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EFFECTS OF DIFFERENT CONCENTRATIONS OF POTASSIUM CHLORIDE ON SOME GROWTH PARAMETERS OF *SOLANUM MELONGENA* L. (EGGPLANT)

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Abstract

This study was aimed to find the effects of various molar concentrations of KCl (0.1M, 0.2M, 0.3M and 0.4M) on some growth parameters of *Solanum melongena* L. (eggplant). The parameters included stem height, leaf length, number of leaves, fresh and dry weight of plant, width of leaf and length of root index were investigated. The plant which is subjected to the highest concentration of KCl drastically effects the plant life cycle as well as productivity of plant. Much of the healthy and strongest plant is formed in control condition as compare to these which received KCl with different concentration. Salinity stress significantly decreased average height of shoot i.e. 30.53cm in control while the least i.e. 10.2cm at 0.4 conc. of KCl. Similarly, average number of leaves i.e. 17.43cm in control while the least i.e. 5.01 at 0.4 conc. of KCl. Likewise average length of leaf i.e. 18.04cm in control while the least i.e. 9.96cm at 0.4 conc. of KCl. Average Fresh and dry weight of plant i.e. 27.96g and 9.12g respectively in control while the least i.e. 7.01g and 2.025g at 0.4 conc. of KCl. Similarly average width of leaf i.e. 7.88cm in control while the least i.e. 3.88cm at 0.4 conc. of KCl. Likewise average length of root i.e. 18.75cm in control while the least i.e. 6.90cm at 0.4 conc. of KCl. These indexes show the same response to different concentration of KCl which means that the concentration and the response of the above indexes are inversely proportional to each other. Greater the concentration of KCl lower will be the response of the above indexes and vice versa. It was concluded that different growth parameters of the eggplant were affected adversely along increased treatments of KCl.

Key words: Potassium chloride, Growth parameters, *Solanum melongena* L. (Eggplant).

Introduction

Eggplant (*Solanum melongena* L.) belongs to family Solanaceae of the dicots. Its importance is based on that it is grown for its fruits which are oval and elongated. This plant is native to India and China and is supposed to be introduced by Arabic traders to Europe and by the traders of Europe to North America. Eggplant is used to treat many ailments which include asthma, arthritis, bronchitis and diabetes. Its extract has reducing effects on live cholesterol and blood pressure rate in humans (Khan, 1979, Jorge *et al*., 1998; Silva *et al*., 1999). It is itself sensitive to several pests and diseases which cause great crop losses (Magioli & Mansur, 2005).

