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Response of Strawberry *(Fragaria x ananassa)* cultivars to salinity-A mini Review

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Abstract

Salinity is one of the major environmental stress which acts as a limiting factors apparently limiting the plant growth, development and productivity of the plants. Salinity is widespread or prevalent in the inundated and dry regions. Plant responses to salinity depend on the extent of revelation to salinity circumstances. Salt stress has been reported to bring severe damage to the vital physiological processes in plant and limit the minerals and nutrient uptake. Strawberry (Fragaria x ananassa) is known to be salt-sensitive crop thus various studies have been conducted to observe the responses of strawberry varieties or cultivars to the salinity. This review is a brief compilation of reaction of strawberry varieties to the stress given by salt, showing different levels of properties. It discusses about how salinity influences the growth, ion accumulation, proline content, protein synthesis, stomatal conductance, and relative water content (RWC) etc in the strawberry plants.

Keywords: *Salinity, Strawberry (Fragaria x ananassa), Limiting factor, Ion accumulation, Stomatal conductance, Relative water content (RWC)*

Introduction

Strawberry (*Fragaria x ananassa)* is a nutritional fruit crop which belongs to family Rosaceae. It is a soft fruit crop and mostly cultivated throughout the world. Strawberry is a unique fruit which is an excellent source of vitamin, potassium, fibre, sugars and highly desirable taste and flavor (Sharma, 2004). Originated from France, 98% of fruit is edible in strawberry. According to NHB (2017), Strawberry covers around 9.2 lakh hectare area (73 countries) and the annual production is estimated to be 45.9 lakh in the world. In India, total area under strawberry cultivation is estimated to 1 lakh hectare with an annual production of nearly 5000 million tones.

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India is exporting strawberry fruits to different countries such as Austria, Bangladesh, Germany and Jordan. Taking into consideration, during 2016-17, Haryana ranked no. 1 with a production of 2,010 MTwith an area of 150 Ha following Mizoram, Meghalaya, Maharashtra, Himachal Pradesh, Tamil Nadu, Kerala, Jammu &Kashmir and Madhya Pradesh. Among all these Punjab has an area of 88,560 ha and production of 1,856,920 MT under strawberry respectively.

Salinity of soils and irrigation water serves as a limit to the productivity of the crop and its quality. It is believed that with the impact of salinity area affected includes 20% irrigated land (Rozema and Flowers, 2008). Drought and salinity being major abiotic stresses are one of the major threats to the natural environment and agriculture. These threats are believed to be one of the sources of bringing out byglobal warming and inhabitants growth indirectly(Koyro*et al*.,2011). There are many factors which accounts for soil salinity viz., evapotranspiration, irrigation, compost/fertilizers etc. Inhibition of growth, leaf necrosis, increased rate of senescence, wilting and gradual death of the plant is due to the exorbitant gathering of salts in the rhizosphere.It is believed that if application of Sodium (Na^+) or chloride (Cl^-) is in excessive amounts in the plants then their concentrationin old leaves may ascend to the poisonous levels making damage the plants. Further, if the injury or damage included to the diminished leaf region, at that point it will restrain the streaming of carbon compounds to the meristems and developing zones in leaves.

*Fragaria x ananassa*Duch. is well thought-out to be salt-perceptive crop and the salt stress shows negative effects on the vegetative development and yield of the plant (Garriga*et al.*, 2015). There have been several reports demonstrating the negative effects on the vegetative development &maturity of strawberry (Orsini *et al.,* 2012; Sun *et al.,* 2015). Strawberry (*Fragaria* × *ananassa*Duch.) pursues the common two-stage reaction to salt stress, displaying development concealment well before the leaves give any indications of salt damage (Ehlig and Bernstein, 1958).

Salinity causes changes physiologically and biochemically in the plants leading to the changes in appearance, which depends on the effects of solutes &ions present in the root zone (Greenway & Munns, 1980). These physiological and biochemical changes leads to reduction in turgor, restraining the photosynthesis (Schwarz and Gale, 1981).

