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Effect of Organic Manure, Antioxidant and Proline on Corn (Zea mays L.) Grown under Saline Conditions

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TWO field experiment using maize were conducted at the Experimental Station of the Agriculture Research Center in Tag El-Ezz, Dakahlia Governorate, Egypt, during the growing seasons of 2016 and 2017. Eighteen treatments were arranged in split-split block design, which were the simple possible combination between three sources of organic manures (control, FYM and chicken manure) as main plots and three sources of antioxidants in foliar way (control, ascorbic acid and salicylic acid) as sub plots and two levels of proline as foliar application (0 , 50 mg l-1) as sub-sub plots. The results indicated that, the highest mean values of vegetative growth (plant height, fresh, dry weight of flag), chemical content of flag leaf (chlorophyll a, b, total, proline), quality (N, P and K % in grain, straw and cobs, fat, ash and protein%), yield and its components (cob length, no. of grain/cob, 100 grain weight, grain yield ton/fed, straw yield ton/fed and cobs yield ton/fed of corn) recorded with using chicken manure. The highest mean values of all parameters under investigation indicated with foliar application of ascorbic acid (100 mg l-1). Using of proline in foliar way (50 mg l-1) increased significantly above parameters over the control. While, moisture, total carbohydrates and fiber of decreased significantly with adding organic manure and the highest values recorded with the untreated plant. As for the interaction effect, using ascorbic acid as antioxidant and proline at the rate of (50 mg l-1) under chicken manure application recorded the highest values of all mentioned parameters.

Keywords: Organic manure, Antioxidant, Proline, Maize.

Introduction

Salt-stress is one of the most prime hindrances in salt affected area of the world for crop production. At present, nearly 6.5% of whole area of the world and around 20% of the cultured land is affected by salinity (Hakim et al., 2014). Salinity changes various physiological and biochemical characteristics which reduce the plant growth and yield production (Munns, 2005). Plant grown at high salt stress in the soil brings about hyperosmolarity, ion disequilibrium, nutrient imbalance and creation of reactive oxygen species (ROS) through molecular damage (Nawaz et al., 2010). The excess gathering of ROS at various abiotic stresses in plants which are extremely reactive and noxious and encourage to damage of carbohydrates, proteins, lipids and DNA which ultimately consequences to oxidative stress (Gill and Tuteja, 2010). Hydrogen peroxide (H_2O_2), produced by salt-stress, is the most stable among all the ROS and reacts with above molecules. Using enzymatic and non-enzymatic antioxidants treatment, these ROS would be managed strategically within a fine influential range (Bose et al., 2013). Moreover, exogenous antioxidant overcomes the low production of growth regulators at stress condition (Ejaz et al., 2012).

Maize (Zea mays) is one of the most versatile emerging cash crops having wider adaptability under varied climatic conditions. Is considered of maize of the most important crops, food grains and industrial important in many areas of the world, comes this crop ranked third in the world after wheat and rice in terms of cultivated area and production, and that the main producing areas of maize in the world are: North and South America, Europe, Russia, China, India and South Africa (Fisher et al., 2015). Plants differ genetically in their response to salt stress (Ahmad et al., 2005). Different mechanisms of salt tolerance by plants have been suggested by Flowers and Hajibagheri (2001). Keeping in view the importance of maize and salinity, present study has been planned

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to examine the role of salicylic, ascorbic acid, proline and organic manure in salt tolerance of maize (Zea mays L.). With the increase in demand from poultry and other feed industries, more area is expected to increased area of hybrid maize in coming years. There is a great possibility to bring saline areas under maize cultivation with proper reclamation and management.

The best means of maintaining soil fertility, productivity and salt tolerance could be through addition of organic manures. Various organic amendments such as farmyard manure (FYM), compost, poultry manure (PM) and mulch can be used for the amelioration of saline soils. Organic amendments improve physical, chemical and biological properties of soils under saline conditions. There are evidences that soil amendments with organic manures reduce the toxic effects of salinity in various plant species (Leithy et al., 2010; Raafat and Thawrat, 2011; Das et al., 2013).

Salicylic acid plays an important role in the regulation of plant growth and development, flowering, fruit yield, seed germination. Ion uptake and transport, photosynthetic rate, stomatal conductance and transpiration (Khan et al., 2003) could also be affected by SA application. Salicylic acid (SA) acts as an endogenous signal molecule responsible for inducing abiotic stress tolerance in plants (Gunes et al., 2007). Salicylic acid is an endogenous growth regulator of phenolic nature, which participates in the regulation of physiological processes in plant (Shakirova et al., 2003). A direct physiological impact of SA is the alteration of antioxidant enzyme activities in vivo. Exogenous application of SA enhances the activities of antioxidant enzymes received much attention due to its role in plant responses to abiotic stresses such as ozone, UV-B, heat stress, drought, oxidative stress (Singh and Usha 2003; Clark et al., 2004), salt and osmotic stress (Khodary, 2004; El-Tayeb, 2005). The review summarized the role of exogenously applied and /or endogenous SA in physiological and biochemical changes that occur in plants under salt stress conditions.