Plant stress is a status in which plant is growing in conditions non-ideal for its normal growth, reducing its productivity hence increases its demand. If the stress exceeds the plant tolerance limits, it can lead to insufficiency in growth, crop yields, permanent damage or death of plant (Zhu, 2007). Due to abiotic stresses productivity of the crops is greatly reduced (Araus *et al.*, 2002). Chilling, severe temperatures, salinity or decrease in water availability, extreme light, reduction of essential nutrient elements in soil are among the common stress factors that plant face (Verslues *et al.*, 2006). In arid and semi-arid regions salinity is one of the major problems in the production of crops worldwide (Ghassemi *et al*., 1995; Hillel, 2000). Similarly osmotic stress is also a major physiological disturbance as it lowers the water potensial in soil (Hu & Schmithaler, 2005). Soil salt solution causes osmotic stress which negatively effect leaf growth, stomatal conductance and to some extent roots growth (Munns, 1993). It makes roots unable to absorb sufficient water; and is chronic for seed germination and seedling growth which are critical for the formation of plant population (Ashraf & Khanum, 1997; Sabir and Ashraf, 2007, Saeed & Ahmad, 2009 & 2013a, b). Germination is lost in radish, cabbage, mustard and water spinach in 8 and 16 $ds.m^{-1}$ treatments of salinity (Sarkar *et al*., 2014). Irrigation with saline water in combination with over fertilization often causes serious problems in Pepper production (Tadesse *et al*., 1999). Decreased in the yield of potato (*Solanum tuberosum* L.) caused by salt stress was due to nutritional imbalance, resulting in the inactivation of enzymes (Ghosh *et al*., 2001). *Solanum Scabrum* (Huckleberry) is more tolerant to salinity than *Solanum melongena* (Assaha *et al*., 2013). Saline stress causes sterility of Rice plants ultimately resulting in losses of yield (Shereen *et al*., 2005). When agricultural crops are irrigated with waste water they show high levels of heavy metals accumulation in comparison to fresh water (Rehman *et al*., 2013). The application of Salicylic acid enhances salinity tolerance in eggplant (Rajeshwari & Bhunvaneshwari, 2017). Inoculation of eggplant seedlings with plant growth promoting rhizobacteria could mitigate the adverse effects of salinity (Bochow *et al*., 2001). Foliar application of selenium improves the tolerance of Eggplant grown under different salt stress condition (Abdul-Saud and Abd-Elrhman, 2015). Growth of plant under salinity stress with foliar practice of ascorbic acid significantly increases germination percentage and seedling growth as contrast to control plants, (Jan *et al*., 2016). Due to high salinity the rate of germination decreases in Aeluropus *lagopoides* and with warmer temperature seed recover quickly with optimum response (Gulzar & Khan, 2001). K^+ and Ca^{2+} high level presence in *Brassica juncea* is affective for promoting growth and productivity under saline condition (Yousaf *et al*., 2015) Salinized soil decrease the yield of rice grain by 30% containing increased amount of protein as compare to the normal soil (Mahmood *et al*., 1999). Foliar practices of Ca2+ significantly mollify the conflicting effects of salinity on plant biomass production morphology, physiology and fruit production (Parvin *et al*., 2015). When tomato plant is treated with well water (45.22%; 99.08% kg/ha) pursue by pond (27.08%; 27.25 kg/ha) flowering and yield decrease (Boamah *et al*., 2011). Silicium supply to tomato increases markedly the lycopene contents irrespective of the salinity status in tomato fruit (Giannakoula & Ilias, 2013). Combine application of Abscisic acid and proline are more effective and help Faba bean to restore the changed physiological process caused by water stress (Ali *et al*., 2013). In *Spartina patens* under salinity lipid of the major membrane remain constant but high NaCl concentration cause decrease in protein to lipid ratio of membrane (Wu *et al*., 2005). The salt stress effect fresh and dry weight of shoot, root weight but however chlorophyll, proline accumulation and relative water content remain unaffected in Walnut (Akca & Samsunlu, 2012). *Vicia sativa* can brook bearable levels of salinity and might be grown on minimal saline environment as a source of forage and nutrients the soil (Akhtar & Hussain, 2009). Physiological and biochemical Feedback under salt stress helps to improve salt resilience of crop species (Chinnusamy *et al*., 2005). Salinity stress enhances production of solasodine (steroidal alkaloid) in *Solanum nigrum* (Bhat *et al*., 2008). The response of *Solanum melongena* to the salinity stress attributed by decrease in total chlorophyll and elevated levels of other stress biomarkers such as proline, Flavonoids, Ascorbic acid (ASC) and Glutathione (GSH) (Shishira *et al*., 2016). Germination rates decrease with an increase in NaCl concentration (Murillo-Amador *et al*., 2002). The negative effect of salinity can be reduce by adding leonardite to salinized soils in which tomato plants growing under greenhouse condition (Casierra-Posada *et al*., 2009). Increasing salt stress 0, 50, 100 and 150 mM NaCl negatively affected growth and development of eggplant (Akinci *et al*., 2004). By applying Si growth and yield of rice plant can be increased in advisable concentration at proper time (Kim *et al*., 2012). Application of phosphorus hinder Na^+ and Cl^- build-up while it boost K^+, P and Ca^{+2} in leaf and root antagonistic effect of salt stress in *Oryza sativa* L. (Naheed *et al*., 2008). Different salt levels affect the growth pramters and biochemistry of eggplant which is very much sensitive to salinity caused osmotic stress (Shaheen *et al*., 2013; Unlukara *et al*., 2010). The current research work was aimed to find the effects of an essential plant nutrients; Potassium from its chloride salts applied in different molar concentrations; on different growth parameters of the eggplant.

