Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Effect of Organic Fertilizers and Foliar Application of some Stimulants on Barley Plants Under Saline Condition.

Maha M. Othman*

Soil Fertility and Plant Nutrition Research Department, Soil, Water and Environment Research Institute, Agriculture Research Centre, El-Gama St., Giza, Egypt

ABSTRACT

Salinity stress is one of the most deleterious abiotic stress factors that affect the growth, productivity, and physiology of plants. So, two field experiments were implemented aiming at assessing the influence of three types of organic fertilizers as main plots *i.e.* farmyard manure (FYM), plant compost (PC) and animal compost (AC) and foliar application of different stimulants *i.e.* proline, ascorbic acid and salicylic acid as sub-plots on the performance of barley plants grown on soil having EC value of 6.5 dSm^{-1}. The results showed that the barley plants fertilized with animal compost (AC) possessed the best performance under soil salinity stress followed by that fertilized with plant compost (PC) then plants fertilized with farmyard manure (FYM), while barley plants untreated with organic fertilizers possessed the lowest performance. The investigated organic fertilizers increased the nutrient's availability and uptake and enhanced the synthesis of chlorophyll in the plant tissues and this may be the reason for increasing the ability of barley to tolerate salinity. Regarding the foliar application of stimulants, proline treatment was the superior one followed by ascorbic acid then salicylic acid and lately control treatment. Concerning the interaction effect, the highest values of barley growth criteria, as well as yield and its components, were realized when plants treated with plant compost (PC) and sprayed with proline, while the lowest values were recorded when barley plants were not treated with both organic fertilizer and antioxidants. Also, the organic fertilizers positively affected soil available nutrients (N, P and K) and EC values.

***Keywords**:* Farmyard manure, plant compost, animal compost, proline, ascorbic acid, salicylic acid and barley plants.

INTRODUCTION

Barley (*Hordeum vulgare* L.) is an important crop used as feed for animals, malt, and human food. It's a highly adaptable cereal grain and ranks fifth among all crops for dry matter production in the world (Thalooth, Bahr, and Tawfik 2012). Barely has wide adaptability to different agro-climatic conditions and different soil properties (Ko *et al.* 2019). Its importance derives from the ability to grow and produce in marginal environments, which are often characterized by drought, low temperature, and salinity. Among major cereals, the total cultivated area of barley in the world is 47 million hectares with an annual production of 147.4 million tons, with average productivity of 3136 kg ha^{-1} (FAO, 2018). In Egypt, barley is the fourth most important food crop, with a cultivated area of 31612 hectares in 2017 which produced 115478 tones with average productivity of 3653 kg ha1 (FAO, 2018).

In Egypt, reclamation of degraded soils *e.g.* salt-affected soil is the main target for the government to face rapid population growth and their food demands. According to FAO, (2005) saline soils represent about 30 % of the total cultivated area in Egypt, where the North Delta contains the biggest zone of salt-affected soil (46%). Soil salinity has a hazard influence that leads to decline all crops yield (Amer and Hashem, 2018). Salinity imposes a negative effect on plants growth by inducing morphological and physiological changes, decreasing leaf water potential, production of reactive oxygen species (ROS), increased ion toxicity, osmotic stress, and altering the biochemical processes (Amer and Hashem, 2018).

Organic manures have the possibility of providing the energy of microflora, improving soil physical, chemical and biological properties, supplying nutrients. Compost soil addition was observed to possess positive impacts that aid crop growth, therefore, improving the crop phytonutritional components (El-Hadidi *et al.* 2020 and Mohamed *et al.* 2020). Khaled *et al.* (2011) reported that compost possesses a vital role in salt-affected soils because the organic material causes an improving the soil properties, which have been deteriorated to the extent that passage of both air and water becomes extremely difficult in these soils.

One of the protective ways from soil salinity stress is using some stimulants *e.g.* proline, ascorbic acid and salicylic acid, which causes an increase in tolerance of plant grown on salt-affected soil.

*** Corresponding author.**
E-mail address: m2005y2009@gmail.com
DOI: 10.21608/jssae.2021.171531

Proline amino acid is known to be helpful in declining oxidative damage by reducing free radicals and helps plants to maintain the cell turgor (Huang *et al.* 2000). Also, ascorbic acid has a role in increasing salt tolerance of plants and also leads to scavenge free radicals which were produced due to salinity stress as well as the role of ascorbic acid in cell expansion and division making it an important stimulant (Conklin, 2001; Ozgur *et al.* 2013 and Gest *et al.* 2013). Salicylic acid plays an essential role in the regulation of plant growth and development, photosynthetic rate, ion uptake and transport, stomatal conductance and transpiration (Khan *et al.* 2003). Gunes *et al.* (2007) indicated that foliar application of salicylic acid increase abiotic stress tolerance in plants.

Therefore, the present investigation aims at evaluating the impact of different organic manures and different stimulants on barley grown on saline soil and find out the best treatment under soil salinity stress.

MATERIALS AND METHODS

Experimental setup.

Two field trials were implemented at a private farm located in El-Gawadeya Village, Belqas District, Dakahlia governorate, Egypt during the two consecutive winter seasons of 2017/2018 and 2018/2019 to evaluate the influence of different types of organic fertilizers as main plots and foliar application of some stimulants on improving growth performance, yield and its components of barley (*Hordeum valgare* L.) plants grown on salt-affected soil. The combined influences of organic fertilizers and stimulants substances were investigated by combining four organic treatments [without organic fertilization (control), farmyard manure (FYM), plant compost (PC) and animal compost (AC) at a rate of 36 m^3 ha^{-1} for all them] and four foliar applications of stimulants [without foliar (control), proline (30 mg L^{-1}), ascorbic acid (10.0 mM L^{-1}) and salicylic acid (0.01mM L^{-1}) at the volume of 900 L ha^{-1} for all them]. Sixteen treatments were arranged in a split plot design with three replicates, thus, the total number of experimental split-plot was 48. The subplot area was 6 m^2 (2.0 m width and 3.0 m length).Barley grains (CV Giza 126) were obtained from the agricultural research center (ARC) and sown on 19th of November in both growing seasons at a rate of 150 kg ha^{-1}.

