South Asian Journal of Life Sciences 2 (2): 29 – 32
http://dx.doi.org/10.14737/journal.sajls/2014/2.2.29.32

Research Article

Influence of Sodium Chloride on Growth and Chemical Composition of *Tagetes erecta*

Aqib Sayyed[1*], Humaira Gul [1], Muhammad Hamayun[1], Hasnain Nangyal[2], Imran Fazal[1]

[1]Department of Botany, Abdul Wali Khan University Mardan, Pakistan; [2]Department of Botany, Hazara University, KPK, Pakistan
*Corresponding author: aqib.sayyed@yahoo.com

ARTICLE HISTORY

Received: 2014–11–01
Revised: 2014–12–01
Accepted: 2014–12–04

Key Words: *Tagetes erecta*, Carotenoids, Fresh and dry biomass, Salt stress

ABSTRACT

Salt stress is a biotic stress and affects plant growth, development and productivity throughout the world. A research was conducted to evaluate the inhibitory effects of salt stress on *Tagetes erecta*, a common ornamental and medicinal herbaceous plant. During experiment plants were treated with different concentration of NaCl solution (50 mM, 100 mM, 150 mM and 200 mM). Different growth parameter (plant height, root length, no of leaves, and fresh and dry biomass) and some biochemical aspects (Chlorophyll a, b and carotenoids) were observed under different concentration of salt stress. Results indicated that *Tagetes erecta* is moderately tolerant to salt stress. After two weeks treatment fresh biomass of plant increased significantly ($P<0.001$) in 50 and 100 mM but decreased in 150 mM and 200mMNaCl. Plant height, root length, no of leaves, fresh and dry biomass, Chlorophyll a, b and caroteneoids exhibited reduction under higher concentration of NaCl.

ARTICLE CITATION: Sayyed A, Gul H, Hamayun M, Nangyal H, Fazal I (2014). Influence of sodium chloride on growth and chemical composition of *Tagetes erecta*. S. Asian J. Life Sci. 2 (2): 29 – 32

INTRODUCTION

Plant growth and development is prone to different environmental stresses (Bohnert et al., 1995). A biotic stresses, such as high temperature, and salt stress are major factors which reduce crop productivity (Babu and Devaraj, 2008).Salt stress is a major environmental stress affecting plants growth and development throughout the world (Heidari and Akbari, 2012).Almost 10% of arable land and 24% of irrigated areas are affected by NaCl (Pessarakli and Szabolcs, 1999).

Salt stress affects various physiological and yield contributing characters of the plants (Hossain et al., 2008). It affects seed germination (Taffouo et al., 2009) by creating osmotic potential to prevent water uptake or by providing conditions for the entry of the ions that maybe toxic to embryo or developing seedlings (Almodares et al., 2007). Morphophysiological characters such as plant height, number of leaf, leaf area, yield contributing characters such as number of pods/ plant, number of seeds/ pod, 1000 seeds weight (Hossain et al., 2010) fresh and dry weight, leaves number and area reduce with increasing salinity (Zhani et al., 2012).Chlorophyll is the main pigment responsible for photosynthesis. Under adverse circumstances, the chlorophyll level is a good indicator of the photosynthesis function. It has been found that the chlorophyll level of trees decreases with aggravated salt stress (Rao and Rao, 1986) due to enzymatic chlorophyll degradation (Carter and Cheeseman, 1993; Xu et al., 2000).

Tagetes erecta is a common ornamental and medicinal herbaceous plant commonly known as Marigold belongs to family Asteraceae. *Tagetes erecta* is a small shrub, which grows up to 1–2 m in height (Priyanka et al., 2013) moderately tolerant to salinity because growth is affected when EC of irrigation water exceed to 8 dSm^{-1} (Aguilar et al., 2009). *Tagetes erecta* is important medicinal plant with diverse pharmacological spectrum. Plant shows the presence of many chemical constituents which are responsible for varied pharmacological and medicinal property (Gopi et al., 2012) like anti–bacterial and mosquitocidal and Anti–oxidant (Rhama and Madhavan,2011; Nikkon et al., 2011]. Decoction of the leaves used for dysmenorrhea and upper respiratory tract infection (Balangcod and Balangcod, 2011) and leaf juice is used to treat intestinal worms (Ahirrao and Patil, 2012). The objective of the present study was to evaluate the effect of high salinity on different morphological and physiological character of this plant.

