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SALINE ALKALINE BLACK COTTON SOIL AMENDMENT WITH PEG FOR THE GROWTH OF LYCOPERSICON ESCULENTUM MILL.

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ABSTRACT

Salinity stress has a major impact on plant growth and yield. Salt stress presents an increasing threat to plant agriculture. However, the research efforts are made to provide new insight into the plant responses to salinity and successful amendments for saline soil reclamation with the use of PEG. The effect of PEG at different concentrations was studied on the most popular tomato plant species (Lycopersicon esculentum Mill) of the family Solanaceae. The species of Lycopersicon esculentum Mill were raised in triplicates sets of earthen pots with saline alkaline black cotton soil and compared with a non-saline agricultural soil. All the sets of saline alkaline black cotton soil were treated with PEG concentrations of 10 ppm, 20 ppm, 30 ppm and 40 ppm as an amendment, and the growth parameters studied. The average root length was 17.2 cm in the set treated with 10 ppm concentration of PEG, while in control it was 16.2 cm. Likewise; shoot length was 15.4 cm, while in control set it was 15.3 cm, the chlorophyll a and b in control were 4.38 mg/g and 5.36 mg/g whereas in 10 PEG treatment set these were 4.34 and 5.26 mg/g respectively. The average number of branches was highest (13.6) in the set treated with 10 ppm PEG concentration as compared with the other higher concentrations including control (12.4). The fresh biomass was 15.1 gm per plant in set treated with 10% PEG concentration and 16.5 gm per plant in control. Dry weight in control was 0.58 gm per plant in 10% PEG treated set and was 0.61gm per plant in control set. The lowest overall growth was observed in set treated with 40% PEG concentration after the non survival of seedlings in blank set of saline-alkaline black cotton soil. The results revealed that the saline soil can be reclaimed with PEG, but the higher concentrations of PEG curtail the growth. The PEG at 10% yields better growth in tomato (Lycopersicon esculentum Mill).

Keywords: *Polyethylene Glycol, Seedling growth, Seed germination, Soil reclamation, soil salinity, tomato (Lycopersicon esculentum* Mill.*) Solanaceae;*, growth parameters, vegetable plants.

INTRODUCTION

A wide range of environmental stresses such as drought, salinity, alkalinity, metal toxicity, acidic rain and pathogen infection are harmful to the plants (Kahlaoui *et al.*, 2011; Rahdari and Hoseini 2011). The impact of agro-industrial revolution on the environment may be unparalleled in history of human civilization and the Biosphere in recent period. Indiscriminate and ever-growing use of chemical fertilizers, pesticides, herbicides, non-biodegradable consumer products and wastes, indiscriminate use of energy may not only cause wide spread degradation of natural resources but may also influence our life support system including soil. Soil salinity is one of the serious problems resulting from excess irrigation, excess use of chemical fertilizers, pesticides and poor soil management practices.

Salinity stress has a major impact on plant growth and yield. Salt stress presents an increasing threat to plant agriculture. Increasing concentrations of salt in agricultural soils calls the researchers to reclaim the saline soil by suitable soil amendment or to develop tolerant crops if the global food supply is to be sustained. Adaptation of crop plants to salts involves a complex network of different mechanisms whose responses to high salinity are regulated in an integrated mechanism. Plant growth responds to salinity in either a rapid, osmotic phase that inhibits growth of young leaves or a slower, ionic phase that accelerates senescence of mature leaves or with these both phases simultaneously (Rahdari and Hoseini, 2011). The various sources of soil salinity represent losses of once productive agricultural land into the non-productive barren land. Salinity stress causes negative impacts on agricultural yield throughout the world affecting food production and may lead to food shortages or for subsistence or economic loss.

The plant response to salinity consists of numerous processes which should work in co-ordination to alleviate both cellular hyper-osmolarity and ion disequilibrium. In addition to such functioning, the crop plants must be capable for satisfactory biomass production in a saline soil with yield stability. Tolerance and yield stability are complex genetic traits that are difficult to establish in crops. Because the salt stress can occur as a catastrophic episode, which gets imposed continuously or intermittently, cause damage or become gradually more severe, and at any stage during the plant growth and development. However, new and continuous research efforts may provide new insight into the plant responses to salinity and successful amendments for saline soil reclamation. It also expects identifying genetic determinants that affects salt tolerance.

Soil salinity refers to the build up of the Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_3^- and SO_2^4. There are minerals that are deposited on the surface by evaporating water by over irrigation and excessive evaporation. Soil salinity is caused built up with the process of salinization and sodification. Salinity is a soil condition by high content of soluble salts. The problem of soil salinity is increasing in recent years (FAO, 2000). Soil salinity stresses plants in tow ways: High concentrations of salts in the soil make it harder for roots to extract water from the soil, and high concentrations of salts within the plant can be toxic (Munns and Tester, 2008). Based on the reports of FAO (2005) it is documented that 2% of agriculture land is salt affected (Cheong and Yun, 2007). Nearly 20% of the worlds cultivated area and nearly half of the worlds irrigated lands are affected by the problem of soil salinity.