One month before sowing, three organic fertilizers were applied to the studied soil in a single application, where each experimental sub-plot was mixed with organic fertilizer and irrigated after adding. Foliar application of the studied stimulants was done at periods of 20, 45, and 60 days from sowing by hand sprayer until saturation point, where studied stimulants were obtained from El-Gamhoria Company, El- Mansoura, Egypt. The normal agricultural practices, mineral fertilization and irrigation were done for the barley production according to the Ministry of Agri. and Land Rec (MALR). Harvest of barley plants was done on 26th of April in both seasons.

Soil sampling and organic manures preparation.

The soil of the experimental site was analyzed before sowing according to Dewis and Fertias (1970).Table 1 shows some of its properties. Also, soil samples of each experimental subplots at the harvest stage of barley plants were analyzed, taking into account that all soil samples either at the start or the end of the field experiment were taken at a depth of 0-30 cm.

Table 2 shows the characteristics of studied organic manures, where they also were analyzed according to Dewis and Fertias (1970). Plant compost (plant residues *i.e.* maize, rice and wheat straw) and animal compost (horses and cows excrements) were prepared in the experimental site as described by El-Hammady *et al.* (2003). FYM was taken from Sakha station of animal production, ARC, Kafer El-Shiekh governorate, Egypt.

Table 1. Some soil characteristics.

Physical analyses		**Soluble cations, cmol L^{-1}**	
C. Sand,%	5.10	Ca^{++}	15.3
F. Sand,%	10.3	Mg^{++}	12.7
Silt,%	29.9	K^{+}	1.2
Clay,%	54.7	Na^{+}	35.8
T. Class	Clay	Soluble anions, cmol L^{-1}	
Chemical analyses		CO_3^{-}	---------
EC, dSm^{-1}	6.5	HCO_3^{--}	2.9
$CaCO_3$, %	2.45	Cl^{-}	33.5
pH (1:2.5sus.)	8.10	SO_4^{--}	28.6
O.M, %	2.25	Available element, mg kg^{-1} Nitrogen	62.3
S.P, %	89	Phosphorus	6.60
F.C, %	44.5	Potassium	270.6

Table 2. Studied organic manures characteristics

Properties	FYM*	PC*	AC*
Weight of m^3 (kg)	635	335	570
pH (1:10)	6.65	6.10	6.70
EC, dSm^{-1}(1:10)	4.39	3.51	4.15
O.M,%	32.62	35.3	39.6
Organic C, %	19.28	20.81	17.51
Total N,%	1.23	1.39	1.55
C/N ratio	15.67	14.97	11.29
Total P,%	0.40	0.48	0.56
Total K,%	0.66	0.88	0.72
Fe, mg kg^{-1}	64.32	54.5	65.95
Mn, mg kg^{-1}	25.40	14.47	29.33
Zn, mg kg^{-1}	17.43	18.56	19.56

***FYM : Farmyard manure PC: Plant compost AC: Animal compost**

Measurement traits.

- At a period of 65 days after barley sowing:

Random samples of ten barley plants were taken from each sub-plot to determine the following criteria:

a- Plant height (cm) and leaf area (cm^2) of flag leaf using the following equation L.A= L **x** W **x** 0.7; where L=length and W is width of flag leaf.

b- Chlorophyll content (SPAD, value).

c- Concentration of malondialdehyde (MDA) was analyzed using method of Heath and Packer (1968).

d- Proline was determined according to Carillo and Gibon, (2011).

- At harvest stage.

Random samples of ten barley plants were taken from each sub-plot to estimate barley yield and its components as well as some qualitative traits as follows:

a- Yield and its components: Spike length, spike weight, No.of grain spike^{-1}, weight of 1000 grain, grain yield, straw yield, biological yield and harvest index (grain yield / biological yield x100).

b- Nutrient status and qualitative traits of grains: N, P and K contents of barley grain were determined according to Chapman and Pratt (1961),where the oven-dried barley grains were ground then wet digested by a mixture of sulfuric, and perchloric acids (1:1) as described by Peterburgski (1968). Protein content in barley grain was calculated by using the following formula: Protein % = (N) × 5.75 as described by Anonymous, (1990), while total carbohydrates in barley grain were determined according to Hedge and Hofreiter (1962).

c- Soil analysis: Soil samples from each sub-plot were taken after harvesting barley plants in order to determine available nutrients content (N, P and K).

Statistical Analysis.

It was done according to Gomez and Gomez, 1984, using CoStat (Version 6.303, CoHort, USA, 1998–2004)].

RESULTS AND DISCUSSION

1. Performance at 65 Days from Sowing.

Soil addition of some organic manures [without organic fertilization (control), farmyard manure (FYM), plant compost (PC) and animal compost (AC)] and foliar application of some stimulants [without foliar (control), proline, ascorbic acid and salicylic acid] significantly affected growth criteria *i.e.* plant height (cm), leaf area(cm^2) as well as some biochemical traits *i.e.* chlorophyll (SPAD, reading), malondialdehyde (MDA) (µmol.g^{-1} F.W) and proline (mg g^{-1} F.W) at a period of 65 days from barley sowing (Table3),

Table 3. Effect of soil addition of some organic manures, foliar application of some stimulants and their interactions on growth of barley plants at 65 days from sowing during seasons of 2017/2018 and 2018/2019.

