acid (kg/ha)										
0	29.00 b	29.66 b	4.06 c	3.80 c	4.02 c	3.80 c	0.40 c	1.13 c	0.39 c	1.15 c
12	27.00 c	27.68 b	5.39 b	5.27 b	5.40 b	5.22 b	0.69 b	1.45 b	0.7 b	1.45 b
24	32.83 a	33 a	6.09 a	6.91 a	6.10 a	6.93 a	1.55 a	1.93 a	1.55 a	1.92 a
LSD at 0.05	1.32	2.12	0.17	0.38	0.22	0.54	0.02	0.01	0.04	0.09
B) Foliar application of bio stimulants										
Water spray	23.55e	23.39 e	3.33 f	4.26 b	3.34 e	4.03 b	0.25 g	0.95 f	0.26 g	0.96f
SA (100 mg/l)	37.00 a	36.77 ab	4.47 e	5.40 a	4.35 d	5.42 a	0.64 f	1.34 e	0.64 f	1.26 d
FA (1.2 kg/ha)	28.33 c	28.33 c	5.54 bcd	5.40 a	5.53 bc	5.41 a	0.89 d	1.59 c	0.89 d	1.60 bc
HP (1000 mg/L)	34.22 b	34.66 b	5.74 ab	5.86 a	5.77 ab	5.87 a	0.94 c	1.63 b	0.94 c	1.64 bc
SA + FA	36.55 a	37.55 a	5.83 a	5.17 a	5.83 a	5.21 a	1.22 b	1.57 c	1.22b	1.55 cd
SA + HP	25.33 d	25.88 d	5.34 d	5.67 a	5.36 c	5.72 a	1.43 a	1.85 a	1.42 a	1.87 a
FA + HP	28.22 c	29.66 c	5.71 abc	5.85 a	5.73 ab	5.86 a	0.94 c	1.64 b	0.90 cd	1.66 b
SA + FA + HP	23.66 e	24.65 de	5.48 cd	5.03 ab	5.50 bc	5.03 a	0.76 e	1.46 d	0.77 e	1.48 d
L.S.D at 0.05	0.98	2.12	0.25	0.84	0.27	0.86	0.02	0.02	0.04	0.10
Interaction										
A x B	**	**	**	**	**	**	**	**	**	**

Means in the same row/column (s) followed by the same letter are not significant at 0.05 level of probability, **: significant difference, p <0.01.

C) Interaction Effect:

1- Number of Leaves/Plants:

Table (4) indicated a significant interaction impact between the two components, with control (untreated + water spray) in each of the two seasons recording the lowest values of this feature while employing 24 kg/ha of HP or SA + HP or FA recorded the highest number of leaves/plants compared to the other treatments.

2- Crop Growth Rate (CGR) (g/m^2/day):

Results in Table (4) showed the interaction between soil application of HA and application of Biositmulants substances treatments, where the results cleared that application of 24 kg HA/ha + HP or with FA + HP at the first stage achieved higher CGR in the two seasons, but at the second stage, the rate of HA at 24 kg with FA or HP or SA+FA+HP gave the highest values of CGR as compared to the other treatments, while the lowest values of this trait were given with control (untreated + water spray) in the two seasons**.**

3- Relative growth rate (RGR) in (g/g/day)

Results given in Table (4) revealed a significant interaction between soil HA application and Biostimulants substances application, with the findings indicating that the first-stage application of 24 kg HA/ha + HP or with FA + HP resulted in increased CGR over the course of the two seasons. The second stage, however, showed that the rate of HA at 24 kg with FA or HP or SA+FA+HP offered the highest values of CGR in comparison to the other treatments, while the control (untreated + water spray) across the two seasons gave the lowest values of this feature.

Table 4: The interaction difference of number of leaves/plant, Crop growth rate and Relative growth rate (RGR) of sugar beet as affected by humic acid and foliar application of some biostimulators in both seasons.