The soil salinity is of universal concern for the human society as is closely concerned with the food production. Around the world nearly one billion hectors of soil is having some degree of salinization and sodification problem (FAO, 1992). Many scientific studies in the past have compared the effectiveness of various amendments for improving the physical and chemical properties of saline alkaline soil (Amezketa and Aragues, 1995; Hanay, 2004; Khan *et al.*, 2010; Chavan, 2014). The gypsum and sulfuric acid organic received the most attention due to their relative effectiveness and are widely used as reclamation amendments. But, in recent years, crop or cops residues and synthetic polymers have been also studied (Chavan and Pawar, 2011a; Hanay, 2004; Zahow and Amrhein, 1992; Chavan, 2014). The treatment's effectiveness for soil salinity reclamation are studied for different crops, vegetables and other plants to establish the suitable treatment concentration and tolerance levels of these plants for their successful growth and production (Almansouri *et al.*, 2001; Chavan, 2014).

The application of chemical fertilizer to soil in excess makes the soil saltier near the point of application. When the salinity of a soil increases, it causes a change in the soil's osmotic pressure; in turn it forces water in the soil to move from a lower to a higher salt concentration and causes more damage to the plants. Nitrogen and potassium fertilizers have higher ability to cause such effect. So, the salt damage is more likely to cause to the crop plants. When a fertilizer causes a change in the soil's salt content, it comes into direct contact with the plant which can cause a condition known as salt effect or salt burning. When water moves to soil with a higher salt concentration, less moisture is available for the plant to soak up and growth rates are dramatically diminished.

Soil salinity is a major problem caused due to soil salts accumulation on the upper layer of soil that involves and supports the root zone, hence affects the plant growth. High concentration of these complex inorganic salts present in the upper layer of soil with 4-6 inch depth can retard the growth in most of the crop plants depending on the nature of salt present, concentration of salts, the plant growth stages and its salt tolerance or avoidable mechanism of the plant tissue (Ashraf *et al.,* 2002). High concentration of salts causes both hyper osmotic and ionic stress that results in the alteration of plant metabolism including reduced water potentials, ionic imbalances and specific ion toxicity (Cramer *et al.*, 1990; Tester and Devenport, 2003) and modifies the metabolisms of plants as well as it also affects the morphology. Extent of metabolism modification depends upon cultivars, management practices, duration and intensity of stress caused by saline soil and the other properties of soil (Khan *et al.,* 2003b; Munns and James, 2003).

Most of the crops, vegetables and agro-plants tolerate salinity to a threshold level and above which growth and yield reduces with the increase in the salinity (Khan *et al.,* 2006). High salt accumulation in the upper layer of soil that supports the root zone hinders the growth of plant roots from withdrawing water from surrounding soil and lowers the amount of water available to the plant, regardless the amount of water actually available in the root zone. The water is not held tighter to the soil in saline conditions. Such presence of excessive salt concentration in the water or soil leads the plants to exert more energy for extracting water and growth minerals from the soil (Chavan, 2014) and ultimately, may decrease availability water for the crop and cause plant stress.

Scientific researchers working on the plants and the problem of soil salinity have adopted various strategies to mitigate or overcome the problem of soil salinity. One of the important strategies is to exploit genetic variability of the available germplasm to identify a tolerant genotype that can sustain, grow and produce a reasonable yield on salt affected soil (Ashraf *et al.*, 2006; Chavan, 2014).

Screening of large number of genotypes of a crop is necessary to identify the salt tolerance of the germplasm for breeding projects, in the salinity amendment programs or to efforts evolve the salt tolerant and high yielding crop varieties. Such scientific approach involves the understanding of the plant responses to different salt concentrations and impacts at different growth stages under saline or soil amendment conditions as reported in different crops such as maize (Khan *et al.*, 2003 a), wheat (Ali *et al.*, 2002; Khan *et al.*, 2003 b), soybean (Kamal *et al.*, 2003), sorghum (Azhar and Khan, 1997), rice (Shannon et al., 1998), cotton (Azhar and Ahmad, 2000). Such scientific studies provide clues for selecting suitable vegetable and crop plants of social needs and economic importance with improved salt tolerance of saline soils. This is one of the important ways of developing salt tolerant agro-production patters with the use of the already existing varieties (Flowers and Yeo, 1995).

