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RESEARCH PAPER

Impact of Ascorbic acid and Potassium on Okra (*Abelmoschus esculentus*) Growth in Saline Condition

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A B S T R A C T:

Salinity regards as one of the abiotic stress factors affect that effect the growth and development of the plant. In present investigation the combination effect of ascorbic acid and potassium has been studies on okra growth under salt stress condition. The study conducted in factorial experiment of three replications in Completely Randomized Designed replicated three times. Three levels of potassium (K) (0,200, 400 ppm) applied to the soil. Three levels of foliar application of ascorbic acid (ASA) (0, 100, 200ppm). Irrigated with three levels of NaCl (0,100,200 µS). Parameters were recorded plant height (cm), number of leaves per plant, leaf area (cm^2), water content (%), chlorophyll content, protein and proline content of leaves, mineral content; nitrogen, phosphorus, calcium, potassium, and sodium. The results elucidate that combination impact of ascorbic acid and potassium significantly the tolerance of okra plant to salinity due to an increase in height of plant, number of leaves, shoot water content, protein and proline content of leaves, and mineral contents such as nitrogen and sodium content of leaves under salt stress conditions.

KEY WORDS: Potassium; Ascorbic acid; Okra; Salt stress;
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1. INTRODUCTION

Okra *Abelmoschus esculentus* is a herbaceous annual tall, warming season vegetables grows in all types of soil, known as lady's fingers in many countries (Singh *et al.*, 2014).Okra plant belong to malvaceae family, it's a large family many important plant belong to it. It's planting as a crop in late spring this crop takes three to four months to complete its cycle, needs well drained soil, used as fresh fruit vegetables (Tong, 2016). Okra plant is important economical vegetable known in the world, its seeds the main source of protein and oil, and use in production of oil (Gemede *et al.*, 2015).

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Its fibrous fruit contains white seeds, which grow in warm weather and tolerant drought soil. Okra is the main source of vitamins A, B, C, minerals such as potassium, calcium, fiber, protein, carbohydrates, as well as low in cholesterol, fats and sodium chloride (Singh, 2014) (Tiwari and Ahmad, 2018).

Potassium is one the main important nutrients for plant growth beside nitrogen (Kumar *et al.*, 2006). It's play an important role in many physiological and biochemical roles in plant like; potassium increased protein production, photosynthesis, chlorophyll synthesis, formation of carbohydrates, transfer of energy, movement of stomata, resistance to stress, transport of nutrition in plant, its important in production of (ATP), and activating of several enzymes in plant processes (

Mathiyazhagan, 2015). Potassium survives the plants against salt stress, the deficient potassium level in soil led to decrease the photosynthetic process rate.(Wang *et al*, 2013). (Alrawi and Aljumail, 2018) showed that foliar application of Potassium increased plant height, leaves area. plant^{-1}, chlorophyll content and final yield. (Al.meida *et al.*, 2015) reported that potassium increased number of leaves, height and grain yields.

Ascorbic acid (Vitamin C) is one of the main antioxidant in plant; regulate many physiological processes, surviving environmental stress, controlling growth and development, (Hossain *et al.*, 2018); growth of cell wall and expansion of cell, transport function and production of other plant hormones like ethylene Pre-treatments of plants with ascorbic acid increased significantly height of plant, leaves number, and branches number, stem diameter, shoot fresh and dry weight (Aboohanah, 2016). (Al- Atrushy and Abdul-qader, 2016) showed that Ascorbic acid increased significantly all vegetative characters like leaf area dry weight of leaves, fresh weight, and also (Rashid, 2018) showed that ascorbic acid significantly increased yield in different cultivars of *Vicia faba* plants. Ascorbic acid used in pharmaceutical industry which added as antioxidants to juices and foods (Qader *et al.*, 2019).

Salt stress is a biotic stress condition due to accumulation high level of salt in soil it make difficult to plant to absorb water, and other ions which destroy the balance of water (Wang *et al.*, 2013). Salt stress due to inhibition of important nutrients like potassium which decrease germination of seed, length of shoot and root (Mittal *et al.*, 2018). As well as it effect on plant growth and development, which effect on photosynthesis, water relations, synthesis of proteins (Parida and Das, 2005). The harsh effect of salinity on plant growth makes increasing the okra tolerance to salt stress through applying potassium as soil fertilizer and ascorbic acid to the leaves an important objective of the study.