Ascorbic acid (AA) is regarded as one of the most effective growth regulators against biotic stresses (Conklin, 2002). Ascorbic acid not only acts as an antioxidant but the cellular levels of ascorbic acid are correlated with the activation of complex biological defence mechanisms (Conklin & Barth, 2004). It has also been used to counteract the adverse effects of salt stress in many crop plants (Beltagi, 2008). It has proposed functions in whole plant metabolism (Debolt et al., 2007). Furthermore, experimental studies on different plants have shown that exogenous application of AA may reduce salt induced adverse effects and results in a significant increment of growth and yield (Salama, 2009). The importance and changes in ascorbic acid (AA) levels in plant cells in response to varying environmental stress conditions are well established (Venkatesh and Park, 2014). Functionally, it is an essential metabolite which operates as antioxidant and acts as a significant protagonist of several plant species for salt tolerance (Hameed et al., 2012; Ozgur et al., 2013). Actually, it associates with H2O2 metabolism as well as lipid hydroxyl peroxidase and also reacts with various sorts of biotic actions in plant as a patron or receptor in electron transportation system and also as an enzyme co-factor (Conklin, 2002), this approach effectively minimizes the stress impact of salinity and encourage the plant growth. However, exogenous claim of non-enzymatic antioxidant is an imperious suppository for salt sensitive variety.

Plants have defense mechanisms that allow them to acclimatize in saline environment. One of them is the accumulation of certain organic metabolites/osmolytes. These are also collectively known as compatible solutes (Vinocur and Altman, 2005). Proline and quaternary ammonium compounds are key osmolytes, which help plants to maintain the cell turgor (Huang et al., 2000). Proline which is usually considered as an osmoprotection agent is also known to be involved in reducing the oxidative damage by scavenging and/or reducing the free radicals. Proline accumulation was proposed to be associated with tolerance to osmotic and saline stress (Mansour, 2000). Exogenous application of proline is known to induce abiotic stress tolerance in plants (Claussen, 2005; Ashraf and Foolad, 2007). Proline is the most common compatible solute that occurs in a wide variety of plants. Increased levels of proline accumulated in plants correlate with improved salt tolerance (Okuma et al., 2004 and Ashraf and Foolad, 2007).

Therefore, the present study was undertaken to investigate the effect of foliar spray with antioxidants, i.e. ascorbic, salicylic acids and proline on vegetative criteria, some physiological, yield, nutrient uptake and quality of corn plants grown under different forms of organic manure and salinity stress.

Materials and Methods

Two field experiment using maize as a test crop were conducted at the Experimental Station of the Agriculture Research Center in Tag El-Ezz, Dakahlia Governorate, Egypt, during the growing seasons of 2016 and 2017. To investigate the effect of antioxidant as Ascorbic acid (AA) and Salicylic acid (SA) in foliar application and proline on maize plant grown under organic manure of farmyard manure (FYM) and chicken manure (ChK) and saline condition on plant growth, chemical contents, yield and its components. Average soil properties of the experiment for two seasons are presented in Table 1. Eighteen treatments were arranged in split-split block design with three replicates, which were the simple possible combination between three sources of organic manures (control, Farmyard manure and chicken manure) as main plots and three sources of antioxidants in foliar way (control, ascorbic acid and salicylic acid) as sub plots and two levels of proline as foliar application (0, 50 mg l-1) as sub-sub plots. Thus, the total number of the experimental plot was 54 plots. Organic manures were added to the soil before sowing at the rate of 10 m3 fed-1 for each FYM and chicken manure and irrigated up to saturation percentages. Then, plots were left for two weeks to elucidate the damage on seedlings and their roots resulted from the heat of decomposition. Chemical analyses of the organic manures used are presented in Table 2.

Foliar applications of Ascorbic acid at 100 mg l-1 (AA), Salicylic acid at 100 mg l-1 (SA) and proline at 50 mg l-1 were carried out three

TABLE 1. Average physico-chemical properties of the used soil during two seasons of the experiment.

Soil characters		value
Particle size distribution (%)	Coarse sand	3.38
	Fine sand	29.41
	Silt	38.19
	Clay	29.02
	Texture class	Sand clay loam
EC dS m^{-1}*		6.65
pH (1:2.5)**		8.12
S.P (%)		59.5
Organic matter (g 100 g^{-1})		1.19
Total $CaCO_3$ (g 100 g^{-1})		4.15
Ions (meq/100 g soil)	Ca^{++}	1.88
	Mg^{++}	1.27
	Na^{+}	2.98
	K^{+}	0.44
	$CO3^{=}$	-
	$HCO3^{-}$	2.05
	Cl^{-}	2.73
	$SO4^{=}$	1.79
Available nutrients (mg kg^{-1})	N	51.9
	P	4.55
	K	138.4

***soil paste extract** ****soil suspension (1:2.5)**

TABLE 2. Average chemical analysis of the organic manures used for two seasons.