Treatments		Plant height, cm		Chlorophyll, SPAD reading		Flag leaf area,cm^2		MDA, µmol.g^{-1} F.W		Proline, mg g^{-1} F.W	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Organic fertilization											
Control (without)		72.63d	75.55c	28.94d	29.10d	94.44d	97.96d	8.69a	8.03a	6.19a	5.73a
FYM		94.53c	98.03b	36.40c	36.95c	110.43c	114.53c	7.12b	6.59b	5.64b	5.21b
PC		95.24b	98.68b	37.85b	38.18b	114.67b	118.75b	6.49c	5.99c	5.12c	4.76c
AC		96.17a	99.98a	38.81a	39.24a	117.65a	122.25a	5.83d	5.38d	4.53d	4.18d
LSD at 5%		0.18	0.72	0.18	0.05	0.37	2.14	0.02	0.03	0.05	0.05
Foliar application											
Control (without)		87.61d	90.93c	33.50d	33.83d	104.20d	107.76d	8.04a	7.47a	5.15b	4.79b
P		90.98a	94.67a	36.75a	37.10a	112.29a	116.82a	6.45d	5.93d	6.72a	6.19a
ASC		90.37b	93.87ab	36.12b	36.57b	111.03b	115.34b	6.68c	6.16c	4.69d	4.35d
SA		89.61c	92.78c	35.62c	35.97c	109.66c	113.56c	6.95b	6.43b	4.92c	4.54c
LSD at 5%		0.32	1.19	0.15	0.14	0.40	1.21	0.03	0.05	0.07	0.08
Interaction											
Control	Control	69.67l	72.87h	28.00o	28.17n	92.87o	95.69l	9.14a	8.46a	6.16d	5.81d
	P	75.10i	78.27f	30.15l	30.32k	96.13l	100.23j	8.29d	7.60d	6.93a	6.38a
	ASC	73.83j	76.47fg	29.25m	29.40l	95.00m	98.63jk	8.52c	7.86c	5.74f	5.28f
	SA	71.93k	74.60gh	28.36n	28.51m	93.77n	97.27kl	8.80b	8.20b	5.93e	5.45e
FYM	Control	93.03h	95.87e	34.95k	35.41j	106.33k	109.40i	7.95e	7.50e	5.48g	5.07g
	P	95.30de	99.17a-d	37.55f	38.02f	113.13g	117.61ef	6.53j	6.01j	6.78b	6.26ab
	ASC	95.10ef	98.93bcd	36.93g	37.41g	111.93h	116.64fg	6.83i	6.28i	5.03i	4.64i
	SA	94.67fg	98.17a-d	36.15h	36.95h	110.30i	114.47gh	7.15h	6.58h	5.27h	4.87h
PC	Control	93.53h	97.20de	35.30j	35.75i	108.03j	112.30h	7.69f	7.13f	4.84j	4.46j
	P	96.23bc	99.73abc	39.02c	39.31d	118.17d	122.49c	5.92m	5.46m	6.65b	6.12bc
	ASC	95.80cd	99.20a-d	38.72d	39.05d	116.93e	120.90cd	6.06l	5.60l	4.39l	4.15k
	SA	95.41de	98.60bcd	38.36e	38.62e	115.53f	119.30de	6.27k	5.79k	4.62k	4.29k
AC	Control	94.20g	97.80cde	35.75i	36.01i	109.57i	113.63h	7.39g	6.81g	4.15m	3.84l
	P	97.30a	101.50a	40.29a	40.76a	121.73a	126.95a	5.05p	4.65p	6.51c	6.00c
	ASC	96.73ab	100.87ab	39.60b	40.41b	120.27b	125.20ab	5.32o	4.91o	3.61o	3.33n
	SA	96.43b	99.73abc	39.62b	39.80c	119.03c	123.20bc	5.56n	5.14n	3.85n	3.55m
LSD at 5%		0.63	2.37	0.29	0.26	0.78	2.43	0.05	0.09	0.14	0.16

1st: First growing season2017/2018, 2nd: Second growing season 2018/2019, FYM: Farmyard manure, PC: Plant compost, AC: Animal compost, P: Proline, ASC: Ascorbic acid, SA: Salicylic acid and MDA: malondialdehyde.

Effect of treatments on the growth of barely plants:

a- Growth criteria and chlorophyll content:

The barley plants fertilized with animal compost (AC) possessed the highest values of plant height (cm), chlorophyll (SPAD, reading) and leaf area (cm^2) under soil salinity stress followed by that fertilized with plant compost (PC) then plants fertilized with farmyard manure (FYM), while barley plants untreated with organic fertilizers possessed the lowest values.

Regarding the foliar application of stimulants, proline treatment was the superior one followed by ascorbic acid then salicylic acid and lately control treatment (without foliar application).

Concerning the interaction effect, the highest values of plant height, chlorophyll content and leaf area were realized when plants were treated with plant compost (PC) and sprayed with proline, while the lowest values were recorded when barley plants were not treated with both organic fertilizers and antioxidants (control treatment).

The high organic materials contained in all studied organic manures are a good explanation of its impact on the performance growth of barley at 65 days from sowing. The superiority of AC compared to other studied organic manures may be due to its high content from nutrients more than others (Table2), also, it possesses the lowest C/N ratio. The obtained findings are in harmony with the results of Olesen *et al.* (2007) and Janusauskaite and Ciuberkis, (2010).

The superiority of proline more than ascorbic and salicylic acids may be attributed to that foliar application of proline promoted soil salinity stress tolerance during barley plant development in addition to its role in cell division and cell wall expansion. El Moukhtari *et al.* (2020) stated that under high-salt conditions, proline foliar application improves plant growth performance with increases in biomass, photosynthesis and gas exchange .also, These positive Influences are mainly driven by better nutrient acquisition, biological nitrogen fixation and water uptake. As well as ASA inhibits the effect of salt stress, increases physiological availability of water and nutrients that regulate root elongation, cell vacuolation and cell expansion as well as it increases the content of IAA that induce cell division and enlargement leading to an increase in plant growth(Smirnoff, 1996).

b- Malondialdehyde (MDA) and proline content:

Regarding barley plant's self-production from malondialdehyde (MDA) (µmol.g^{-1} F.W) and proline (mg g^{-1} F.W), salinity stress of soil (control treatment) led to raising MDA and proline contents in barley leaves at period of 65 days from sowing, where the cultivation without any both soil additions and foliar applications caused an increase of barley self-production from MDA and proline to scavenge the ROS, thus increase of salinity stress tolerance.