2. MATERIALS AND METHODS

2.1. Preparation of soil

Twenty seven plastic pots each pot with a diameter of 24 cm in length and 21 cm in depth, each pot loaded up with 7kg of sandy loam dried soil, the soil sieved through 2mm pore size sieves. Some physical and chemical properties of the soil were estimated (table 1). Three seeds of Okra (variety Clemson which take from college of agriculture) were sown in each pot and afterward thinned to one plant later. Fertilizers at the rate of 10kg.donm^{-1} which included urea containing %45 N, super phosphate P_2O_5 containing 45% P, added to the pots as solutions (Muhummed, 2004). Three levels of potassium(K0,K2,K3); 0,200,400 ppm applied to the soil. Three levels of foliar application of ascorbic acid (ASA0, ASA1 and ASA2); 0,100,200 ppm. Irrigated with three levels of salt (NaCl0, NaCl 1, NaCl 2);0,100,200 µS, this study done during April 20, 2019 to July 23, 2019.

Table 1: Some physical and chemical properties of the soil

Properties	value
Sand	70.10 %
Silt	24.22 %
Clay	5.68 %
Soil texture (sieve method) (Kapur and Govil, 2004)	Sandy loam
Soil moisture (Manual method) (Kapur and Govil, 2004)	3.1 %
Organic matter(Walkley and Blacks rapid titration method) (Kapur and Govil, 2004)	0.91 %
PH	7.24
$CaCO_3$ (Trimetric method)	25.7%
Electrical conductivity (ds m^{-1} at 25°C)	0.58
Total nitrogen % (kjeldahl method)	400ppm

Total phosphorus ppm(Olsen method)	118 ppm
Total potassium ppm (flame photometer)	45 ppm
Total calcium ppm (atomic absorption method)	240 ppm

2.2. Experimental parameters

2.2.1. Growth parameters

Plant height(cm).plant^{-1}, leaves number.plant^{-1}, shoot dry weight plant^{-1}, shoot water content (g.plant^{-1}): fresh weight of shoot system dried at 110 °C for 1 hours and afterward dried at 70 °C for 24 hours, in an oven. Dry weight of shoot system obtained for thirty minutes after cooled at room temperature (He et al., 2005).

2.2.2. Biochemical characters of leaves

2.2.2.1. Chlorophyll content

Chlorophyll content in leaves was estimated by chlorophyll meter by clipping the sensor on different locations on leaf surface except the veins (Padilla *et al.*, 2015).

2.2.2.2. Proline content of leaves (µg.g^{-1} fresh weight)

Proline was estimated according to the method as described by (Bates et *al.*, 1973 and Hassan, 2011)**.**

2.2.2.3. Mineral content of leaves

The total nitrogen (mg.g $^{-1}$) in dry weight of leaves was determined by kejeldahl method as described by A.O.A.C, (2010). The total phosphorus (mg.g $^{-1}$) was estimated, using spectrophotometer method as portrayed by Ryan *et al.*, (2001). The total potassium and sodium are determined by flame photometer methods as investigated by Allen (1974).

2.3. Statistical Analysis

The study conducted in factorial experiment of three treatments in complete randomized design replicated three times. Three levels pf potassium; 0,200,400 ppm applied to the soil. Three levels of foliar application of ascorbic acid; 0,100,200 ppm. Irrigated with three levels of NaCl; 0,100,200 µS. All the data were statistically analyzed using Statistical Package for Social Sciences (SPSS version 16 software). For comparison of treatment means at 5% for green house parameters and 1% levels for laboratory parameters using Duncan multiple range test (Al-Rawi and Khalafulla, 1980).