Organic manure properties	Ch. K manure	FYM
E.C dS m^{-1} in 1:10*	3.75	3.98
pH 1:5**	6.05	6.27
O.M %	36.12	32.09
O.C %	21.0	18.66
Total N %	1.42	1.07
C/N	14.8	17.5
Total P %	0.41	0.35
Total K %	0.59	0.48
SP %	93.4	85.6

where: Ch. K: chicken manure, FYM: farmyard manure
*soil extract {1:10} **soil suspension {1:5}

times using hand atomizer and wetting agent after 25, 45 and 65 days from sowing. All other practical agricultural were done according to the recommended by the Ministry of Agriculture and Soil Reclamation (The recommended phosphorus fertilizer rate was 200 kg fed-1 as calcium super phosphate, potassium fertilizer rate was 50 kg fed-1 as potassium sulphate and nitrogen fertilizer rate was 120 N unit as ammonium sulphate).

Sultan hybrid maize was cultivated in the 1st week of May. Sowing was done by dibbling method (by placing 2 seeds manually per hill at 20 cm apart hills) on 75 cm apart ridges. After germination of seeds, one plant per hill was maintained in order to achieve proper plant population. Manual weed control was practiced to keep the field weed free. First irrigation was applied twenty five days after sowing then irrigation was applied every two weeks. After 90 days from sowing; vegetative samples were randomly taken from each experimental plot. Vegetative growth parameters i.e., plant height cm, fresh weight and dry weight of flag as well as chlorophyll and proline concentration were estimated in flag leaves.

At harvesting stage (120 days); representative plant samples were randomly taken from each plot. The plant samples were separated into cobs, grain and straw. The separated parts of the plant were weighed and recorded the following parameters; cobs length, No. of grains/cobs, 100 grain weight, grains ton/fed, straw yield ton/fed and cobs ton/fed. Then, the dried samples of separated parts were stored for chemical analysis of N, P and K (%) in straw, cobs and grains, moisture (%), protein (%), fat (%), ash (%), total carbohydrates (%) and fiber (%).

Soil analysis

The electrical conductivity value, pH value, CaCO3 and organic matter contents were determined according to Sahlemedhin and Taye (2000). Particle size distribution was determined according to the methods of Haluschak, (2006), as for available N, P and K in the soil were determined according to the methods of Reeuwijk, (2002).

Chemical composition

Total N, P and K (%) was determined according to the methods described by Mertens, (2005a, b), Agrilasa, (2002), respectively. Chlorophyll content was estimated as the method described by Gavrilenko and Zigalova (2003), proline was determined according to (Marin et al., 2010). Total carbohydrates (%) (Shumaila and Safdar, 2009), ash, fat and fiber according to (A.O.A.C, 2000), Protein content (%) was calculated by multiplying N percent by the = Nitrogen (%) × 5.75 according to (A.O.A.C, 2000). Data were statistically analyzed according to the technique of analysis variance (ANOVA) and the least significant difference (L.S.D) method was used to compare the deference between the means of treatment values to the methods described by Gomez and Gomez (1984). All statistical analyses were performed using analysis of variance technique by means of CoSTATE Computer Software.

Results And Discussion

Vegetative growth parameters

The results of analysis of variance test in Table 3 showed that the effects of organic manure, foliar application with antioxidant and proline under saline stress as well as their interaction on average values of plant height, fresh and dry weight of flag during two seasons at Table 3. The results at Table 3 indicate that, using of organic manure in the form of chicken manure or FYM under study increased significantly growth parameters over the control. The highest mean values of plant height, fresh and dry weight of flag recorded with using chicken manure at the rate of 10 m3 fed-1 were 229.11, 13.85 and 4.17, respectively following by FYM at the same rate. The increase in plant growth parameters with Ch.K was mainly due to the reason of more concentrated nutrients or minerals were made readily available and easily absorbable by the receiving plants leading to faster growth and development. These results are in accordance with the findings of Tuna et al. (2013), Das et al. (2013) and Shiyam et al. (2017).

In the same Table, the plant height, fresh and dry weight of flag leaf increased significantly by using antioxidant as ascorbic and salicylic acid in foliar way comparing with untreated plant. The highest mean values of plant growth parameters indicated with foliar application of ascorbic acid at the rate of 100 mg l-1, while the lowest one was recorded for the untreated plants. The ascorbic acid induced growth improvement as observed for the maize plant during the present investigation might be due to increased growth may be the implication of ascorbic acid in regulation of cell growth and cell division by influencing the cell cycle (Smirnoff and Wheeler, 2000). These results are in accordance with the findings of Ahmad et al. (2014), Ahmad et al. (2015), Abo-Marzoka et al. (2016) and Billah et al. (2017).