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Effect of salinity on growth

Salinity significantly effects the growth of the affected plants. Salinity decreased the dry weight when concentration of salt between 10-16 mol L^{-1} NaCl was given to the strawberry plants. Also, Elsanta strawberry showed reduction in dry weight of leaves, petioles and roots when NaCl with levels of 30 and 60 mol L^{-1} was applied. In a study it was observed that number of runners per plant reduced from 2.4 to 1.4 and from 3.6 to 1.6 in cultivars Fern and Camarosa when salinity with an electrical conductivity of 2.0 $mScm^{-1}$ was given (Pirlak and Esitken 2004). It has been reported that Chandler cultivar of strawberry showed reduction in the leaf number by 64.73% when given 34 mM concentration of NaCl whereas no such reduction was observed in Camarosa when 8.5 mM NaCl was applied (Saied *et al.*, 2005). When a high concentration of NaCl (35 mM) applied to Camarosa, it was reported that the cultivar showed decrease in the dry weight than Oso Grande (Kaya *et al.*, 2006). When a concentration of 60 Mmol L^{-1} NaCl was given to Camarosa cultivar, it developed leaf thickness with an increase in salinity whereas, leaf area per plant decreased by increasing salinity (Rahimi A *et al.,* 2011). It was observed in a study that Kurdistan cultivar showed reduction of 31% and 32% in total dry weight when concentration of 40 mM and 80 mM of NaCl was given (Ghaderi *et al.,* 2018).

Effect of salinity on ion accumulation

Na concentration is believed to be increased, with an increase in salinity in the plants when salt is applied to the above ground part of the plant. Amount of Na and Cl increased with the application of salt whereas, it decreased the quantity of Potassium (K) & Magnesium (Mg) (Turhan and Atilla, 2004). Kaya *et al.,* (2003) have confirmed that concentration of Calcium (Ca) & Potassium (K) decreased in the strawberry plants when elevated NaCl concentration was applied in the plants. In a study conducted by Ferreira *et al.,* (2019) potassium ions K^+increasedin petioles and leaves of strawberry varieties whereas sodium ions (Na^+) remained stable in foliage while augmented in the petioles & roots. This indicated that there was no antagonism between Na^+ (Sodium) and K^+ (Potassium) in strawberry foliage and petioles.

Effect of salinity in proline accumulation

Lutts*et al.*, (1999) in their study narrated that accumulation of proline is an indication of salt injury. Also it was reported that proline has no significant role in the osmotic adjustment in

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strawberry (Zhang and Archbold, 1993) but there was an osmotic defense role of proline against the salt toxicity and a positive association between accretion of proline and Na in leaves was reported having a important role in adjustment of the osmotic pressure under salinity (Chowdhury *et al.,* 1993; Ashraf, 1994; Aziz *et al.,* 1999; Harivandi*et al.,*1982). However, negative relationship between the salinity acceptance and proline accumulation was observed (Pandey & Ganapathy, 1985). Pirlak and Esitken, (2004), suggested that cultivar Fern takes up less level of Na and Cl thereby, accumulating less amount of proline helping in the adjustment of osmotic pressure when compared to the Camarosa cultivar of strawberry. When compared to Camarosa cultivar of strawberry, Albino had higher proline accumulation at salinized and non-salinized treatments. Proline content in Camarosa increased when increase in salinity concentration with 50 mM NaCl was observed (Al-Shorafa, *et. al.,* 2014).

Conclusion

This review briefly discusses the effects and problems of salinity with regard to salt tolerance and ecological performance. It provides the information regarding how salinity affects the growth, ion accumulation and proline content in the strawberry plants. Various studies have been conducted which describes how salinity affects these factors at different levels of concentration in different cultivars of strawberry. It was suggested that with an increase in the levels of salinity, different cultivars of strawberry showed decrease in the dry weight of roots, leaves and petioles. It was also observed that number of runners in the plants also decreased with an increase in salinity concentration. Also with an increase in salinity, Na concentration increased but concentration of K and Mg decreased gradually. It was also observed in some studies that proline contentincreased in the tolerant cultivars of strawberry.

References

Al-Shorafa, W., Mahadeen, A., & Al-Absi, K. (2014). Evaluation for salt stress tolerance in two strawberry cultivars. *American Journal of Agricultural and Biological Sciences*, *9*(3), 334-341.

Ashraf, M. (1994). Organic substances responsible for salt tolerance inEruca sativa. *Biologia Plantarum*, *36*(2), 255-259.