3. RESULTS AND DISCUSSION

3.1. Growth characters

Table (2) shows that soil application of potassium and foliar application of ascorbic acid under salt stress significantly ($p \leq 0.05$) increased height of plant at treatment (K_1 ASA_1 $NaCl_1$) its value (19.16) after 15 days from application, and also increased significantly number of leaves at treatment (K_2 ASA_2 $NaCl_2$) its value (2.66) after 15 days from application and at treatment (K_2 ASA_1 $NaCl_1$) its value (4.66) after 45 days from application as compared with controls (Table 3). Interaction effect of potassium and ascorbic acid significantly increased water content of shoot system at treatment (K_2 ASA_2NaCl_2) its value (3.90) as compared with their control (Figure 1). As well as there were significant difference between treatments. The results partially agreed with obtained by (Alrawi and Aljumail, 2018) and (Raza *et al*, 2013), that potassium and ascorbic acid increased vegetative growth under salt stress, and also found that ASA increased plant height, number of leaves, leaf area in okra plant under salt stress condition. Potassium responsible to cell elongation and cell division due to producing pressure in cells, accumulation of potassium in cells make osmotic stress in cells which increased plant production (Mengel and Kirkby, 2001). (Almeida *et al.*, 2015) found potassium increased the number of leaves that potassium increased transportation of nutrients, increasing photosynthesis, and also its role influence in hormonal balance in plants like axuin. ASA have roles in more processes like cell elongation, photosynthesis, resistance to environmental stresses such as salt stress .The negative and positive influence of salinity of plants rely on numerous factors like concentration, types, span of salinity and types of plants (Abdelgawad *et al.*, 2019). ASA have a good role in plant metabolism and stresses of plant (El- Bassiouny and Sadak, 2015). (Mittal *et al.*, 2018) showed that salinity because of the aggregation of ions Na^+, Cl^- which caused inhibition of uptake of main nutrients such K^+, application of ASA significantly increased plant growth, due to increasing cell division in apical meristem.

Table 2: Interaction effects of potassium (K) and Ascorbic acid (ASA) on plant height at different growth stages under saline condition

Treatment combinations	Plant height (cm) at different growth stages			
K ASA NaCl	**15 days**	**30 days**	**45 days**	**60 days**
K_0 ASA_0 $NaCl_0$	14.93 ^{b}	16.66 ^{a}	19.33^{a}	23.96 ^{a}
K_0 ASA_1 $NaCl_1$	16.56 ^{b}	17.50 ^{a}	20.50 ^{a}	26.93 ^{a}
K_0 ASA_2 $NaCl_2$	18.50 ^{ab}	19.66 ^{a}	21.00 ^{a}	24.50 ^{a}
K_1 ASA_0 $NaCl_0$	18.16 ^{b}	20.66 ^{a}	23.00 ^{a}	25.36 ^{a}
K_1 ASA_1 $NaCl_1$	19.16 ^{a}	20.00 ^{a}	24.00 ^{a}	28.00 ^{a}
K_1 ASA_2 $NaCl_2$	18.66 ^{ab}	20.50 ^{a}	23.00 ^{a}	27.23 ^{a}
K_2 ASA_0 $NaCl_0$	16.83 ^{b}	17.93 ^{a}	20.33 ^{a}	24.45 ^{a}
K_2 ASA_1 $NaCl_1$	16.45^{ab}	18.83 ^{a}	23.50 ^{a}	26.66 ^{a}
K_2 ASA_2 $NaCl_2$	16.50 ^{ab}	19.00 ^{a}	21.00 ^{a}	25.50 ^{a}

*Data presented as mean, the same letters mean not significantly different, while the different letters mean significant differences $p \leq 0.05$

Table 3: Interaction effects of potassium (K) and Ascorbic acid (ASA) on leaves number plant^{-1} at different growth stages under saline condition

Treatment combinations	Leaves number plant^{-1} at different growth stages			
K ASA NaCl	**15 days**	**30 days**	**45 days**	**60 days**
K_0 ASA_0 $NaCl_0$	2.00 ^{b}	2.33 ^{a}	3.33 ^{ab}	3.66 ^{a}
K_0 ASA_1 $NaCl_1$	2.00 ^{b}	2.33 ^{a}	3.66 ^{ab}	4.00 ^{a}
K_0 ASA_2 $NaCl_2$	2.33 ^{b}	2.66 ^{a}	3.33 ^{ab}	3.33 ^{a}
K_1 ASA_0 $NaCl_0$	2.33 ^{ab}	3.00 ^{a}	4.00 ^{ab}	4.00 ^{a}
K_1 ASA_1 $NaCl_1$	2.00 ^{b}	3.00 ^{a}	4.33 ^{ab}	4.66 ^{a}
K_1 ASA_2 $NaCl_2$	2.00 ^{b}	2.66 ^{a}	3.33 ^{ab}	4.00 ^{a}
K_2 ASA_0 $NaCl_0$	2.00 ^{b}	2.66 ^{a}	3.00 ^{b}	5.00 ^{a}
K_2 ASA_1 $NaCl_1$	2.00 ^{ab}	3.33 ^{a}	4.66 ^{a}	4.33 ^{a}
K_2 ASA_2 $NaCl_2$	2.66 ^{a}	2.66 ^{a}	4.33 ^{ab}	5.00 ^{a}