Materials and Methods

This experiment was conducted in order to study the effect of salinity on different growth parameters of Eggplant. *Solanum melongena* L. Seeds of Chinese variety were selected. The study was carried out in the Botanical garden of Islamia College, Peshawar from 2017 to 2018. Twenty (20) equal sized pots were filled sand mixed soil and 10 seed were sown in each pot. The seed started germination after 7 days of sowing. The seedlings were watered once a day in equal amount. Thinning was done after 14 days of germination. The experiment was arranged in randomized block design with five clones. Four different concentration of potassium chloride solution was made. For 0.1 M of KCl solution 3.725 gram of salt was dissolved in 500 ml of water. Similarly for 0.2M, 0.3M and 0.4M of KCl solution 7.45, 11.175 and 14.9 grams of salt were dissolved in 500ml of water respectively. When the *Solanum melongena* plants gained an average size of 10cm treatments were applied. The germinated seedlings that were grown under various saline as well as non-saline conditions were observed and various growth parameters of the plant such as height of shoot, number of leaves, size of leaf, fresh and dry weights of plant and length of the root were recorded.

Results

Now we are studying the effect of KCl on various parameter of eggplant. The below data revealed that much of the agronomical parameter of eggplant show negative response to various concentration of KCl. These effects of KCl show different response depend on the condition of plant subjected to these salts in the pots. In table 1 represent the means of plants length at different concentration of KCl, The highest value of plant size are formed in control (which is 16.89cm) plant and the plant which subjected to the various level of KCl have different response. in such case the plant size were inversely proportional to the KCL concentration which means that high the concentration of salt lower well be the plants growth like at 0.1MKCl the plant growth is 15.3cm at 0.2MKCl 14.7cm at 0.3MKCl 12.23cm and at the highest concentration of 0.4MKCl the growth reduced up to 10.2cm after its treatment and vice versa. The same response is also formed in the number of leaves per plant. In such case like in case of 0.1MKCl the average number of leaves are 7.1, 7.8, and 8.3 after interval of 1st 2nd and 3rd treatment, in at 0.2MKCl the leaves are 5.75, 6.82, and 7.15 after 1st, 2nd and 3rd treatment, in at 0.3MKCl concentration the number of leaves are 5.25, 6.2 and 6.85 after interval of 1st 2nd and 3rd treatment. And at the last 0.4 MKCl the number of leaves reach up to 5.01, 5.93and 6.2 after interval of 1st 2nd and 3rd treatment. The data revealed that much of leaves become degenerate due to the toxic effect of KCl which affects the water content of cell. The length of leaves is also affected by salts, and the reduction of length of leaves occur at higher concentration of KCl.

The data are given below in the table 1 which show high differentiation at different concentration. In control plant the length of leaves are 15.21cm, 17.04cm and 18.04cm after interval of 1st 2nd and 3rd treatment. Like other parameter length of leaves also show reduction in length due to high concentration of KCl. In such case the plant which subjected to the highest value of KCl show the lowest length of leaf say 12.12cm, 12.83cm and 13.25cm at 0.1MKCl at 1st 2nd and 3rd and 11.01cm, 11.56cm, and 12.20cm at 0.2MKCl, 10.21cm, 10.96cm and 11.30 cm at 0.3MKCl and the last one at 0.4MKCl the length is reduced up to 9.96cm, 10.50cm and 11.21cm after interval of 1st 2nd and 3rd treatment of KCl. The plant fresh weight and dry weight are represented below in Table 2 which show that, plant effected by stress very drastically. In case of control plant the highest weight are formed but increase in concentration of KCl salt reduced the plant fresh weight and dry weight. The width of leaves is also affected by salts, and the reduction of width of leaves occur at higher concentration of KCl. The data are given below in the table 1 which show high differentiation at different concentration. In control plant the width of leaves is 7.45cm, 8.50 cm and 9.88cm after interval of 1st 2nd and 3rd treatment. Like other parameter such as length, width of leaves also show reduction in high concentration of KCl. In such case the plant which are subjected to the highest value of KCl show the lowest width of leaf say 4.98cm, 6.47cm and 7.01cm at 0.1MKCl, 4.42cm, 5.93cm and 6.85cm at 0.2MKCl, 4.2cm, 5.72cm and 6.2cm at 0.3MKCl and the last one at 0.4MKCl the width is reduced up to 3.8cm, 5.4cm and 5.90cm after interval of 1st 2nd and 3rd treatment of KCl. The length of root is also affected by salt stress very drastically. In case of control plant the highest root length are formed but increase in concentration of KCL salt reduce the length of root. The plant root length is represented below in Table 1.