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Aziz, A., Martin-Tanguy, J., & Larher, F. (1999). Salt stress-induced proline accumulation and changes in tyramine and polyamine levels are linked to ionic adjustment in tomato leaf discs. *Plant Science*, *145*(2), 83-91.

Chowdhury, J. B., Jain, S., & Jain, R. K. (1993). Biotechnological approaches for developing salt tolerant field crops. *Journal of Plant Biochemistry and Biotechnology*, *2*(1), 1-7.

Ehlig C.F. & Bernstein L. (1958) Salt tolerance of strawberries. *Proceedings of the American Society for Horticultural Science,72*:198-206.

Garriga, M., Muñoz, C. A., Caligari, P. D., & Retamales, J. B. (2015). Effect of salt stress on genotypes of commercial (Fragaria x ananassa) and Chilean strawberry (F. chiloensis). *Scientia Horticulturae*, *195*, 37-47.

Greenway, H., & Munns, R. (1980). Mechanisms of salt tolerance in nonhalophytes. *Annual review of plant physiology*, *31*(1), 149-190.

Harivandi, M. A., Butler, J. D., & Soltanpour, P. M. (1982). Salt influence on germination and seedling survival of six cool season turfgrass species. *Communications in Soil Science and Plant Analysis*, *13*(7), 519-529.

Kaya, C., Ak, B. E., & Higgs, D. (2003). Response of salt- stressed strawberry plants to supplementary calcium nitrate and/or potassium nitrate. *Journal of Plant Nutrition*, *26*(3), 543-560.

Koyro, H. W., Geissler, N., Seenivasan, R., & Huchzermeyer, B. (2016). Plant stress physiology: physiological and biochemical strategies allowing plants/crops to thrive under ionic stress. In *Handbook of Plant and Crop Stress* (pp. 1047-1089). CRC Press.

Lutts, S., Majerus, V., & Kinet, J. M. (1999). NaCl effects on proline metabolism in rice (Oryza sativa) seedlings. *Physiologia Plantarum*, *105*(3), 450-458.

Orsini, F., Alnayef, M., Bona, S., Maggio, A., & Gianquinto, G. (2012). Low stomatal density and reduced transpiration facilitate strawberry adaptation to salinity. *Environmental and Experimental Botany*, *81*, 1-10.

Pandey, R., & Ganapathy, P. S. (1985). The proline enigma: NaCl-tolerant and NaCl-sensitive callus lines of Cicer arietinum. *Plant Science*, *40*(1), 13-17.

ISSN:0971-1260
Vol-22-Issue-34-December -2019

Pirlak, L., & Eşitken, A. (2004). Salinity effects on growth, proline and ion accumulation in strawberry plants. *Acta Agriculturae Scandinavica, Section B-Soil & Plant Science*, *54*(3), 189-192.

Asghar, R., Biglarifard, A., Mirdehghan, H., & Borghei, S. F. (2011). Influence of NaCl salinity on growth analysis of strawberry cv. Camarosa. *Journal of Stress Physiology & Biochemistry*, *7*(4).

Rozema, J., & Flowers, T. (2008). Crops for a salinized world. *Science*, *322*(5907), 1478-1480.

Saied, A. S., Keutgen, A. J., & Noga, G. (2005). The influence of NaCl salinity on growth, yield and fruit quality of strawberry cvs.'Elsanta'and 'Korona'. *Scientia Horticulturae*, *103*(3), 289-303.

SCHWARZ, M., & GALE, J. (1981). Maintenance respiration and carbon balance of plants at low levels of sodium chloride salinity. *Journal of Experimental Botany*, 933-941.

Sun, Y., Niu, G., Wallace, R., Masabni, J., & Gu, M. (2015). Relative salt tolerance of seven strawberry cultivars. *Horticulturae*, *1*(1), 27-43.

Turhan, E., & Eris, A. (2005). Effects of sodium chloride applications and different growth media on ionic composition in strawberry plant. *Journal of plant nutrition*, *27*(9), 1653-1665.

Zhang, B., & Archbold, D. D. (1993). Solute accumulation in leaves of a Fragaria chiloensis and a F. virginiana selection responds to water deficit stress. *Journal of the American Society for Horticultural Science*, *118*(2), 280-285.