The soils have heterogeneity of physico-chemical properties and seasonal fluctuations in rainfall which make it difficult to screen the suitable plant varieties tolerant to soil salinity conditions in the field. Laboratory scale and bench scale studies can provide better option for such studies. Keeping in view this idea, present investigation was planned to address the problem of soil salinity and amend it with PEG for the cultivation of Tomato *(Lycopersicon esculentum* Mill.*)*.

MATERIAL AND METHODS:

A. Description of Study Region:

Solapur is a city situated on Deccan plateau on the south-eastern border of Maharashtra State near to State Boundary of Karnataka (Fig. 1). It is the fourth largest district in Maharashtra in terms of land area; ultimately the agriculture is major occupation in the district. Solapur city is seventh largest in terms of population in the State of Maharashtra.

The Solapur region and district has scanty and no uniform rains resulting in water scarcity conditions in the entire district (Table 1). Due to scanty and non uniform rains scarcity conditions prevail in the district, which have adversely affected the socio-economic conditions of the people. Geographic information of the study region in brief is as below;

Latitude : 17.10” to 18.32” N

Longitude: 74.42” to 76.15” E

Elevation : 460 t0 480 M above MSL

Area : 180.33 sq. km.

Major Water bodies:

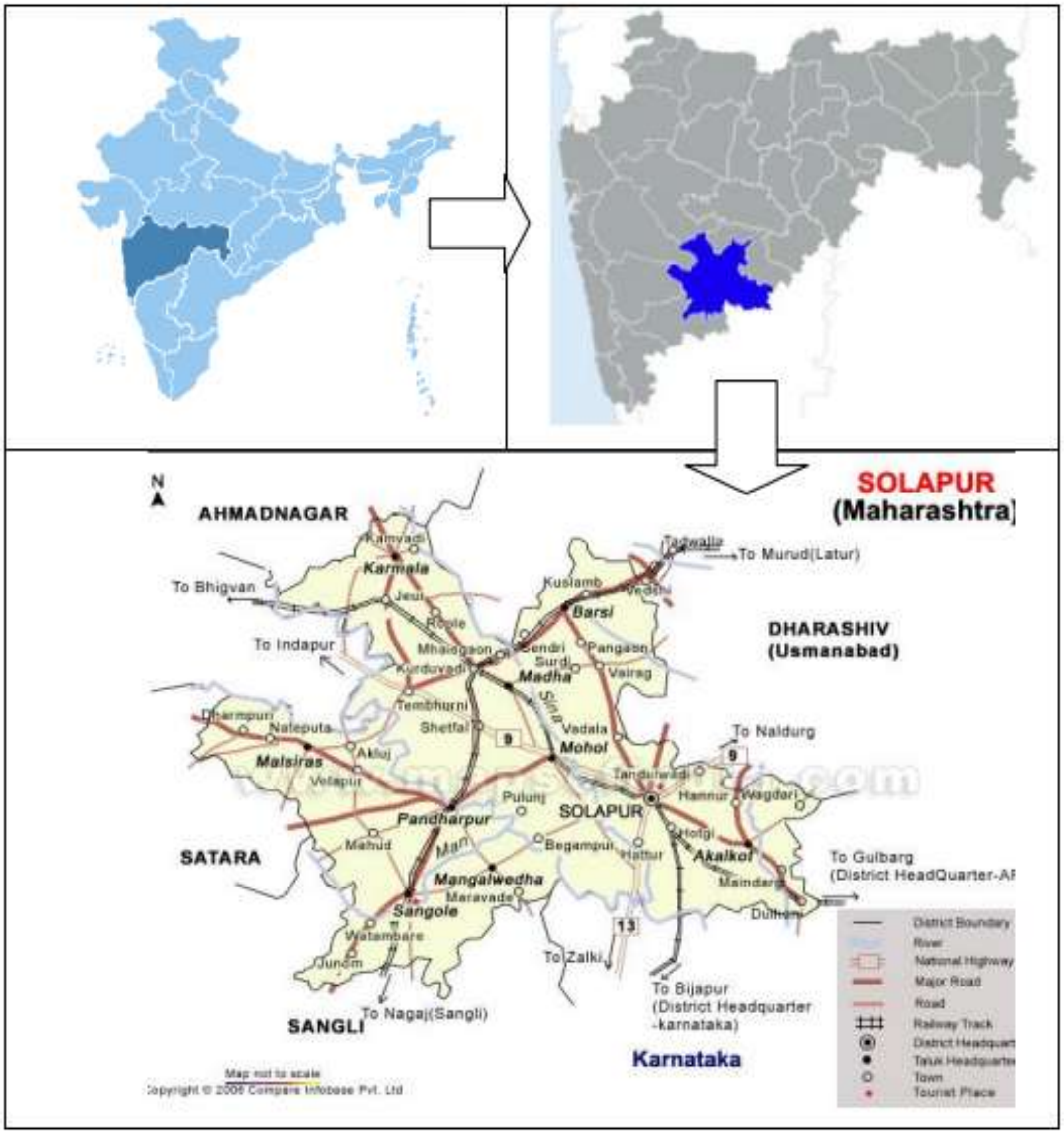
Siddheshwar Lake, Sambhaji Lake

Geography: Flat terrain undulating where the low table land and small hills acting as a watershed between Sina and Bhima rivers.