*Data presented as mean, the same letters mean not significantly different, while the different letters mean significant differences $p \leq 0.05$

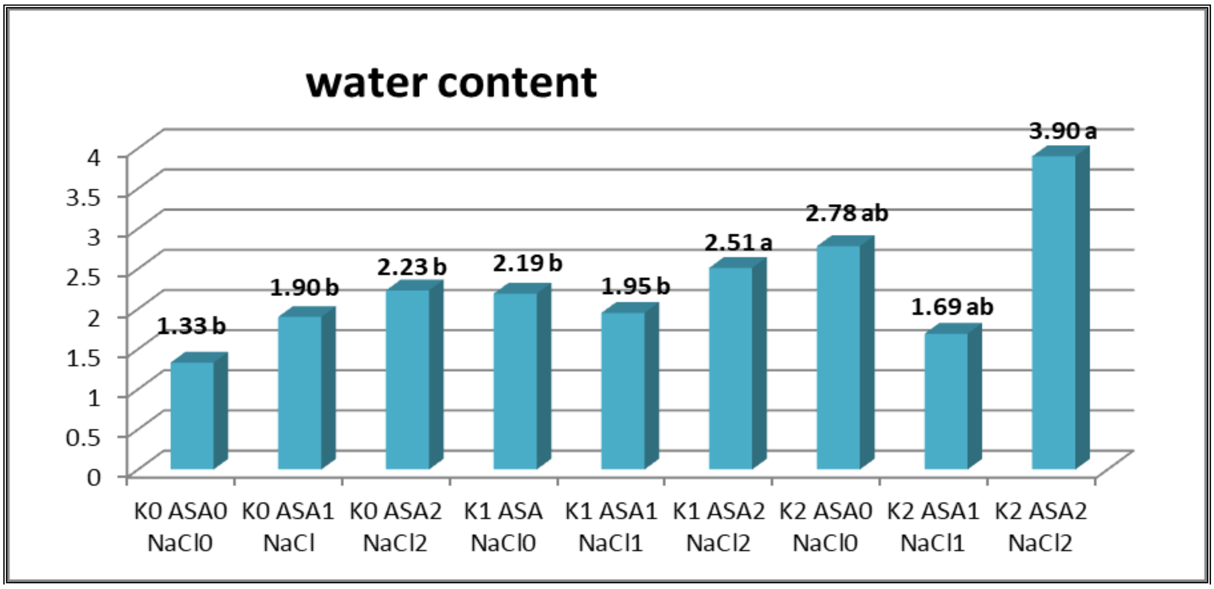

Figure 1: Interaction effects of potassium (K) and Ascorbic acid (ASA) on water content of shoot system at different growth stage under saline condition
*Data presented as mean, the same letters mean not significantly different, while the different letters mean significant differences $p \leq 0.05$

3.2. Biochemical characters

Interaction effect of potassium and foliar application of ascorbic acid increased protein content of leaves at (K_1 ASA_0 NaCl), (K_1 ASA_1 $NaCl_1$), (K_2 ASA_0 $NaCl_0$) as compared with controls, and proline content of leaves at (K_1 ASA_2 $NaCl_2$) under salt stress (table 4). Combination impact of ascorbic acid and potassium significantly ($p \leq 0.01$) increased mineral nutrients such as nitrogen at treatments (K_1 ASA_0 $NaCl_0$), (K_1 ASA_1 $NaCl_1$), and sodium content at treatment (K_2 ASA_2 $NaCl_2$) as compared with control (K_0 ASA_0 $NaCl_0$) (table 5). (Rani and Jose, 2009) reported that potassium application to okra plant significantly increased protein and nutrient uptakes such as nitrogen, phosphorus, potassium. Aboohanah (2016) mentioned that ascorbic acid increased significantly the total chlorophyll and total soluble carbohydrates, ASA provide protect cell, and cell differentiation as well as have many important function in plants antioxidant defense, regulation of photosynthesis, affected in nutritional cycle in higher plants. (Hussein and Kumar, 2014) indicated that interaction effect ascorbic acid as foliar application and salinity stress increased significantly all parameters of growth by their effects on cell division, cell enlargement in millet plant.