As for the effect of foliar application with proline, data of Table 3 indicated that using proline at the rate of 50 mg l-1 increased significantly parameters of growth over the control which recorded 9.03, 6.23 and 10.54 for plant height, fresh and dry weight of flag leaf, respectively. These results are in agreement with the findings of Ali et al. (2007), Qasim et al. (2007) and Alam et al. (2016). Concerning the effect of interaction among antioxidant, proline and organic manure on plant growth parameters, data at Table 3 indicated that using of the treatments under investigation significantly increased parameters of growth, the highest mean values were realized with using ascorbic acid as antioxidant and proline at the rate of 50 mg l-1 under chicken manure application.

Chemical content

Chlorophyll content and proline concentration in flag leaves

Data present in Table 4 showed the effect of organic manure, antioxidant, proline in foliar way under saline stress condition as well as their interaction on chlorophyll and proline concentration in flag leaves during seasons of 2016 and 2017. Concerning the effect of organic manures data in Table 4 reveal that the mean values of chlorophyll a, b, total and proline in flag leaves were significantly increased due to adding chicken manure or FYM at the rate of 10 m3 fed-1 comparing with the control. The highest mean values of parameters realized with adding chicken manure during two seasons. Chicken manure contains essential nutrient elements associated with high photosynthetic activities (Das et al. 2013).

Regarding the effect of antioxidant as ascorbic and salicylic acid on chlorophyll content and proline in flag leaves, data in Table 4 indicated that the mean values of chlorophyll a, b, total and proline in flag leaves were significantly increased by foliar application of antioxidant as compared to the untreated treatment. The highest mean values of these parameters were realized for the plants treated with ascorbic acid in foliar way followed by salicylic acid and lately the untreated plant. Ascorbic acid can detoxify and neutralize the effect of the reactive oxygen species by prevention of free radicals activity, leading to increase in chlorophyll content of vitamin C treated plants. Also, an application of salicylic acid and vitamin C (ascorbic acid) was effective to mitigate the adverse effect of abiotic stress on plant growth due to increased leaf area and improved chlorophyll a, b and total chlorophyll contents. These results are in agreement with Ahmad et al. (2014), Ahmad et al. (2015), Abo-Marzoka et al. (2016) and Billah et al. (2017).

As shown from data in Table 4, it can be observed that the average values of chlorophyll a, b, total and proline in flag leaves sprayed with proline were higher than the untreated plant. This trend was true during the two seasons. These results suggest that the increase in photosynthesis was primarily due to increase in stomatal conductance which caused higher CO2 diffusion inside the leaf thus favoring higher photosynthetic rate (Sharkey et al. 2007). Thus, foliar applied proline enhanced the photosynthetic capacity of both maize cultivars under water stress conditions. There are

TABLE 3. Average values of plant growth parameters as affected with organic manure, antioxidant and proline as well as their interaction under saline condition during two seasons of 2016 and 2017.

Treatments			Plant height cm	Fresh weight of flag leaf g	Dry weight of flag leaf g
Organic fertilization					
Without			190.94	12.24	3.39
Ch. K			229.11	13.85	4.17
FYM			224.17	13.63	4.06
LSD at 5%			**2.17**	**0.05**	**0.06**
Antioxidant					
0			208.61	12.98	3.74
Ascorbic acid			221.72	13.52	4.00
Salicylic acid			213.89	13.22	3.87
LSD at 5%			**1.96**	**0.04**	**0.04**
Proline application					
0			204.25	12.80	3.65
Proline			224.52	13.65	4.08
LSD at 5%			**1.99**	**0.05**	**0.04**
Interactions					
With-out	**0**	**0**	181.67	11.79	3.19
		Proline	192.33	12.34	3.42
	Ascorbic acid	**0**	189.33	12.15	3.35
		Proline	201.33	12.66	3.58
	Salicylic acid	**0**	184.00	11.98	3.27
		Proline	197.00	12.50	3.51
Ch. K	**0**	**0**	213.33	13.19	3.84
		Proline	230.67	13.97	4.23
	Ascorbic acid	**0**	224.33	13.62	4.05
		Proline	249.00	14.66	4.58
	Salicylic acid	**0**	216.67	13.35	3.91
		Proline	240.67	14.32	4.40
FYM	**0**	**0**	204.67	12.84	3.66
		Proline	229.00	13.77	4.13
	Ascorbic acid	**0**	221.67	13.53	3.97
		Proline	244.67	14.48	4.49
	Salicylic acid	**0**	209.00	13.02	3.76
		Proline	236.00	14.15	4.37
LSD at 5%			**5.99**	**0.15**	**0.11**

*Ch. K: chicken manure * FYM: farmyard manure

TABLE 4. Average values of chlorophyll a, b, total and protein in leaves as affected with organic manure, antioxidant and proline as well as their interaction under saline condition during two seasons.