HA (k/ha)	Biostimulators	No. of leaves/plant		CGR (g/m^2/day)				RGR (g/g/day)			
		2021/022	2022/023	2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/023	2021/2022	2022/023
				Days after sowing (DAS)							
				120 -150	150-180	120 -150	150-180	120 -150	150-180	120 -150	150-180
0	Water	25.00	25.37	1.58	2.68	1.57	2.63	0.13	0.83	0.13	0.82
	SA	37.33	36.66	3.11	4.10	2.74	4.09	0.23	0.93	0.23	0.94
	FA	26.66	26.00	4.66	3.87	4.63	3.82	0.53	1.23	0.53	1.24
	HP	34.66	35.66	4.43	3.88	4.46	3.86	0.42	1.12	0.43	1.13
	SA + FA	38.33	40.00	5.56	3.68	5.53	3.73	0.32	1.02	0.32	1.05
	SA + HP	18.33	18.33	4.14	4.22	4.16	4.26	0.92	1.83	0.92	1.84
	FA + HP	27.66	30.66	4.64	5.12	4.67	5.13	0.41	1.11	0.27	1.13
	SA + FA + HP	24.00	24.62	4.38	2.87	4.42	2.89	0.29	0.99	0.30	1.02
12	Water	14.00	14.15	4.37	5.28	4.39	4.64	0.21	0.91	0.22	0.93
	SA	35.66	35.66	5.54	4.77	5.52	4.81	0.56	1.26	0.56	1.25
	FA	22.00	22.33	5.54	4.34	5.51	4.38	0.60	1.30	0.61	1.32
	HP	24.00	24.33	5.92	6.26	5.94	6.28	0.86	1.56	0.86	1.57
	SA + FA	39.00	40.00	5.51	5.09	5.51	5.12	0.91	1.83	0.90	1.74
	SA + HP	29.00	30.33	5.12	5.55	5.15	5.59	0.93	1.86	0.92	1.87
	FA + HP	30.00	31.00	5.65	6.11	5.67	6.14	0.86	1.56	0.87	1.57
	SA + FA + HP	22.33	23.66	5.47	4.79	5.50	4.83	0.62	1.32	0.63	1.33
24	Water	31.66	30.66	4.03	4.81	4.06	4.82	0.42	1.12	0.43	1.14
	SA	38.00	38.00	4.76	7.33	4.79	7.37	1.12	1.82	1.13	1.59
	FA	32.33	36.66	6.43	8.00	6.44	8.03	1.52	2.22	1.53	2.25
	HP	28.66	44.00	6.88	7.43	6.90	7.48	1.54	2.24	1.54	2.22
	SA + FA	32.33	32.66	6.43	6.75	6.44	6.79	2.43	1.87	2.43	1.87
	SA + HP	28.66	29.00	6.77	7.26	6.77	7.30	2.44	1.87	2.44	1.89
	FA + HP	27.00	27.33	6.85	6.31	6.84	6.31	1.56	2.26	1.56	2.28
	SA + FA + HP	24.66	25.66	6.61	7.43	6.59	7.38	1.37	2.07	1.37	2.09
$LSD_{0.05}$		1.71	3.68	0.44	1.43	0.48	1.49	0.04	0.05	0.08	0.18

Water sprays (control), SA= Salicylic acid at the rate of 100 mg /L, FA= Fulvic acid at the rate of 1.2 kg/ha, HP= Hydroxyproline at the rate of 1000 mg/L.

Conclusion

It was determined that the Karam variety of sugar beet was planted in clay soil that was affected by salinity, fertilized with a combination of humic acid at a rate of 24 kg/ha as a soil amendment, and sprayed with some bio stimulators like fluvic acid (FA), hydroxyproline, and salicylic acid (SA) to get the maximum amount of growth characters under surface irrigation system in Alexandria, Egypt.

REFERENCES

AbDeLAAL, K. A., RASHeD, S. H., HOSSAIN, A., and Sabagh, A. E. (2020). Yield and quality of two sugar beet (*Beta vulgaris* L. ssp. vulgaris var. altissima Döll) cultivars are influenced by foliar application of salicylic acid, irrigation timing, and planting density. *Acta agriculturae Slovenica*, *115*(2), 273-282.

Abido, W. A. E., and Ibrahim, M. E. M. (2017). Role of foliar spraying with biostimulants substances substances in decreasing mineral nitrogen fertilizer of sugar beet. *Journal of Plant Production*, *8*(12), 1335-1343.

Abido, W.A.E.; M.E.M. Ibrahim, and M.M. El-Zeny (2015). Growth, productivity and characteristic of sugar beet as affected by antioxidants foliar sprinkling and potassium fertilizer top dressing. *Asian Journal of Crop Science,* 7(2): 113-127, doi. Org /10. 3923 /ajcs .2015 .113.127.

Abo-Elwafa, S. F., Abdel-Rahim, H. M., Abou-Salama, A. M., and Teama, E. A. (2006). Sugar beet floral induction and fertility: Effect of vernalization and day-length extension. *Sugar Technology*, *8*, 281-287.