Generally, barley plants untreated with organic fertilizers (control) contained the highest MDA and proline contents followed by barley plants fertilized with FYM and lately followed by that fertilized with plant compost (PC), while the lowest values were realized when barley plants were fertilized with animal compost (AC). Also, the barley plants treated with proline produced the lowest values of MDA content, while the lowest values of proline content in barley leaves were realized with foliar application of Ascorbic acid (ASC).

Generally, it can be concluded that all studied stimulants have a beneficial effect on reducing barley plant's requirements from MDA self-production. The same trend was found with proline content in barley leaves, but the foliar application of proline gave the highest proline content in barley leaves.

Proline plays an adaptive role in the tolerance of barley plant to salinity by raising the concentration of cultural osmotic components to equalize the osmotic potential of the cytoplasm. The increase of proline content in barley plant tissues with the increase in soil salinity retards protein synthesis thus accumulates proline **(Yurekli *et al.* 1996 and El-Leboudi *et al.* 1997).**

This is attributed to the vital role of studied stimulants in scavenging ROS in the chloroplast as well as their role in regulating barley plant physiology, photosynthesis and immunological enhancement. The obtained results showed that all studied stimulants possessed a positive effect on scavenging compared to untreated plants. The obtained findings are in harmony with the results of **Marcote *et al.* (2001)** and **Daei *et al.* (2009).**

2. Performance at Harvest Stage.

Soil addition of different studied organic manures [without organic fertilization (control), farmyard manure (FYM), plant compost (PC) and animal compost (AC)] and foliar application of some stimulants [without foliar (control), proline, ascorbic acid and salicylic acid] significantly affected barley yield and its components *i.e.* spike length (cm), spike weight (g), No. of grain $spike^{-1}$, weight of 1000 grain (g), grain, straw and biological yield (Mg ha^{-1}) and harvest index (Table4), as well as nutrient status and qualitative traits of grains i.e. N, P, K, protein and carbohydrates content (Table5).

a- Yield and its components:

Data of Table 4 show that barley plants fertilized with AC possessed the highest values of spike length, spike weight, No. of grain $spike^{-1}$, weight of 1000 grain, grain, straw and biological yield and harvest index under soil salinity stress followed by that fertilized with PC, then plants fertilized with FYM, while barley plants untreated with organic fertilizers obtained the lowest values.

Regarding the foliar application of stimulants, foliar application of proline gave the highest values of all aforementioned traits, while ascorbic acid came in the second-order then salicylic acid and lately control treatment (without foliar application).

Concerning the interaction effect, the highest values of spike length, spike weight, No. of grain $spike^{-1}$, weight of 1000 grain, grain, straw and biological yield and harvest index were realized with plants treated with PC and sprayed with proline, while the lowest values were recorded when barley plants were not treated with both organic fertilizers and antioxidants.

Table 4. Effect of soil addition of different studied organic manures, foliar application of some stimulants and their interactions on barley yield and its components at harvest stage during two seasons of 2017/2018 and 2018/2019.

Treatments		Spike length, cm		Spike weight, g		No. of grain spike^{-1}		Weight of 1000 grain, g	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Organic fertilization									
Control (without)		13.38d	13.81d	2.52d	2.89d	31.50d	32.42d	30.95d	31.72d
FYM		15.23c	15.67c	4.19c	4.44c	37.92c	38.67c	37.79c	38.55c
PC		15.61b	16.16b	4.31b	4.72b	39.08b	40.58b	38.84b	39.49b
AC		16.21a	16.74a	4.41a	4.92a	40.50a	41.33a	39.70a	40.49a
LSD at 5%		0.20	0.13	0.03	0.06	0.64	0.93	0.12	0.69
Foliar application									
Control (without)		14.46c	14.92c	3.67c	3.90c	35.25c	36.25b	35.48d	36.07c
P		15.45a	15.94a	3.97a	4.40a	38.25a	39.00a	37.52a	38.34a
ASC		15.33ab	15.85ab	3.93a	4.38a	38.00ab	39.17a	37.28b	38.08ab
SA		15.19b	15.67b	3.87b	4.29b	37.50b	38.58a	37.00c	37.75b
LSD at 5%		0.19	0.19	0.05	0.04	0.65	0.76	0.13	0.38
Interaction									
Control	Control	13.20g	13.57g	2.43k	2.79k	30.00m	31.00h	30.66l	31.51g
	P	13.50g	13.97f	2.60j	2.96j	31.33l	32.00gh	31.18k	32.04g
	ASC	13.40g	13.87fg	2.56j	2.92j	32.67k	33.67f	31.02k	31.76g
	SA	13.40g	13.83fg	2.51jk	2.88j	32.00kl	33.00fg	30.93k	31.55g
FYM	Control	14.80f	15.27e	4.03i	4.20i	36.33j	38.00de	36.62j	36.69f
	P	15.50cd	15.97c	4.30ef	4.47g	39.00efg	39.33d	38.50e	39.55bc
	ASC	15.40cd	15.87cd	4.26fg	4.63f	38.33fgh	39.00de	38.22f	39.13c
	SA	15.23de	15.57de	4.18gh	4.48g	38.00ghi	38.33de	37.82g	38.82cd
PC	Control	14.87ef	15.37e	4.09hi	4.26i	37.00ij	38.33de	37.11i	37.95e
	P	16.00b	16.57b	4.42bcd	4.99c	40.33bcd	41.67abc	39.71c	40.21b
	ASC	15.90b	16.47b	4.39cde	4.87d	39.67cde	41.33bc	39.45c	40.21b
	SA	15.67bc	16.23bc	4.34def	4.77e	39.33def	41.00c	39.09d	39.58bc
AC	Control	14.97ef	15.47e	4.14hi	4.35h	37.67hi	37.67e	37.54h	38.13de
	P	16.80a	17.27a	4.55a	5.19a	42.33a	43.00bc	40.67a	41.57a
	ASC	16.60a	17.20a	4.51ab	5.10b	41.33ab	42.67ab	40.42ab	41.20a
	SA	16.47a	17.03a	4.46abc	5.04bc	40.67bc	42.00abc	40.18b	41.06a
LSD at 5%		0.37	0.38	0.10	0.09	1.31	1.53	0.27	0.77

See footnote of Table3.