Treatments			Chlorophyll a mg/g FW	Chlorophyll b mg/g FW	Total chlorophyll mg/g FW	Proline mcg/g F.W
Organic fertilization						
Without			0.644	0.453	1.097	7.84
Ch. K			0.750	0.538	1.288	9.97
FYM			0.735	0.526	1.261	9.68
LSD $_{at\ 5\%}$			0.002	0.004	0.004	0.03
Antioxidant						
0			0.694	0.492	1.187	8.84
Ascorbic acid			0.727	0.520	1.247	9.51
Salicylic acid			0.708	0.504	1.212	9.13
LSD $_{at\ 5\%}$			0.003	0.003	0.003	0.02
Proline application						
0			0.681	0.481	1.162	8.57
Proline			0.737	0.528	1.265	9.71
LSD $_{at\ 5\%}$			0.002	0.002	0.003	0.02
Interactions						
With-out	0	0	0.616	0.429	1.045	7.25
		Proline	0.649	0.458	1.107	7.99
	Ascorbic acid	0	0.639	0.447	1.086	7.68
		Proline	0.673	0.477	1.150	8.42
	Salicylic acid	0	0.628	0.439	1.067	7.47
		Proline	0.659	0.466	1.125	8.20
Ch.K	0	0	0.706	0.502	1.208	9.07
		Proline	0.762	0.546	1.308	10.15
	Ascorbic acid	0	0.737	0.527	1.264	9.72
		Proline	0.798	0.581	1.379	10.98
	Salicylic acid	0	0.716	0.510	1.227	9.29
		Proline	0.782	0.564	1.345	10.58
FYM	0	0	0.683	0.483	1.166	8.64
		Proline	0.750	0.537	1.287	9.93
	Ascorbic acid	0	0.726	0.518	1.244	9.50
		Proline	0.788	0.571	1.359	10.75
	Salicylic acid	0	0.693	0.490	1.183	8.86
		Proline	0.772	0.555	1.327	10.37
LSD $_{at\ 5\%}$			0.007	0.006	0.008	0.07

number of reports which show that either stomatal or metabolic impairment is a major limitation to photosynthesis. These results are in agreement with Molazem et al. (2010), Abd El-Samad et al. (2010), Al-Shaheen and Soh (2016) and Alam et al. (2016). The comparison among the means of the various combined treatments of organic manure, foliar application of antioxidant and proline under saline condition as shown in Table 4 reflected a significant effect on chlorophyll a, b, total and proline in flag leaves. The highest values were recorded with chicken manure + ascorbic acid + proline during both seasons.

Nitrogen, P and K content in grain, straw and cobs

Table 5 illustrated the mean values of N, P and K % in grain, straw and cobs as affected by organic manures, foliar application of antioxidant and proline as well as their interactions during both seasons of 2016 and 2017. It is clear from the data presented in Table 5, that adding organic manure either chicken manure or FYM significantly gave higher magnitudes of N, P and K % of corn grain, straw and cobs comparing with the untreated plant. Adding chicken manure as organic manure was superior for increasing the aforementioned traits followed by FYM and finally the untreated plants. For example the rate of increases over the untreated plants for N% was accounted to be 27.21, 44.86 and 46.67% for grain, straw and cobs, respectively for chicken manure. This increase in maize hybrid could be due to the reason that compost is generally more concentrated in nutrients and narrow in C:N (Farhad et al. 2011). These results may be attributed to the roles of chicken manures in soil properties which produce humus substances wherein improved the physical and chemical soil properties leading to increasing nutrients release availability, i.e., N, P and K uptake. Moreover, incorporation of organic materials in soils can further increase NPK availability by increasing CO2 forming H2CO3 in the soil solution. In the same connection, it was found that inorganic N. P. & K. fractions were increased due to application of organic amendments such as poultry manures (Aziz et al. 2010; Sarwar et al. 2012; Das et al. 2013).

Table 5 reveals that the effect of antioxidant as foliar application on N, P and K % of grain, straw and cobs during both seasons were significantly increased with sprayed with ascorbic and salicylic acid. The highest mean values of N, P and K % of corn grain, straw and cobs were 1.65, 0.314 and 1.93, respectively for N, P and K in grain. This result may be due to having a better antioxidant system for the effective removal of ROS from plants and maintenance of ion homeostasis (Athar et al., 2008). Similar result recorded by Tuna et al., (2013); Osman et al., (2014) and Berenice et al. (2017). Results in Table 5 show that spraying proline, statistically increased the average mean values of N, P and K% in grain, straw and cobs than those obtained with untreated plants. Thus, exogenous application of proline may be an efficient means of ameliorating the adverse effects of salinity stress on plants as has been observed in the present study (Ali et al. 2007; Qasim et al. 2008; Alam et al. 2016). As for the interaction effect among the previously mentioned parameters data in the same Table also proved that the highest mean values of N, P and K% in grain, straw and cobs were realized for the plants treated with chicken manure + ascorbic acid + proline.