Ali, Q., Haider, M. Z., Shahid, S., Aslam, N., Shehzad, F., Naseem, J., ... and Hussain, S. M. (2019). Role of amino acids in improving abiotic stress tolerance to plants. In Plant tolerance to environmental stress (pp. 175-204). CRC Press.

Ali, Q., Shehzad, F., Waseem, M., Shahid, S., Hussain, A. I., Haider, M. Z., ... and Perveen, R. (2020). Plant-based biostimulants substances and plant stress responses. Plant Ecophysiology and Adaptation under Climate Change: Mechanisms and Perspectives I: General Consequences and Plant Responses, 625-661.

AlKahtani, M. D., Hafez, Y. M., Attia, K., Rashwan, E., Husnain, L. A., AlGwaiz, H. I., and Abdelaal, K. A. (2021). Evaluation of silicon and proline application on the oxidative machinery in drought-stressed sugar beet. *Antioxidants*, 10(3), 398.

Altaf, A., Nawaz, F., Majeed, S., Ahsan, M., Ahmad, K. S., Akhtar, G., ... and Farman, M. (2023). Foliar Humic Acid and Salicylic Acid Application Stimulates Physiological Responses and Antioxidant Systems to Improve Maize Yield under Water Limitations. *JSFA Reports*. 3(3), 119-128

Anjum, S. A., Xie, X., Wang, L. C., Saleem, M. F., Man, C., and Lei, W. (2011). Morphological, physiological and biochemical responses of plants to drought stress. *African journal of agricultural research*, *6*(9), 2026-2032.

Ashraf, M., Akram, N. A., Arteca, R. N., and Foolad, M. R. (2010). The physiological, biochemical and molecular roles of brassinosteroids and salicylic acid in plant processes and salt tolerance. *Critical Reviews in Plant Sciences*, *29*(3), 162-190.

Ayed, S., Bouhaouel, I., Jebari, H., and Hamada, W. (2022). Use of biostimulants substances: towards sustainable approach to enhance durum wheat performances. *Plants*, *11*(1), 133.

Badawi, M. A., Attia, A. N., EL-Moursy, S. A., Seadh, S. E., and Hamada, A. M. A. (2013). Effect of compost, humic acid and nitrogen fertilizer rates on: 1-growth of sugar beet crop. *Journal of Plant Production*, *4*(5), 705-719.

Cakmak, I. (2005). The role of potassium in alleviating detrimental effects of abiotic stresses in plants. *Journal of Plant Nutrition and Soil Science*, 168(4), 521-530.

Cernusak, L. A. (2020). Gas exchange and water-use efficiency in plant canopies. *Plant Biology*, *22*, 52-67.

Chapman, H. D., and Pratt, P. F. (1978). Method of Analysis for Soil and Water. Chapter, 17pp 150-161. University of California Division of Agricultural Science, USA, 220-308.

Charles-Edwards, D. A. (1982). Physiological determinants of crop growth (Vol. 1). London: Academic Press.

Chen, S., Zhao, C. B., Ren, R. M., and Jiang, J. H. (2023). Salicylic acid had the potential to enhance tolerance in horticultural crops against abiotic stress. *Frontiers in Plant Science*, *14*, 457.

Claussen, W. (2005). Proline as a measure of stress in tomato plants. *Plant science*, 168(1), 241-248.

CoStat (2005). CoStat statistical software: CoHort Software, PO Box 1149, Berkeley, California 94701, US $79.

Das, R., and Tzudir, L. (2021). Climate Change and Crop Stresses. *Biotica Research Today, 3*(5), 351-353.

Dawood, M. G., Abdel-Baky, Y. R., El-Awadi, M. E. S., and Bakhoum, G. S. (2019). Enhancement quality and quantity of faba bean plants grown under sandy soil conditions by nicotinamide and/or humic acid application. *Bulletin of the National Research Centre,* 43(1), 1-8.

Deolu-Ajayi, A. O., van der Meer, I. M., Van der Werf, A., and Karlova, R. (2022). The power of seaweeds as plant biostimulants substances to boost crop production under abiotic stress. *Plant, Cell and Environment*, *45*(9), 2537-2553.

Dubey, A., Kumar, A., and Khan, M. L. (2020). Role of biostimulants substances for enhancing abiotic stress tolerance in Fabaceae plants. *The Plant Family Fabaceae: Biology and Physiological Responses to Environmental Stresses,* 223-236.