MATERIAL AND METHOD

The research was conducted at Botanical Garden, Department of Botany, Abdul Wali khan University Mardan in 2013. *Tagetes erecta* was selected for this experiment. Sixty plastic pots were used in this experiment having loamy soil and basal outlet for drainage. Sixty pots are divided in to 5 sets having 12 pots / set. These set were treated as control, 50 mM, 100 mM, 150 mM and 200 mM NaCl solutions. Two weeks old uniform size seedlings were transplanted in pots. Plants were irrigated twice a week with tap water/ solution. Concentration of NaCl was gradually increased in irrigation water till it reached to desired salinity of each treatment. Plants harvest was started after 15 days of establishment of seedlings under stress condition. Plants were harvested weekly and no of leaves, dry and fresh weight of leaves, root and stem length, fresh and dry biomass were recorded at

ISSN 2311–0589

each harvest. Chlorophyll a, b and Carotenoids were estimated in plants of both control and treated plants.

Extraction and Estimation of Chlorophyll

The chlorophyll 'a', chlorophyll 'b', total chlorophyll and Carotenoids were measured as per standard method of Maclachlan and Zalik (1963).

Statistical Analysis

All statistical analysis was performed using SPSS v.21.0 (IBM Corp., Armonk, NY, USA).

RESULT AND DISCUSSION

Reduction in shoot growth due to salinity is commonly expressed by a reduced leaf area and stunted shoots (Läuchli, 1990). Plant height severely affected by salt stress (Figure 1). After one week of treatments in 1st harvest plant height exhibited significant (P<0.001) increase in 50 mM NaCl treatment while exhibited significant (P<0.001) decrease in plants treated with 100, and 150 mM NaCl as compare to their respective control. After 2 and 3 weeks of treatment with NaCl plants showed significant reduction (P<0.001) in all salinity treatments as compare to control. da Silva et al., (2008) and Shahid et al.,(2011) also reported that after 15 stress days, young umbu plants and *Abelmoschus esculentus* L. plant height decrease at 75 and 100 mM NaCl.

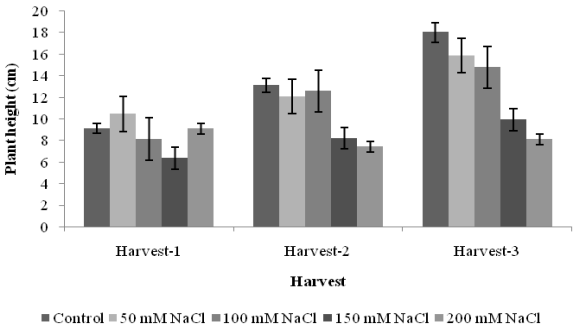

Figure 1: Effect of different concentration of NaCl on plant height (cm) of *Tagetes erecta*