Cont. Table 4.

Treatments		Grain yield, Mg ha^{-1}		straw yield, Mg ha^{-1}		Biological yield, Mg ha^{-1}		Harvest index, %	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Organic fertilization									
Control (without)		2.13d	2.17d	4.24d	4.34d	6.36d	6.51d	33.45c	33.32c
FYM		4.05c	4.15c	8.19c	8.38c	12.24c	12.54c	33.06c	33.09c
PC		4.38b	4.48b	8.47b	8.66b	12.85b	13.14b	34.01b	34.07b
AC		4.67a	4.77a	8.75a	8.94a	13.42a	13.71a	34.73a	34.75a
LSD at 5%		0.06	0.06	0.11	0.12	0.10	0.11	0.54	0.53
Foliar application									
Control (without)		3.35d	3.41d	6.95d	7.09d	10.29d	10.50d	32.72b	32.66b
P		4.06a	4.16a	7.71a	7.88a	11.77a	12.04a	34.24a	34.28a
ASC		3.96b	4.06b	7.57b	7.74b	11.53b	11.80b	34.19a	34.18a
SA		3.86c	3.95c	7.43c	7.60c	11.29c	11.55c	34.11a	34.11a
LSD at 5%		0.04	0.05	0.09	0.09	0.11	0.12	0.33	0.34
Interaction									
Control	Control	2.05n	2.07m	3.93n	4.02m	5.98l	6.08k	34.26cde	33.97ef
	P	2.20m	2.25l	4.55l	4.67j	6.75j	6.92i	32.56hi	32.50hi
	ASC	2.14m	2.18l	4.32m	4.43k	6.46k	6.61j	33.14gh	32.98gh
	SA	2.12mn	2.17l	4.14m	4.25l	6.26k	6.42j	33.85ef	33.82ef
FYM	Control	3.66l	3.73k	7.85k	8.03i	11.51i	11.76h	31.78j	31.70j
	P	4.33g	4.45f	8.41fg	8.60e	12.74e	13.04de	33.97ef	34.09def
	ASC	4.19h	4.30g	8.32gh	8.53ef	12.51f	12.83e	33.48fg	33.52fg
	SA	4.03i	4.14h	8.17hi	8.38fg	12.20g	12.52f	33.03gh	33.04gh
PC	Control	3.77k	3.86j	7.94jk	8.11hi	11.71i	11.97h	32.18ij	32.25ij
	P	4.70d	4.79d	8.76cd	9.00c	13.46c	13.79b	34.90abc	34.75bcd
	ASC	4.60e	4.71d	8.63de	8.82d	13.23c	13.53c	34.76bcd	34.83bc
	SA	4.45f	4.57e	8.55ef	8.69de	13.00d	13.26d	34.21de	34.46cde
AC	Control	3.91j	3.99i	8.06ij	8.21gh	11.97h	12.21g	32.67hi	32.71hi
	P	5.02a	5.16a	9.10a	9.26a	14.12a	14.42a	35.53a	35.77a
	ASC	4.93b	5.03b	8.99ab	9.19ab	13.92a	14.23a	35.39ab	35.38ab
	SA	4.84c	4.91c	8.85bc	9.08bc	13.69b	13.99b	35.34ab	35.12abc
LSD at 5%		0.09	0.10	0.18	0.17	0.23	0.23	0.68	0.68

See footnote of Table3.

b- Nutrient status and qualitative traits of grains:

The grains of barley plants fertilized with AC had the highest values of N, P, K, protein and carbohydrates contents under soil salinity stress followed by grains of barley plants fertilized with PC then grains of barley plants fertilized with FYM, while barley plants untreated with organic fertilizers possessed the lowest values of nutrient status and qualitative traits of grains (Table5).

Data of Table5 indicate that proline treatment was the superior one followed by ascorbic acid then salicylic acid and lately control treatment (without foliar application).

Concerning the interaction effect, the same Table illustrates that the highest values of N, P, K, protein and carbohydrates contents were recorded when plants treated with PC and sprayed with proline, while the lowest values were realized when barley plants were not treated with both organic fertilizers and antioxidants (control treatment).

The increase of barley plant growth and chlorophyll content (Table 3) due to either soil addition of studied organic manures or foliar applications of studied stimulants positively reflected on barley yield and grain quality. These results are in the line with those obtained by Lone et *al.* (1987) and Rekaby *et al.* (2020).

Table 5. Effect of soil addition of different studied organic manures, foliar application of some stimulants and their interactions on nutrient status and qualitative traits of barley grain at harvest stage during two seasons of 2017/2018 and 2018/2019.