EL Sabagh, A., Hossain, A., Barutçular, C., Iqbal, M. A., Islam, M. S., Fahad, S., ... and Erman, M. (2020). Consequences of salinity stress on the quality of crops and its mitigation strategies for sustainable crop production: an outlook of arid and semi-arid regions. *Environment, climate, plant and vegetation growth*, 503-533.

El-Kady, M. S., Abu-Ellail, F. F., and El-Laboudy, E. H. S. (2021). Evaluation of some sugar beet varieties under water salinity stress in new reclaimed land. *Journal of Plant Production*, *12*(1), 63-72.

El-Safy, N. K., and Abo-Marzoka, E. A. (2021). Growth of Some Sugar Beet Varieties Under Different Locations as Affected by Foliar Application with Salicylic Acid on Yield and Quality. *Egyptian Academic Journal of Biological Sciences, H. Botany,* 12(1), 161-173.

FAO (2022) Food and agriculture organization. World Food and Agriculture - Statistical Pocketbook. FAO, Rome.

FAOSTAT. *Food and Agriculture Organisation of the United Nations Statistical Database*; Statistical Division; FAO: Rome, Italy, 2021; Available online: http://www.fao.org/statistics/en/ (accessed on 5 February 2021).

Franzoni, G., Cocetta, G., Prinsi, B., Ferrante, A., and Espen, L. (2022). Biostimulants substances on crops: Their impact under abiotic stress conditions. *Horticulturae*, *8*(3), 189.

García-García, A. L., García-Machado, F. J., Borges, A. A., Morales-Sierra, S., Boto, A., and Jiménez-Arias, D. (2020). Pure organic active compounds against abiotic stress: a biostimulant overview. *Frontiers in Plant Science, 11*, 575829.

Gezgin, S., and Sanal, H. T. (2012). “Water-lily sign” as a rare finding of spinal hydatidosis. *The Spine Journal*, *12*(6), e5-e7.

Ghaffari, H., Tadayon, M. R., Bahador, M., and Razmjoo, J. (2021). Investigation of the proline role in controlling traits related to sugar and root yield of sugar beet under water deficit conditions. *Agricultural Water Management,* 243, 106448.

Gilani, A., Gholami, A., Abbasdokht, H., and Tabari, Z. T. (2022, February). Evaluation of Superabsorbent Polymer on Leaf Area Index, Relative Leaf Water Content and Growth Rate of Sesame under Water Deficit Stress Condition. In *Chem. Proc* (Vol. 4). s Note: MDPI stays neu-tral with regard to jurisdictional claims in published maps and institutional affiliations.

Gomez, K. A., and Gomez, A. A. (1984). Statistical procedures for agricultural research. John wiley and sons.

Hartwigsen, J. A., and Evans, M. R. (2000). Humic acid seed and substrate treatments promote seedling root development. *HortScience*, *35*(7), 1231-1233.

Hasanuzzaman, M. (Ed.). (2020). *Plant Ecophysiology and Adaptation under Climate Change: Mechanisms and Perspectives II: Mechanisms of Adaptation and Stress Amelioration*. Springer Nature.

Joshi, S., Nath, J., Singh, A. K., Pareek, A., and Joshi, R. (2022). Ion transporters and their regulatory signal transduction mechanisms for salinity tolerance in plants. *Physiologia Plantarum*, *174*(3), e13702.

Kiymaz, S., and Ertek, A. (2015). Yield and quality of sugar beet (*Beta vulgaris L.*) at different water and nitrogen levels under the climatic conditions of Kırsehir, Turkey. *Agricultural Water Management*, *158*, 156-165.

Li, J., Van Gerrewey, T., and Geelen, D. (2022). A meta-analysis of biostimulant yield effectiveness in field trials. *Frontiers in Plant Science*.

Malan, C. (2015, November). Review: humic and fulvic acids. A Practical Approach. In Sustainable soil management symposium. Stellenbosch (pp. 5-6).

Malik, A., Mor, V. S., Tokas, J., Punia, H., Malik, S., Malik, K., ... and Karwasra, A. (2020). Biostimulant-treated seedlings under sustainable agriculture: A global perspective facing climate change. *Agronomy*, *11*(1), 14.

Misra, V., Mall, A. K., and Pathak, A. D. (2020). Sugar beet: a sustainable crop for saline environment. *Agronomic Crops: Volume 3: Stress Responses and Tolerance*, 49-61.