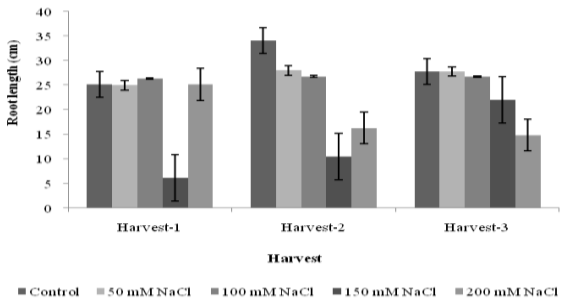

Figure 2

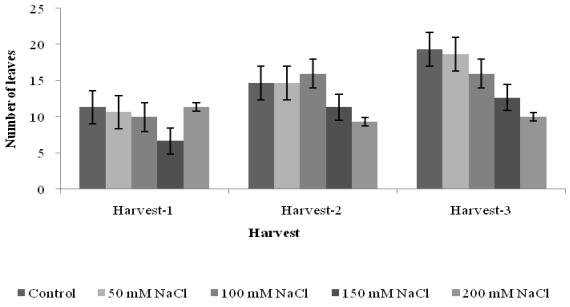

Figure 3

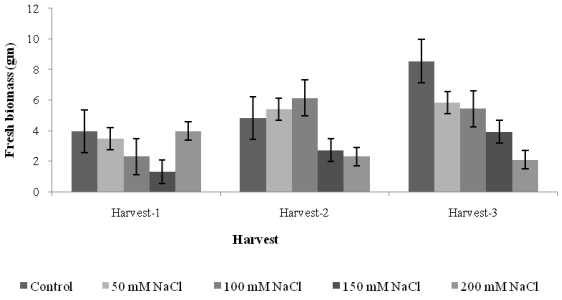

Figure 4

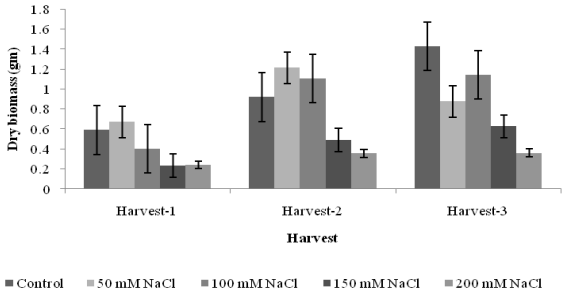

Figure 5

Figure 2: Effect of different concentration of NaCl on root length (cm) of *Tagetes erecta*; Figure 3: Effect of different concentration of NaCl on number of leaves of *Tagetes erecta*; Figure 4: Effect of different concentration of NaCl on fresh biomass (mg) of *Tagetes erecta*; Figure 5: Effect of different concentration of NaCl on dry biomass (mg) of *Tagetes erecta.*

In soil, the root system is the direct injured part, caused by salt and alkaline. Under the adverse conditions root system morphology and physiology showed the adaptive characteristics and behaviors of the plant in effectively absorbing and using nutrients of the soil (Feng et al., 2000). Plants of *Tagetes erecta* when treated with different concentrations of NaCl, it showed significant (P<0.001) reduction in root length in three harvests (Figure 2). West et al., (2004) also reported that the root growth of Arabidopsis was progressively reduced due to increasing concentration of NaCl. Neumann, 1995 indicated that salinity can rapidly inhibit root growth and hence capacity of water uptake and essential mineral nutrition from soil.

After treatment with different concentrations of NaCl no of leaves showed significant (P<0.001) reduction in three harvests (Figure 3). Romero–Aranda et al., (1998) and Dong and Dong (2007) reported that saline environment results in decrease in leaf area and number of leaves. Akram et al., (2010) also observed decrease in number of leaves due to salinity.

One of the initial effects of salt stress on plant is the reduction of growth rate. Fresh and dry biomass of plant exhibited reduction in high salinity (Figure 4 and 5). After

ISSN 2311–0589

Table 1: Effect of different concentrations of NaCl on Chlorophyll a, b and Carotenoids contents of *Tagetes erecta*

Treatment	Chlorophyll–a (mg/gm fr.wt)	Chlorophyll–b (mg/gm fr.wt)	Total Chlorophyll (mg/gm fr.wt)	a/b Ratio	Carotenoids (mg/gm fr.wt)
Control					
Mean	0.555 a	0.260 a	0.815 a	2.152 a	0.206 a
SE	±0.045	±0.028	±0.073	±0.062	±0.031
T1 (50 mMNaCl)					
Mean	0.744 a	0.365 a	1.109 a	2.039 a	0.288 a
SE	±0.042	±0.015	±0.055	±0.067	±0.031
T2(100 mMNaCl)					
Mean	0.534 a	0.295 a	0.829 a	1.841 a	0.238 a
SE	±0.148	±0.088	±0.236	±0.124	±0.079
T3(150 mMNaCl)					
Mean	0.418 a	0.213 a	0.631 a	1.310 a	0.153 a
SE	±0.209	±0.107	±0.316	±0.655	±0.077
LSD $_{0.05}$	0.510	0.27	0.788	1.146	0.238

Means followed by different Letters in the same column differ significantly at 95% probability level according to New Duncan's Multiple Range Test.

two weeks of treatments fresh biomass increased significantly ($P<0.001$) in 50 and 100 mM NaCl treatments while decreased significantly ($P<0.001$) in plants treated with 150, and 200 mM NaCl as compared to their respective control. After 3 weeks of treatment with NaCl, plant showed significant reduction ($P<0.001$) in both fresh and dry biomass in all salinity treatments as compared to control. Munns (2003) stated that reduction in fresh and dry biomass caused by suppression of plant growth under saline conditions may either be due to decreased availability of water or to the toxicity of sodium chloride. Also the reduction in dry weight under salinity stress may be attributed to inhibition of hydrolysis of reserved foods and their translocation to the growing shoots. Salinity stress imposes additional energy requirements on plant cells and less carbon is available for growth and flower primordial initiation (Cheesman, 1988). These findings are in agreement with other reports suggesting that salt stress reduces the biomass of plants of tomato and rice (Kaya et al., 2006). Kaouther et al., (2013) reported that the fresh biomass of *Capsicum frutescens* L. decreased with increasing salinity. Decrease in dry weight of shoot and a leaf was observed with increase in salt stress (Aguilar et al., 2009; Zapryanova and Atanassova, 2009; Kaouther et al., 2013).