Treatments		N, %		P, %		K, %		Protein, %		Carbohydrates, %	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Organic fertilization											
Control (without)		1.32d	1.38d	0.135d	0.143d	1.51d	1.56d	7.60d	7.94d	52.05d	55.14d
FYM		1.99c	2.03c	0.190c	0.194c	1.98c	2.01c	11.45c	11.69c	64.75c	65.87c
PC		2.08b	2.12b	0.202b	0.207b	2.07b	2.11b	11.96b	12.19b	65.44b	66.55b
AC		2.16a	2.20a	0.213a	0.217a	2.18a	2.23a	12.41a	12.67a	66.16a	67.15a
LSD at 5%		0.01	0.03	0.003	0.004	0.11	0.03	00.6	0.15	0.48	0.20
Foliar application											
Control (without)		1.76d	1.81d	0.168d	0.171d	1.76d	1.81d	10.14d	10.42d	60.77b	61.89d
P		1.97a	2.02a	0.195a	0.203a	2.03a	2.07a	11.31a	11.61a	62.85a	64.66a
ASC		1.94b	1.97b	0.189b	0.197b	2.00b	2.04b	11.13b	11.35b	62.59a	64.43b
SA		1.89c	1.93c	0.187c	0.191c	1.95c	2.00c	10.84c	11.10c	62.18a	63.75c
LSD at 5%		0.02	0.02	0.002	0.002	0.03	0.03	0.14	0.12	0.76	0.22
Interaction											
Control	Control	1.23l	1.31l	0.125l	0.128n	1.38m	1.46k	7.07l	7.55l	51.38h	52.49k
	P	1.41k	1.48j	0.141j	0.156k	1.60k	1.63i	8.11k	8.53j	52.55h	56.64i
	ASC	1.38k	1.41k	0.135k	0.148l	1.57k	1.61i	7.95k	8.09k	52.37h	56.47i
	SA	1.26l	1.32l	0.138jk	0.141m	1.50l	1.53j	7.26l	7.57l	51.90h	54.95j
FYM	Control	1.93j	1.96i	0.178i	0.181j	1.84j	1.87h	11.08j	11.29i	63.47g	64.55h
	P	2.04fg	2.09ef	0.200e	0.204f	2.06fg	2.09e	11.75fg	12.00ef	65.50b-e	66.71de
	ASC	2.01gh	2.06fg	0.193f	0.198g	2.02gh	2.05ef	11.56gh	11.83fg	65.21c-f	66.55e
	SA	1.99hi	2.03gh	0.188g	0.192h	2.00h	2.03f	11.42hi	11.65gh	64.80d-g	65.69f
PC	Control	1.94ij	1.98i	0.182h	0.186i	1.89ij	1.91h	11.16ij	11.37i	63.91fg	65.22g
	P	2.16cd	2.21c	0.213c	0.218c	2.18cd	2.22c	12.42cd	12.69c	66.28a-d	67.02cd
	ASC	2.13de	2.17cd	0.207d	0.214d	2.13de	2.19c	12.25de	12.46cd	65.97a-d	67.04cd
	SA	2.09ef	2.13de	0.205d	0.210e	2.09ef	2.14d	12.02ef	12.23de	65.60a-e	66.92de
AC	Control	1.96ij	2.00hi	0.185gh	0.188i	1.93i	1.97g	11.27ij	11.48hi	64.33efg	65.27fg
	P	2.25a	2.30a	0.227a	0.233a	2.29a	2.35a	12.96a	13.21a	67.08a	68.25a
	ASC	2.22ab	2.27ab	0.222b	0.228b	2.26ab	2.30b	12.75ab	13.03ab	66.78ab	67.66b
	SA	2.20bc	2.25b	0.217c	0.220c	2.23bc	2.29b	12.65bc	12.96b	66.43abc	67.43bc
LSD at 5%		0.05	0.04	0.004	0.003	0.05	0.04	0.29	0.25	1.53	0.45

See footnote of Table3.

3- Soil Properties.

Post-harvest soil analysis (Table 6 and Figs1) illustrated that studied salt soil properties *i.e.* available nutrients content (N, P and K, mg kg^{-1}) pronouncedly differed as a result of studied treatments.

The values of available N, P and K in the soil after harvesting generally increase over that before barley sowing as shown in the materials section (Table 1) may be due to the influence of roots activity, which relatively affects on pH value of soil, therefore increases of these elements availability.

Soil addition of different studied organic manures clearly increased available N, P and K in soil, where the highest values were recorded with AC followed by PC then FYM, while the lowest values of available N, P and K in the soil were realized with untreated soil. This may be due to the decomposition of organic manures (FYM, PC and AC) which supplied more available N, P and K in the soil and the formation of organic and inorganic acids during decomposition process which slightly reduced the soil pH affected the solubility and availability of N, P and K.

Table 6. Individual effect of soil addition of studied organic manures and foliar application of some stimulants on some available nutrients values of soil after harvest during two seasons of 2017/2018 and 2018/2019.

Treatments	N, $mgkg^{-1}$		P, $mgkg^{-1}$		K, $mgkg^{-1}$	
	1st	2nd	1st	2nd	1st	2nd
Organic fertilization						
Control (without)	62.56d	67.32d	6.71d	7.69d	274.72d	279.91d
FYM	64.60c	69.66c	8.72c	10.10c	299.62c	307.11c
PC	66.58b	71.39b	9.74b	11.13b	319.57b	324.71b
AC	69.29a	74.94a	11.76a	13.46a	365.84a	372.99a
LSD $_{at\ 5\%}$	1.20	0.53	0.12	0.04	0.59	0.28
Foliar application						
Control (without)	66.40a	71.18a	9.72a	11.21a	323.09a	327.75a
P	65.08c	70.49a	8.74d	9.96d	307.06d	313.05d
ASC	65.53bc	70.85a	9.07c	10.47c	312.17c	320.08c
SA	66.01ab	70.80a	9.40b	10.74b	317.44b	323.84b
LSD $_{at\ 5\%}$	0.72	n.s	0.09	0.04	1.08	1.24

See footnote of Table3.