Table 4: Interaction effects of potassium (K) and Ascorbic acid (ASA) on chlorophyll, protein, proline content at different growth stage under saline condition

Interaction treatments K ASA NaCl	Chlorophyll at leaf sensor (chlorophyll meter)	Protein (%)	Proline($\mu g.g^{-1}$ fresh weight)
K_0 ASA_0 $NaCl_0$	32.70 [a]	31.11 [a]	8.47 [b]
K_0 ASA_1 $NaCl_1$	35.60 [a]	46.66 [abc]	11.52 [b]
$K_0 ASA_2$ $NaCl_2$	35.90 [a]	29.16 [b]	16.10 [b]
K_1 ASA_0 $NaCl_0$	34.76 [a]	81.66 [ab]	11.69 [b]
K_1 ASA_1 $NaCl_1$	33.86 [a]	93.33 [a]	17.45 [ab]

K $_1$ASA $_2$NaCl$_2$	34.30 [a]	70.70 [abc]	22.30 [a]
K $_2$ASA$_0$ NaCl$_0$	37.30 [a]	32.33 [a]	10.16 [b]
K $_2$ASA$_1$ NaCl$_1$	38.2 [a]	70.74 [abc]	8.13 [b]
K $_2$ASA$_2$ NaCl$_2$	34.96 [a]	40.83 [bc]	15.88 [b]

*Data presented as mean, the same letters mean not significantly different, while the different letters mean significant differences $p \leq 0.01$

Table 5: Interaction effects of potassium (K) and Ascorbic acid (ASA) on some mineral content in leaves at different growth stage under saline condition

Treatment combination	**Mineral contents (mg.g^{-1})**			
K ASA NaCl	**Nitrogen**	**Phosphorus**	**Potassium**	**Sodium**
K$_0$ ASA$_0$ NaCl$_0$	3.11 [c]	7.13 [a]	17.00 [ab]	10.29 [ab]
K$_0$ ASA$_1$ NaCl$_1$	4.66 [c]	8.11 [a]	19.66 [ab]	12.34 [a]
K $_0$ASA$_2$ NaCl$_2$	2.91 [c]	8.60 [a]	16.16 [b]	9.53 [b]
K$_1$ ASA$_0$ NaCl$_0$	8.16 [ab]	7.67 [a]	16.66 [b]	9.15 [b]
K$_1$ ASA$_1$ NaCl$_1$	9.33 [a]	8.38 [a]	20.50 [ab]	11.65 [b]
K $_1$ASA $_2$NaCl$_2$	7.04 [abc]	8.22 [a]	18.83 [ab]	10.59 [ab]
K $_2$ASA$_0$ NaCl$_0$	2.33 [c]	7.78 [a]	19.16 [ab]	12.03 [a]
K $_2$ASA$_1$ NaCl$_1$	7.45 [abc]	8.61 [a]	22.83 [a]	10.52 [ab]
K $_2$ASA$_2$ NaCl$_2$	4.08 [bc]	8.45 [a]	18.33 [ab]	14.38 [a]

*Data presented as mean, the same letters mean not significantly different while the different letters mean significant differences $p \leq 0.01$

4. CONCLUSIONS

The combination of soil application of potassium and foliar application of ascorbic acid has a powerful potential to increase the okra tolerance to salt stress.

5. RECOMMENDATIONS

Conducting more studies regarding ascorbic acid to improve the growth and yield components of okra and other plants, as well as further experiments could be carried under field condition to examine the positive effect of ascorbic acid and potassium on plants. More studies are suggested for alleviating negative effects of salt stress by positive effect of ascorbic acid.

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