Chlorophyll content is considered as one of the parameters of salt tolerance in crop plants (Srivastava et al., 1988). In this observation chlorophyll content of *Tagetes erecta* show non–significant effect under saline condition (Table 1).The contents of chlorophyll a increased in 50 mM NaCl while decreased in 100 mM and 150mMNaCl as compared to their respective control. Plants treated with 50 mM and 100 mM NaCl showed a slight increase in Chlorophyll b and total chlorophyll while reduction was noted in 150 mM NaCl. Chlorophyll a/b ratio was reduced in all treatments. Salinity induced chlorophyll degradation in NaCl sensitive pea cultivar as compared with tolerant one have also been reported earlier (Hernandez et al., 1995).

Decrease in chlorophyll is considered as the indicator of oxidative stress condition (Shaw, 1995).The contents of Carotenoids were increased in 50 mM and 100 mM NaCl while decrease in 150 mM NaCl as compared to their respective control. Our results are in agreement with several reports of decreased content of chlorophyll and carotenoids by salinity as reported in a number of glycophytes (Gadallah, 1999; Agastian et al., 2000).

ACKNOWLEDGEMENT

The authors are thankful to the Department of Botany, Abdul Wali Khan University, Mardan for providing full support, encouragements and necessary facilities for conducting this research.

CONFLICT OF INTEREST

There is no conflict of interest among the authors.

REFERENCES

Agastian P, Kingsley SJ, Vivekanandan M (2000). Effect of salinity on photosynthesis and biochemical characteristics in mulberry genotypes. Photosynthetica. 38: 287 – 290.

Aguilar LAV, Grieve CM, Poss J (2009). Salinity and Alkaline pH in Irrigation Water Affect Marigold Plants: I. Growth and Shoot Dry Weight Partitioning. Hort. science. 44 (6): 1719 – 1725.

Ahirrao YA, Patil DA (2012). Ethnomedicinal claims against stomach complaints in Buldhana district (Maharashtra, India). Life Sci. Leaflets. 1: 16 – 25.

Akram M, Ashraf MY, Ahmad R, Waraich EA, Iqbal J, Mohsan M (2010). Screening for salt tolerance in maize (*Zea mays* L.) hybrids at an early seedling stage. Pak. J. Bot. 42 (1): 141 – 154.

Almodares A, Hadi MR, Dosti B (2007). Effects of salt stress on germination percentage and seedling growth in sweet sorghum cultivars. J. of Bio. Sci. 7(8): 1492 – 1495.

Babu RN, Devaraj VR (2008). High temperature and salt stress response in French bean (*Phaseolus vulgaris*). Aust. J. of Crop Sci. 2 (2): 40 – 48.

Balangcod TD, Balangcod AK (2011). Ethnomedicnal knowledge of plant and healthcare practices among the Kalanguya tribe in Tinoc, Ifugao, Luzon, Philippines. Indian J. of Trad. Knowledge. 10 (2): 227 – 238.

Bohnert H, Nelson DE, Jensen RG (1995). Adaptations to environment stresses. Plant Sci. 7: 1099 – 1111.

Carter DR, Cheeseman JM (1993). The effect of external NaCl on thylakoid stacking in lettuce plants. Plant Cell Environ. 16: 215 – 222.

Cheesman JM (1988). Mechanisms of salinity tolerance in plants. J. Plant Physiol. 87: 547 – 50.

Silva EC, Nogueira RJMC, Araujo FP, Melo NF, Azevedo NAD (2008). Physiological responses to salt stress in young umbu plants. Environ. and Exp. Bot. 63: 147 – 15.

Dong YTJ, Dong S (2007). Stress responses to rapid temperature changes of the juvenile sea cucumber (*Apostichopus japonicas* Selenka). J. Ocean Uni. Chin. 6: 275 – 280.

Feng F, Zhang FS, Yang XQ (2000). Plant Nutriology – Advances and Prospects. Beijing: China Agricultural University Press. 12 – 21.

Gadallah MAA (1999). Effects of proline and glycine betaine on *Vicia faba* in response to salt stress. Biol. Plant. 42: 249 – 257.

Gopi G, Elumalai A, Jayasri P (2012). A concise review on *Tagetes erecta*. Int. J. of Phytopharm. Res. 3 (1): 16 – 19.