Quality parameters

Data at Table 6 reflected the effect of organic manure, antioxidant and proline under salt affected soil as well as their interaction on moisture, fat, ash, total carbohydrates, fiber and protein% of grains during both seasons of 2016 and 2017. With respect to the effect of organic manure, it can be noticed from the data in Table 6 that the addition of organic manure were significantly affected the parameters under study. Chicken manure at the rate of 10 m3 fed-1 was superior for increasing the average values of fat, ash and protein% as compared to the control, the rate of increase were accounted to be 2.46, 3.47 and 13.00%, respectively. While, moisture, total carbohydrates and fiber decreased significantly with adding organic manure and the highest values recorded with the untreated plant, which recorded 10.77, 78.10 and 6.83 for fat, total carbohydrates and fiber, respectively. The increase in protein might be due to increase in N contents of leaves, which are rapidly converted to protein and during grain development leaf N is transferred to grain for protein production. Also, improvement of these parameters may be due to the slow and continuous supply of both micro and macro nutrients, which might have helped in the assimilation of carbohydrates. These results are in conformity with the finding of Nagavani and Subbian (2014).

Regarding the effect of foliar application with antioxidant, data in the Table 6. Showed that; the average values of quality parameters significantly

TABLE 5. Average values of N, P and K% in grain, straw and cobs as affected with organic manure, antioxidant and proline as well as their interaction under saline condition during two seasons.

Treatments Grain Straw			N content (%)			P content (%)			K content (%)		
			Cobs	Grain	Straw	Cobs	Grain	Straw	Cobs		
Organic fertilization											
Without			1.36	1.07	0.75	0.265	0.108	0.089	1.30	0.95	0.61
Ch. K			1.73	1.55	1.10	0.326	0.146	0.119	2.11	1.27	0.89
FYM			1.68	1.48	1.05	0.318	0.141	0.115	2.00	1.22	0.85
LSD $_{at\ 5\%}$			**0.01**	**0.03**	**0.04**	**0.004**	**0.006**	**0.002**	**0.03**	**0.01**	**0.03**
Antioxidant											
0			1.54	1.29	0.91	0.293	0.126	0.103	1.68	1.09	0.74
Ascorbic acid			1.65	1.45	1.03	0.314	0.138	0.113	1.93	1.20	0.83
Salicylic acid			1.59	1.36	0.96	0.302	0.131	0.107	1.79	1.14	0.77
LSD $_{at\ 5\%}$			**0.01**	**0.03**	**0.03**	**0.004**	**0.006**	**0.003**	**0.03**	**0.03**	**0.02**
Proline application											
0			1.49	1.23	0.86	0.286	0.121	0.099	1.58	1.05	0.70
Proline			1.69	1.49	1.06	0.319	0.142	0.116	2.00	1.23	0.86
LSD $_{at\ 5\%}$			**0.01**	**0.02**	**0.01**	**0.002**	**0.002**	**0.003**	**0.02**	**0.03**	**0.02**
Interactions											
With-out	**0**	**0**	1.26	0.93	0.66	0.247	0.098	0.081	1.09	0.86	0.53
		Proline	1.39	1.09	0.76	0.268	0.110	0.090	1.34	0.97	0.62
	Ascorbic acid	**0**	1.34	1.03	0.73	0.262	0.105	0.086	1.26	0.93	0.59
		Proline	1.46	1.21	0.84	0.281	0.117	0.097	1.51	1.04	0.68
	Salicylic acid	**0**	1.30	0.98	0.69	0.255	0.102	0.083	1.17	0.90	0.55
		Proline	1.43	1.15	0.80	0.276	0.113	0.095	1.43	0.99	0.66
Ch.K	**0**	**0**	1.58	1.34	0.94	0.299	0.129	0.106	1.77	1.13	0.77
		Proline	1.77	1.59	1.12	0.331	0.150	0.122	2.19	1.29	0.91
	Ascorbic acid	**0**	1.69	1.49	1.05	0.320	0.141	0.116	2.02	1.22	0.85
		Proline	1.91	1.77	1.29	0.356	0.166	0.134	2.45	1.43	1.04
	Salicylic acid	**0**	1.62	1.40	0.97	0.305	0.133	0.110	1.85	1.16	0.79
		Proline	1.84	1.69	1.21	0.344	0.157	0.127	2.36	1.37	0.97
FYM	**0**	**0**	1.50	1.25	0.87	0.287	0.121	0.099	1.60	1.06	0.71
		Proline	1.73	1.53	1.08	0.326	0.146	0.120	2.11	1.25	0.89
	Ascorbic acid	**0**	1.65	1.45	1.02	0.313	0.138	0.114	1.93	1.20	0.82
		Proline	1.87	1.72	1.26	0.350	0.162	0.130	2.38	1.39	1.01
	Salicylic acid	**0**	1.54	1.29	0.91	0.294	0.126	0.102	1.68	1.09	0.73
		Proline	1.80	1.64	1.17	0.338	0.153	0.125	2.27	1.33	0.94
LSD $_{at\ 5\%}$			**0.01**	**0.05**	**0.04**	**0.006**	**0.007**	**0.008**	**0.06**	**0.08**	**0.06**

TABLE 6. Average values of quality parameters as affected with organic manure, antioxidant and proline as well as their interaction under saline condition during two seasons