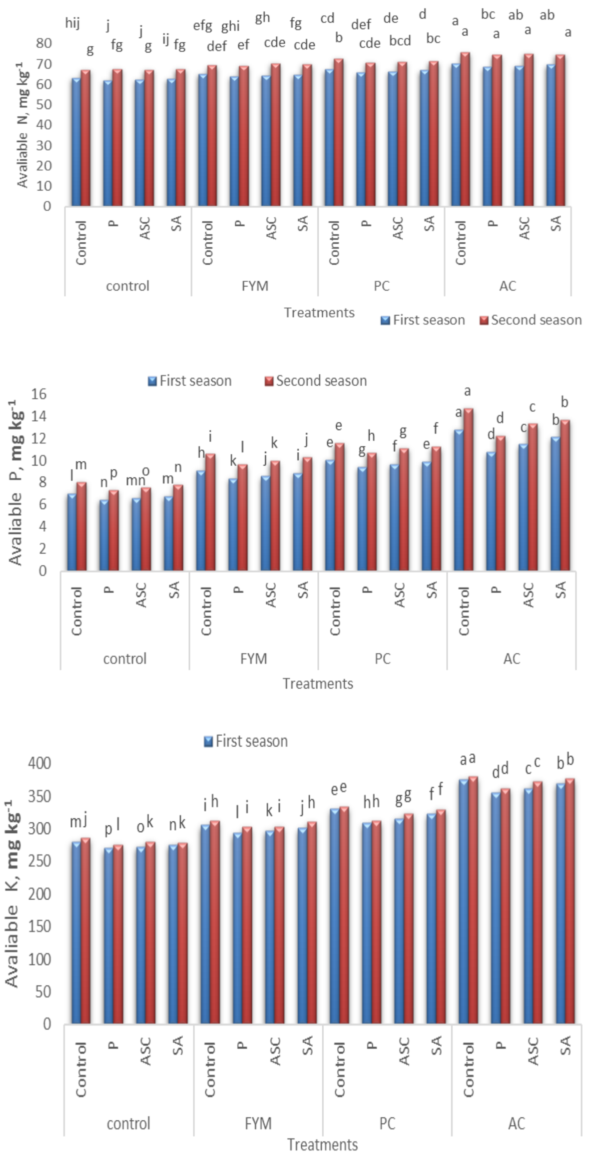

Fig .1. Interaction effect of soil addition of studied organic manures and foliar application of some stimulants on some available nutrients values of soil after harvest during two seasons of 2017/2018 and 2018/2019.

On the other hand, foliar application of stimulants led to a decrease in the values of available N, P and K in the soil after harvesting barley plants due to the role of these stimulants in improving plant status, thus the plants uptake more N, P and K from the soil with foliar application of proline, ascorbic and salicylic acids, respectively more than untreated barley plants (without foliar application). Generally, the values of N, P and K in the soil after harvesting barley plants decreased due to foliar application of studied stimulants.

Similar results were obtained by Saison *et al.* (2006) who reported that compost improved soil fertility and increased soil organic carbon and nutrient availability. The beneficial effect of organic manures also reported by Mohamed *et al.* (2020) who found that compost at rate of 9.5 Mg ha^{-1} improved soil fertility and subsequently wheat production.

CONCLUSION

Findings of the current work confirmed the possibility of alleviating the hazard effects of salt-affected soil on barley plants growth performance, yield and grain quality as well as uptake of some nutrients by soil addition of organic manures and foliar application of some stimulants.

It can be concluded that treating barley plants grown on salt-affected soil by proline as foliar application tree times after sowing (at period of 20, 45, and 60 days from sowing) under soil addition of animal compost at rate of 36 m^3 ha^{-1} is the best treatment that could be recommended to improve performance of barley grown under salinity stress and obtain the highest yield with high quality.

REFERENCES

Amer, M. M. and Hashem, I. M. (2018). Impact of some soil amendments on properties and productivity of salt affected soils at Kafr El-Sheikh governorate. Egyptian Journal of Soil Science, 58(2): 177-191.

Anonymous, (1990). "Official Methods of Analysis of the Association of Official Analytical Chemists". 15th Ed. Vol. 11. Helrich (Ed.) Assoc. off. Ana. Chemists. Inc., Virginia, USA.

Carillo, P and Gibon, Y. (2011). Protocol: extraction and determination of proline. PrometheusWiki.

Chapman, H .D. and Pratt, P.F (1961). "Methods of Analysis for Soil, Plant and Water". Univ., of California, U.S.A.

Conklin, P.L. (2001). Recent advances in the role and biosynthesis of ascorbic acid in plants. Plant Cell Environ. 24, 383–394.

CoStat version 6.303 copyright (1998-2004). CoHort Software 798 Lighthouse Ave. PMB 320, Monterey, CA, 93940, USA.

Daei, G., Ardekani, M. R., Rejali, F., Teimuri, S., & Miransari, M. (2009). Alleviation of salinity stress on wheat yield, yield components, and nutrient uptake using arbuscular mycorrhizal fungi under field conditions. Journal of plant physiology, 166(6): 617-625.

Dewis, J and Feritas. F. (1970). "Physical and Chemical Methods of Soil and Water analysis", FAO, Rome, soil Bulletin, No. 10.

El Moukhtari, A., Cabassa-Hourton, C., Farissi, M and Savouré, A. (2020). How does proline treatment promote salt stress tolerance during crop plant development?. Frontiers in Plant Science, 11, 1127.

El-Hadidi, E.M; Elshebiny, G.M; Ghazi, D.A and El-Bakry, F.A. (2020). Interactive influence of compost, boron and iron on eggplant yield and quality. Plant Archives, (20): pp. 2783-2791.

El-Hammady, A. M., Abo–Hadid, A. F., Selim, S. M., El–Kassas, H. I. and Negm, R. (2003). Production of compost from rice straw using different accelerating amendments. Journal of Environment and Science. Ain Shams University, 6(3): 112-116.

FAO. (2005). Global network on integrated soil management for sustainable use of salt-affected soils. Rome, Italy: FAO Land and Plant Nutr. Manag. Service. http://www.fao.org/ag/agl/agll/spush.

FAO. (2018). FAOSTAT. Food and Agriculture Organization of the United Nations. http://www.fao.org/giews/english/cpfs/index.htm#2018

Gest,N., Gautier, H and Stevens, R (2013). Ascorbate as seen through plant evolution: the rise of a successful molecule. Journal of Experimental Botany 64:33–53.

Gomez,K. A and A.A.Gomez (1984). "Statistical procedures for agricultural research". John Wiley and Sons, Inc., New York.pp:680.

Gunes, A., Inal, A., Alpaslan, M., Eraslan, F., Bagci, E. G and Cicek, N. (2007). Salicylic acid induced changes on some physiological parameters symptomatic for oxidative stress and mineral nutrition in maize (*Zea mays* L.) grown under salinity. Journal of Plant Physiology, 164(6), 728-736.

Heath, R. L and Packer, L. (1968). Photoperoxidation in isolated chloroplast. I. kinetics and stoichiometry of fatty acid peroxidation. Archives of Biochemistry and Biophysics, 125, 189–198.