Heidari M, Akbari T (2012). Effect of Salinity Stress on Photosynthesis Pigments and Osmotic Components of Two Marigold (*Tagete spatula L.*)

ISSN 2311–0589

Genotypes. Int. Ann. Symposium on Sustainability Sci. and Management. 204 – 209.
Hernandez JA, Olmos E, Corpas FJ, Sevilla F, del Rio LA (1995). Plant Sci. 105: 151 – 167.
Hossain MM, Miah MNA, Rahman MA, Islam MA, Islam MT (2008). Effect of salt stress on growth and yield attributes of Mung bean. Bang. Res. Pub. J. 1(4): 324 – 336.
Kaya C, Tuna L, Higgs D (2006). Effect of silicon on plant growth and mineral nutrition of maize grownunder water– stress condition. J. Plant Nutrition. 29:1469 – 1480.
Kaouther Z, Nina H, Rezwan A, Cherif H (2013). Evaluation of Salt Tolerance (NaCl) in Tunisian Chili Pepper (*Capsicum frutescens* L.) on Growth, Mineral Analysis and Solutes Synthesis. J. of stress phy. and biochem. 9 (1): 209 – 228.
Läuchli A (1990). Calcium, salinity and the plasma membrane. In: Calcium in Plant Growth and Development, R.T. Leonard and P.K. Hepler (Eds.). The American Society of Plant Physiologists Symposium Series. 4: 26 – 35.
Munns R (2003). Comparative physiology of salt and water stress. Plant Cell Environ. 25: 239 – 50.
Neumann PM (1995). Inhibition of root growth by salinity stress: Toxicity or an adaptive biophysical response, In: Baluska F, Ciamporova M, Gasparikova O, Barlow PW (Eds.), Structure and Function of Roots, Kluwer Academic Publishers, The Netherlands. Pp. 299 – 304.
Nikkon F, Habib MR, Saud ZA, Karim MR (2011). *Tagetes erecta* Linn. and its mosquitocidal potency against *Culex quinquefasciatus*. Asian Pacific J. of Tropical Biomedicine. 86 – 188
Pessarakli M, Szabolcs I (1999). Soil Salinity and Sodicity as Particular Plant/Crop Stress Factors. In: Handbook of Plant and Crop Stress, 2nd Edition, Revised and Expanded (M. Pessarakli, Ed.), Marcel Dekker, Inc., New York, 1 – 15.
Priyanka D, Shalini T, Navneet VK (2013). A brief study on Marigold (Tagetes Species): A Review. Int. Res. J. of Pharm. 4 (1): 43 – 48.
Rao GG, Rao GR (1986). Pigment composition and chlorophylase activity in pigment pea and Gingelley under NaCl salinity. Indian J. Exp. Biol. 19: 768 – 770
Romero–Aranda R, Moya JL, Tadeo FR, Legaz F, Primo–Millo E (1998). Physiological and anatomical disturbances induced by chloride salts insensitive and tolerant citrus: beneficial and detrimental effects of cations. Plant Cell Environ. 21: 1243 – 1253.
Rhama S, Madhavan S (2011). Antibacterial Activity of the Flavonoid–patulitrin isolated from the flowers of *Tagetes erecta* L. Int. J. of Pharm. Tech. Res. 3 (3): 1407 – 1409.
Shaw BP (1995). Changes in the levels of photosynthetic pigments in Phaseolus aureus Roxb. exposed to Hg and CD at two stages of development: a comparative study. Bull. Environ. Contam. Toxicol. 55: 574 – 580.
Shahid MA, Pervez MA, Balal RM, Ahmad R, Ayyub CM, Abbas T, Akhtar N (2011). Salt stress effects on some morphological and physiological characteristics of okra (*Abelmoschus esculentus* L.). Soil Environ. 30 (1): 66 – 73.
Srivastava TP, Gupta SC, Lal P, Muralia PN, Kumar A (1988). Effect of salt stress on physiological and biochemical parameters ofwheat. Ann. Arid Zone. 27: 197 – 204.
Taffouo VD, Meguekam L, Kenne M, Magnitsop A, Akoa A, Ourry A (2009). Salt stress effects on germination, plant growth and accumulation of metabolites in five leguminous plants. Afri. Crop Sci. Conference Proceedings. 9: 157 – 161.
West G, Inze D, Beemster GTS (2004). Cell Cycle Modulation in the Response of the Primary Root of Arabidopsis to Salt Stress. Plant Phy. 135: 1050 – 1058.
Xu XM, Ye HC, Li GF (2000). Progress in research of plant tolerance to saline stress (in Chinese). Chin. J. Appl. Environ Biol. 6 (4): 379 – 387.
Zapryanova N, Atanassova B (2009). Effects of salt stress on growth and flowering of ornamental annual species. Biotech. and Biotechnological Equipment. 23 (2): 177 – 179.
Zhani K, Mariem BF, Fardaous M, Cherif H (2012). Impact of salt stress (NaCl) on growth, chlorophyll content and fluorescence of Tunisian cultivars of chili pepper (*Capsicum frutescens* L.). J. of Stress Phys. and Biochem. 8(4): 236 – 252.

ISSN 2311–0589