Monreal, J. A., Jimenez, E. T., Remesal, E., Morillo-Velarde, R., García-Mauriño, S., and Echevarría, C. (2007). Proline content of sugar beet storage roots: Response to water deficit and nitrogen fertilization at field conditions. *Environmental and Experimental Botany*, *60*(2), 257-267.

Monteiro, E., Gonçalves, B., Cortez, I., and Castro, I. (2022). The role of biostimulants substances as alleviators of biotic and abiotic stresses in grapevine: A review. *Plants*, *11*(3), 396.

Mosaad, I. S., Serag, A. H., and Sheta, M. H. (2022). Promote sugar beet cultivation in saline soil by applying humic substances in-soil and mineral nitrogen fertilization. *Journal of Plant Nutrition*, *45*(16), 2447-2464.

Mukherjee, E., and Gantait, S. (2023). Genetic transformation in sugar beet (*Beta vulgaris L.*): technologies and applications. *Sugar Tech*, *25*(2), 269-281.

Munns, R., and Termaat, A. (1986). Whole-plant responses to salinity. *Functional Plant Biology*, *13*(1), 143-160.

Munns, R.; Tester, M. (2008). Mechanisms of salinity tolerance. *Annual Review of Plant Biology*, 59, 651–681.

Nardi, S., Pizzeghello, D., Muscolo, A., and Vianello, A. (2002). Physiological effects of humic substances on higher plants. *Soil Biology and Biochemistry*, 34(11), 1527-1536.

Nasr, M. I., and Abd El-Razek, A. M. (2008). Sugar beet performance under newly reclaimed soils conditions of Sinai, Egypt. *Sugar Technology*, *10*, 210-218.

Othman, M. M., and El-Moursy, R. S. (2020). Impact of Applying Potassium Fulvate and Boron on Sugar Beet Yield and Quality. *Journal of Soil Sciences and Agricultural Engineering*, 11(12), 873-880.

Parida, A. K., and Das, A. B. (2005). Salt tolerance and salinity effects on plants: a review. *Ecotoxicology and environmental safety*, *60*(3), 324-349.

Pathak, A. D., Kapur, R., Solomon, S., Kumar, R., Srivastava, S., and Singh, P. R. (2014). Sugar beet: A historical perspective in Indian context. *Sugar Technology*, *16*, 125-132.

Radford, P. J. (1967). Growth analysis formulae-their use and abuse 1. *Crop science*, 7(3), 171-175.

Saddiq, M. S., Iqbal, S., Hafeez, M. B., Ibrahim, A. M., Raza, A., Fatima, E. M., ... and Ciarmiello, L. F. (2021). Effect of salinity stress on physiological changes in winter and spring wheat. *Agronomy*, *11*(6), 1193.

Schwichtenberg, K., Wenke, T., Zakrzewski, F., Seibt, K. M., Minoche, A., Dohm, J. C., ... and Schmidt, T. (2016). Diversification, evolution and methylation of short interspersed nuclear element families in sugar beet and related Amaranthaceae species. *The Plant Journal*, *85*(2), 229-244.

Subrahmanyeswari, T., and Gantait, S. (2022). Advancements and prospectives of sugar beet (*Beta vulgaris L.*) biotechnology. *Applied Microbiology and Biotechnology*, *106*(22), 7417-7430.

Tuteja, N. (2007). Mechanisms of high salinity tolerance in plants. *Methods in enzymology*, *428*, 419-438.

Van Oosten, M. J., Pepe, O., De Pascale, S., Silletti, S., and Maggio, A. (2017). The role of biostimulants substances and bioeffectors as alleviators of abiotic stress in crop plants. *Chemical and Biological Technologies in Agriculture,* 4(1), 1-12.

Wang, M., Zheng, Q., Shen, Q., and Guo, S. (2013). The critical role of potassium in plant stress response. *International journal of molecular sciences,* 14(4), 7370-7390.

Wilczewski, E., Szczepanek, M., and Wenda-Piesik, A. (2017). Response of sugar beet to humic substances and foliar fertilization with potassium. *Journal of Central European Agriculture*, 19(1),153-165.

Yang, F., and Antonietti, M. (2020). The sleeping giant: A polymer View on humic matter in synthesis and applications. *Progress in Polymer Science,* 100, 101182.

Zekri, M., and Obreza, T. A. (2003). Plant nutrients for citrus trees (pp. 1-5). University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, EDIS.

Zhu, J. K. (2001). Plant salt tolerance. *Trends in plant science, 6*(2), 66-71.