Hedge, I.E. and Hofreiter, B. T. (1962). "Carboydrate Chemistry i7 (Eds Whistler R.L. and Be Miller, J.N.) Academic Press New York.

Huang, J., Hirji, R., Adam, L., Rozwadowski, K. L., Hammerlindl, J. K., Keller, W. A and Selvaraj, G. (2000). Genetic engineering of glycinebetaine production toward enhancing stress tolerance in plants: metabolic limitations. Plant physiology, 122(3):747-756.

Janusauskaite, D., & Ciuberkis, S. (2010). Effect of different soil tillage and organic fertilizers on winter triticale and spring barley stem base diseases. Crop Protection, 29(8): 802-807.

Khaled, A.S.; Mona, G.A. and Seham, M.E. (2011).Evaluation of organic farm and compost combined with urea fertilizers on fertility and maize productivity in newly reclaimed. Research J. of Agric, and Biol. Sci., 6(5): 388 – 397

Khan, W., Prithiviraj, B and Smith, D. L. (2003). Photosynthetic responses of corn and soybean to foliar application of salicylates. Journal of plant physiology, 160(5): 485-492.

Ko, J., Ng, C. T., Jeong, S., Kim, J. H., Lee, B and Kim, H. Y. (2019).Impacts of regional climate change on barley yield and its geographical variation in South Korea. International Agrophysics 33 (1):81–96. doi: 10.31545/intagr/ 104398.

Lone, M. I., Kueh, J. S. H., Wyn Jones, R. G and Bright, S. W. J. (1987). Influence of proline and glycinebetaine on salt tolerance of cultured barley embryos. Journal of Experimental Botany, 38(3): 479-490.

Marcote, I., Hernández, T., García, C and Polo, A. (2001). Influence of one or two successive annual applications of organic fertilisers on the enzyme activity of a soil under barley cultivation. Bioresource technology, 79(2): 147-154.

Mohamed, G. A., El-Kfarawy, M. M and Elgamal, B. A. (2020). Soil properties, nutrients availability and wheat productivity as affected by compost and nitrogen sources. Journal of Soil Sciences and Agricultural Engineering, 11(1): 35-42.

Olesen, J. E., Hansen, E. M., Askegaard, M and Rasmussen, I. A. (2007). The value of catch crops and organic manures for spring barley in organic arable farming. Field Crops Research, 100(2-3): 168-178.

Ozgur, R., Uzilday, B., Sekmen, A.H and Turkan, I (2013). Reactive oxygen species regulation and antioxidant defence in halophytes. Functional Plant Biology 40:832–847.

Peterburgski, A. V. (1968). “Hand Book of Agronomic Chemistry”. Kolas Publishing House Moscow, (in Russian).

Rekaby, S. A., Awad, M. Y., Hegab, S. A and Eissa, M. A. (2020). Effect of some organic amendments on barley plants under saline condition. Journal of Plant Nutrition, 43(12):1840-1851.

Saison, C., Degrange, V., Oliver, R., Millard, P., Commeaux, C., Montange, D and Le Roux, X. (2006). Alteration and resilience of the soil microbial community following compost amendment: effects of compost level and compost- borne microbial community. Environmental microbiology, 8 (2) : 247-257.

Smirnoff, N. (1996). Botanical briefing: the function and metabolism of ascorbic acid in plants. Annals of botany, 78(6), 661-669.

Thalooth, T., Bahr, A and Tawfik, M. M. (2012).Productivity of some barley cultivars as affected by inoculation under water stress conditions. Elixir Applied Botany 51:10743–9

تأثير الأسمدة العضوية والرش الورقي لبعض المنشطات على نباتات الشعير تحت ظروف ملحية

مها محمود عثمان

قسم بحوث خصوبة الأراضي وتغذية النبات -معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

يعد إجهاد الملوحة أحد أكثر عوامل الإجهاد الغير حيوي ضررًا التي تؤثر على نمو النباتات وإنتاجيتها ووظائفها. لذلك، تم تنفيذ تجربتين حقليتين بهدف تقييم تأثير ثلاثة أنواع من الأسمدة العضوية كمعاملات رئيسية [سماد بلدي (FYM)، وكمبوست نباتي (PC) وكومبوست حيواني (AC)] والرش الورقي بمضادات الأكسدة المختلفة مثل البرولين وحمض الأسكوربيك وحمض الساليسيليك كمعاملات فرعية على أداء نباتات الشعير النامي بتربة ملوحتها قدرها 6.5 ديسيمتز. أظهرت النتائج أن نباتات الشعير التي تم معاملتها بالكمبوست الحيواني حققت أفضل أداء تحت اجهاد ملوحة التربة يليها تلك التي تم تسميدها بالكومبوست النباتي ثم النباتات المعاملة بالسماد البلدي، بينما امتلكت نباتات الشعير الغير معاملة بالأسمدة العضوية أقل أداء. زادت الأسمدة العضوية المدروسة من صلاحية العناصر الغذائية وامتصاصها وعززت تخليق الكلوروفيل في أنسجة النبات وقد يكون هذا هو السبب في زيادة قدرة الشعير على تحمل الملوحة. فيما يتعلق بالرش الورقي للمحفزات، كانت معاملة البرولين هي الأفضل، يليها حمض الأسكوربيك ثم حمض الساليسيليك ومعاملة الكنترول (بدون رش ورقي) كانت في المركز الأخير (بدون رش ورقي). فيما يتعلق بتأثير التداخل، تم تحقيق أعلى القيم لمعايير نمو الشعير وكذلك المحصول ومكوناته عند معاملة النباتات بالكمبوست الحيواني مع رشها بالبرولين، بينما سجلت أقل القيم مع نباتات الشعير الغير معاملة بكل من السماد العضوي ومضادات الأكسدة (كنترول). أيضا ،استخدام الأسمدة العضوية أثر إيجابًا على قيم المغذيات المتاحة بالتربة (النيتروجين والفسفور والبوتاسيوم) وقيم الملوحة.