Treatments			Moisture (%)	Fat (%)	Ash (%)	Total carbohydrates (%)	Fiber (%)	Protein (%)
Organic fertilization								
Without			10.77	1.19	2.11	78.10	6.83	9.87
Ch. K			9.00	2.46	3.47	75.11	5.44	13.00
FYM			9.24	2.28	3.29	75.46	5.63	12.59
LSD at 5%			0.05	0.03	0.03	0.04	0.04	0.02
Antioxidant								
0			9.95	1.78	2.75	76.69	6.18	11.25
Ascorbic acid			9.37	2.18	3.19	75.76	5.72	12.40
Salicylic acid			9.70	1.96	2.94	76.22	5.99	11.81
LSD at 5%			0.03	0.02	0.02	0.04	0.03	0.05
Proline application								
0			10.16	1.63	2.58	77.07	6.35	10.87
Proline			9.21	2.30	3.30	75.44	5.61	12.72
LSD at 5%			0.02	0.02	0.02	0.02	0.02	0.04
Interactions								
With-out	0	0	11.27	0.87	1.76	78.85	7.25	9.18
		Proline	10.66	1.25	2.18	77.92	6.73	9.93
	Ascorbic acid	0	10.85	1.12	2.04	78.31	6.87	9.54
		Proline	10.29	1.51	2.46	77.32	6.45	10.81
	Salicylic acid	0	11.06	0.99	1.90	78.58	7.06	9.35
		Proline	10.47	1.38	2.32	77.63	6.59	10.40
Ch.K	0	0	9.75	1.92	2.89	76.37	6.02	11.64
		Proline	8.85	2.57	3.58	74.85	5.32	13.09
	Ascorbic acid	0	9.20	2.31	3.31	75.46	5.60	12.27
		Proline	8.15	3.05	4.12	73.70	4.76	15.02
	Salicylic acid	0	9.56	2.06	3.04	76.05	5.87	11.85
		Proline	8.49	2.84	3.87	74.22	5.05	14.12
FYM	0	0	10.12	1.64	2.61	76.99	6.31	10.98
		Proline	9.03	2.43	3.45	75.16	5.46	12.69
	Ascorbic acid	0	9.38	2.18	3.17	75.77	5.74	12.06
		Proline	8.32	2.93	4.01	73.99	4.90	14.68
	Salicylic acid	0	9.93	1.77	2.75	76.69	6.17	11.45
		Proline	8.66	2.71	3.73	74.17	5.19	13.70
LSD at 5%			0.05	0.06	0.06	0.05	0.06	0.13

affected with the foliar application with ascorbic and salicylic acid comparing with the untreated plant. The highest values of fat, ash and protein% were recorded for the plants treated with ascorbic acid, while the average values of moisture, total carbohydrates and fiber were connected with the untreated plants. Similar resulted were obtained by Osman et al. (2014), Farjam et al. (2015), Chattha et al. (2015) and Berenice et al. (2017). Moreover, Azza et al. (2011) stated that the promoting effect of ascorbic acid on total carbohydrates may be due to their important role of biosynthesis of chlorophyll molecules which in turn affected total carbohydrates content.

As shown in this investigation a reduction effect was happened on the average vales of moisture, carbohydrate and fiber% in corn grain due to an addition of proline by foliar way. While an increased was happened with the foliar application on the average values of fat, ash and protien% compared with the untreated plants. These results are in agreement with the findings of Abd El-Samad et al., (2010); Al-Shaheen and Soh (2016). Statistical analysis of the data in Table 6 revealed the average values of quality parameters as affected by the combination between the various treatments under investigation. It could be observed that; a positive effect was happened on the mean values of all quality parameters mentioned due to using the combination between the studied parameters. In this respect, the highest values; (3.05, 4.12 and 15.02 % for fat, ash and protein, respectively) were obtained for the treatment of chicken manure addition + ascorbic acid and proline, while the highest values of moisture, total carbohydrates and fiber was recorded for the untreated plant.

Yield and its components

Data illustrated in Table 7 reflect the effect of organic manure, foliar application treatments of antioxidant and proline as well as their interaction on yield and its components during two seasons of the experiments. Data in Table 7, indicated that an addition of organic manures significantly increased the average values of cob length, no. of grain/cob, 100 grain weight, grain yield ton/fed, straw yield ton/fed and cobs yield ton/fed of corn over the untreated plants. In addition, the highest mean values for the previously mentioned traits were connected with the treatment of 10 m3 fed-1 from chicken manure which recorded 21.38, 493.67, 33.91, 3.55, 4.81 and 0.589 for cob length, no. of grain/cob, 100 grain weight, grain ton/fed, straw ton/fed and cobs ton/fed of corn, respectively. The increase in yield and its components in case of 10 m3 fed-1 Ch. K was mainly due to the reason of more availability of nutrients from PM throughout the growing season. The increase due to Ch. K due to more nutrients were released, could be realized from mineralized rapidly for plant uptake and utilization. It could also be attributed increased microbial activities which favor yield increases as reported by Enujeke et al., (2013). These results are similar to the findings of Farhad et al. (2009), Das et al. (2013) and Shiyam et al. (2017).