Table 1. Values of growth parameters of Eggplant (*Solanum melongena* L.) at different concentrations of KCl.

Growth parameters	Control	0.1M KCl	0.2M KCl	0.3M KCl	0.4M KCl
	16.89	15.30	14.70	12.23	10.20
Plant height (cm)	22.27	16.41	14.82	12.84	11.84
	30.53	18.54	17.10	15.10	13.40
Mean	**23.23**	**16.75**	**15.54**	**13.39**	**11.81**
	8.61	7.10	5.75	5.20	5.01
Number of Leaves	13.06	7.63	6.82	6.20	5.93
	17.43	8.30	7.15	6.85	6.20
Mean	**13.03**	**7.68**	**6.57**	**6.08**	**5.71**
	15.21	12.12	11.01	10.21	9.96
Leaf Length (cm)	17.04	12.83	11.56	10.56	10.20
	18.04	13.25	12.20	11.30	10.60
Mean	**16.76**	**12.73**	**11.59**	**10.69**	**10.25**
	7.45	4.98	4.42	4.2	3.8
Leaf Width (cm)	8.5	6.47	5.93	5.72	5.04
	9.88	7.01	6.85	6.2	5.9
Mean	**8.61**	**6.15**	**5.73**	**5.37**	**4.91**
	18.75	13.17	13.27	10.60	6.86
Root length (cm) after harvesting	19.76	14.18	12.32	8.63	7.95
	18.13	15.20	11.17	9.80	5.88
Mean	**18.88**	**14.18**	**12.25**	**9.68**	**6.90**

Table 2. Water content, fresh and dry weights of Eggplant (*Solanum melongena* L.) under different concentrations of KCl

Plant weight (g)	Control	0.1M KCl	0.2M KCl	0.3M KCl	0.4M KCl
Fresh weight	27.96	15.69	13.00	11.59	7.01
Dry weight	9.12	4.05	4.34	2.74	2.03
Water contents	17.88	11.65	8.66	8.86	4.99
Mean	**18.32**	**10.46**	**8.67**	**7.73**	**4.67**

Discussion

In the current study it was find that average height of plant drop off with increase in concentration of KCl. The highest value of plant size are formed in control (which is 16.89cm) and the plant which are subjected to the various level of KCl have different response, in such case the plant size were inversely proportional to the KCl concentration which means that high the concentration of salt lower will be the plants growth like at 0.1MKCl the plant growth is 15.3cm at 0.2MKCl 14.7cm ,0.3MKCl 12.23cm and at the highest concentration of 0.4MKCl the growth reduced up to 10.2cm after its treatment and vice versa. This show correspondence with those of (Solangi *et al*., 2018) who declare that shoot length decreases in rapeseed under high concentration of KCl. This also show correspondence with those of (Adiloglu *et al*., 2007) who reported that plant shoot length decreases in wheat plant with increasing rate of KCl and NaCl. These pronouncement also concur with (Sumera *et al*., 2015) who described acute cutback in shoot length and total biomass under combo of both salinity and root knot infection in *Solanum melongena*. The average number of leaves of a plant decreases with increase in concentration of KCl (Fig. 1). Highest numbers of leaves are formed at the control plant which are 8.61, 13.06, 17.43 at 1st, 2nd and 3rd treatment, and at various concentration of KCl the plant show much reducation in the number of leaves This show correspondence with those of (Adiloglu *et al*., 2007) who described that average number of leaves per plant rise with time, nonetheless when this compared with control number of leaves per plant decreased with increasing concentration of KCl and NaCl (Jafari *et al*., 2009). Saberi *et al*., 2011 also find reduce number of leaves under salinity stress. The length and width of the leaves is also affected by salts, and the reducation of length and width of the leaves occur at higher concentration of KCl (Fig. 1) This show correspondence with Hernandez *et al*., 2003) who described that salt stress hindered the cell division and cell expansion, consequently leaf expansion as a result leaf area is trim. The plant fresh and dry weights are also affected by KCl stress very drastically. In case of control plant the highest weight are formed but increase concentration of KCl salt reduced the plant fresh and dry weight (Table 1). This show agreement with those of (Solangi *et al*., 2018) who reported that the mean value of shoot fresh and dry weight of all rapeseed varieties were reducing under increased KCl concentration. This also show correspondence with those of (Adiloglu *et al*., 2007) who described that average fresh and dry weight decreases in wheat plant with increasing rate of NaCl and KCl. The length of root is also affected by KCl stress very drastically. In case of control plant the highest root length are formed but increase in concentration of KCl salt reduce the length of root (Fig. 1). This show correspondence with those of (Solangi *et al*., 2018) who described that under higher concentration of KCl the root length of rapeseed considerably got reduce. The highest root length was achieved in control (5.2cm), root length reduce under salinity concentration. This also show correspondence with those of (Mustafa *et al*., 2016) who reported that plant height, root length, root and shoot fresh and dry weights, leaf water potential (Ψw), and leaf osmotic potential got reduce with salt stress.