Concerning the effect of antioxidant sources under study, data of the same Table, also revealed that, exposure of corn plants under the sources of antioxidant such as ascorbic and salicylic acid significantly increased the mean values of traits during the experiment. In this respect, the rates of increases for the most suitable treatment were accounted to be 9.80, 3.91, 5.09, 7.21, 5.19 and 6.99 % for cob length, no. of grain/cob, 100 grain weight, grain yield ton/fed, straw yield ton/fed and cobs yield ton/fed, respectively comparing with the control. This positive effect of salicylic and ascorbic acids on yield components could be attributed to its role as a cofactor for enzymes involved in photosynthesis, hormone biosynthesis, and the regeneration of antioxidants (Yaghoubian et al. 2014; Tuna et al. 2013; Ahmad et al. 2014; Chattha et al. 2015).

According to the data illustrated in the same Table it is evident that foliarly applied of proline on maize plant at the rate of 50 mg l-1significantly increased the average mean values of yield and its components. Comparing with the control the rate of increases for traits, respectively were accounted to be 17.21, 5.93, 8.50, 11.94, 8.76 and 11.03 for cob length, no. of grain/cob, 100 grain weight, grain ton/fed, straw ton/fed and cobs ton/fed of corn, respectively (Alam et al. 2016; Al-Shaheen and Soh 2016).

The different comparison between the average mean values of yield and its components as affected by the combination between organic manure, antioxidant and proline under saline condition in this investigation are presented in Table 7. Data clearly showed that; a stimulation effect on the average values of such traits of maize plant due to an addition of treatments as compared to the untreated plants. it can be observed that the most suitable treatment, which achieved the highest mean values of traits was connected with the plants treated with chicken manure + ascorbic acid + proline, while the lowest one was associated with the treatment of untreated plants.

Conclusion

From the above discussion, it may be concluded

TABLE 7. Average values of yield and its components as affected with organic manure, antioxidant and proline as well as their interaction under saline condition during two seasons.

Treatments			Cob length (cm)	No. of grain/cob	100 grain weight	Grain (ton/fed)	Straw (ton/fed)	Cobs (ton/fed)
Organic fertilization								
Without			15.67	441.89	28.75	2.88	4.10	0.477
Ch. K			21.38	493.67	33.91	3.55	4.81	0.589
FYM			20.67	486.50	33.19	3.45	4.70	0.574
LSD $_{at 5\%}$			0.46	3.22	0.64	0.04	0.03	0.009
Antioxidant								
0			18.36	465.83	31.22	3.19	4.43	0.529
Ascorbic acid			20.16	484.06	32.81	3.42	4.66	0.566
Salicylic acid			19.20	472.17	31.82	3.27	4.52	0.544
LSD $_{at 5\%}$			0.50	2.61	0.46	0.03	0.04	0.005
Proline application								
0			17.66	459.79	30.59	3.10	4.34	0.517
Proline			20.70	487.07	33.19	3.47	4.72	0.574
LSD $_{at 5\%}$			0.34	2.36	0.37	0.02	0.02	0.004
Interactions								
With-out	0	0	14.27	428.33	27.50	2.71	3.92	0.448
		Proline	15.87	446.00	29.07	2.92	4.13	0.482
	Ascorbic acid	0	15.47	442.00	28.43	2.86	4.07	0.472
		Proline	17.07	454.67	30.10	3.05	4.27	0.506
	Salicylic acid	0	14.83	432.67	27.90	2.78	3.98	0.458
		Proline	16.50	447.67	29.50	2.98	4.22	0.496
Ch.K	0	0	18.87	474.00	31.83	3.25	4.51	0.544
		Proline	22.10	495.00	34.13	3.60	4.85	0.598
	Ascorbic acid	0	20.83	485.67	33.33	3.44	4.72	0.576
		Proline	23.90	523.33	36.50	3.96	5.18	0.645
	Salicylic acid	0	19.40	476.00	32.40	3.31	4.57	0.556
		Proline	23.20	508.00	35.23	3.74	5.03	0.616
FYM	0	0	17.63	461.33	30.93	3.12	4.35	0.519
		Proline	21.43	490.33	33.87	3.53	4.78	0.585
	Ascorbic acid	0	20.17	482.33	32.83	3.37	4.63	0.567
		Proline	23.50	516.33	35.67	3.83	5.10	0.629
	Salicylic acid	0	18.50	466.33	31.20	3.18	4.42	0.533
		Proline	22.77	502.33	34.67	3.66	4.92	0.608
LS, D $_{at 5\%}$			1.03	7.08	1.11	0.07	0.07	0.011

that addition of chicken manure as organic source, ascorbic acid as antioxidant and proline in foliar way will improve growth, chemical content, quality, yield and its components of maize plant.

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