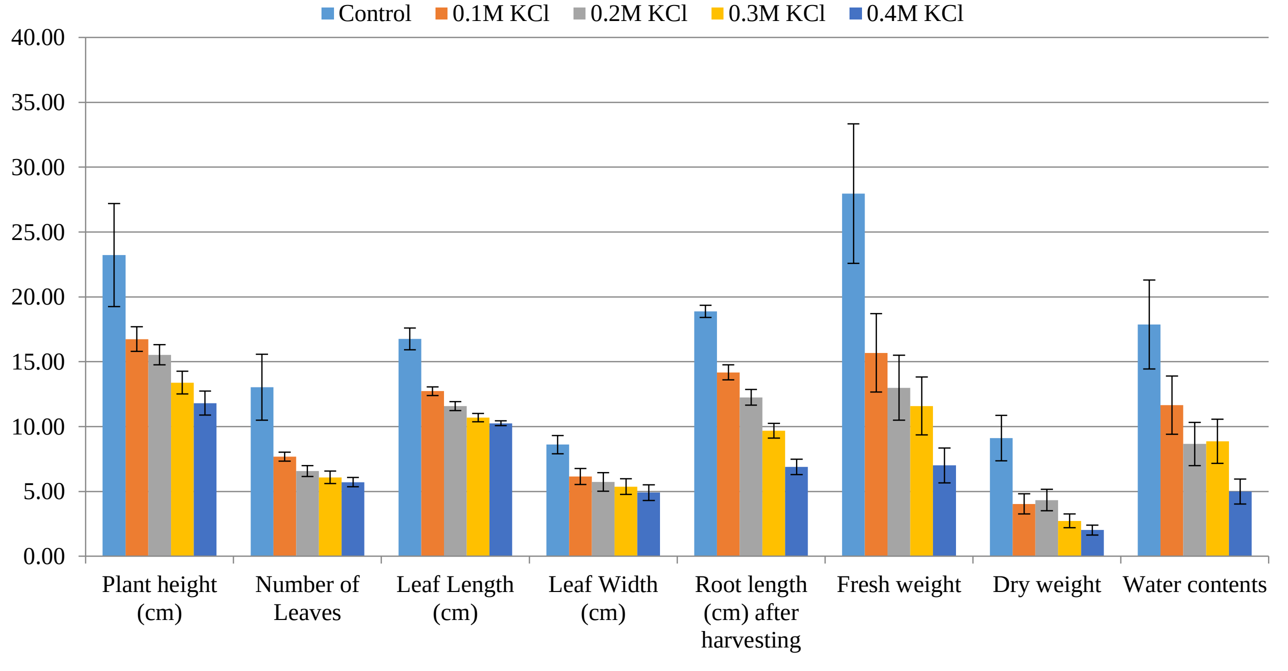

Fig. 1. Effects of different concentrations of KCl on the studied growth parameters of Eggplant (*Solanum melongena* L.) (Error bars denoting the standard error).

Conclusion

Now from the above data we conclude that KCl affects all of the agronomical and other chemical characters of the plant eggplant variously under different concentrations. In such cases the plants are subjected to high concentrations of KCl which drastically effect the plant life cycle as well as productivity of plant. Much of the healthy and strongest plant is formed in control condition as compared to those which received different concentrations of KCl. The plant size, number of leaves, length of leaf, width of leaf, root length and plant fresh weight and dry weight showed the same response to different concentration of KCl which meant that the concentrations and the responses for the above parameters are inversely proportional to each other. Greater the concentration of KCl lower will be the response of the above parameter and vice versa.

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