Climate of Study region: Solapur District falls under the category of dry (arid and semiarid) climate according to the Koppen Climate Classification (1936) and experiences three distinct seasons; Summer, Monsoon and Winter. Typical summer months are from March to May, with maximum temperatures ranging from 30 to 40°C (86 to 104°F) with the warmest months April and May. The city often receives locally developed heavy thundershowers in May. The city of Solapur receives an average rainfall of 554 mm per year (Fig. 2) with uneven distribution in its tahsils (Table 1). The monsoon lasts from June to end of September, with moderate rainfall.

The major rivers of the district are the Bhima, its right-bank feeders the Nira and the Man and its left-bank feeder the Sina. Besides, a number of lesser streams form the tributaries of the Bhima serve as its local feeders. During the peak of south-west monsoon season, not only the main streams but also the seasonal feeder streams are flooded, though for a short span of time providing excess water for irrigation.

In order to face the water scarcity situations in non-monsoon period, the Ujani dam is built to provide water to the draught prone areas and hence, total agricultural area of about 296107 hectares is under irrigation in the district from various sources for the cultivation of cash crops including sugarcane which requires the use of application of heavy doses of chemical fertilizers to the soils under cultivation, ultimately suffers or is prone to suffer the problem of soil salinity.



Source: Solapur City Sanitation, Final Draft, 2011.

Fig. 1: Location map of Solapur city and District.

Table 1: Tahsil wise mean rainfall (mm) and variability of rainfall of Solapur District in the period of 2000 to 2010

Year	North Solapur	South Solapur	Akal-kot	Barshi	Pandh-arpur	Manga-lwedha	Sangola	Mal-shiras	Madha	Mohol	Karmala	Average
2000	586.3	586.3	745	782.4	554.2	372.6	505.9	263	630.7	652.9	940	601.7
2001	629.8	629.8	568	601	545.8	454.1	482.8	371	367	519	472	512.7
2002	582.3	582.3	516	480.7	403.3	583	642	296	355	415.1	364	474.5
2003	300.2	300.2	344	338.4	954.6	322.2	377.8	107	308.9	217.6	194.9	342.3
2004	603.8	603.8	445.7	488.9	532.8	711.4	379	388.5	469	429.5	522.4	506.8
2005	697.6	697.6	588.6	757.5	519.7	756.4	369.6	324.3	631	538.2	571.3	586.5
2006	453.1	453.1	551.1	659.6	474.8	623.9	560.6	437.2	487.3	588.1	608.8	536.1

2007	582.9	582.9	542.4	916.3	605.3	954.7	716.5	651.1	617.4	638	340.2	649.8
2008	634.3	634.3	424.8	670.3	469.2	529.5	499.3	596.5	600.3	595	715.7	579
2009	680.9	680.9	567.2	706.9	730.8	736.9	683.6	788.7	632.8	519.1	556.3	662.2
2010	674.2	674.2	567.2	667.2	726.2	723.9	667	788.7	606.3	512.4	561.3	651.7
Mean	584.13	584.13	532.7	642.6	592.43	615.33	534.92	455.64	518.70	511.35	531.54	554.8
S.D.	110.15	110.15	98.89	153.0	149.44	178.43	122.77	211.77	120.43	117.57	188.64	94.74
CV (%)	18.86	18.86	18.56	23.8	25.23	29	22.95	46.48	23.22	22.99	35.49	

Source: Agricultural District Office and Season and crop Reports, 2011.

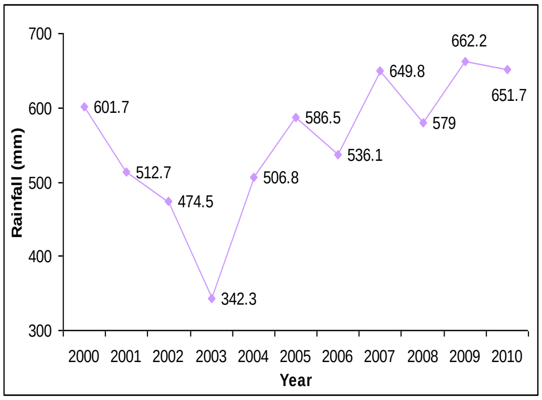


Figure 2: Yearwise average rainfall in Solapur District from 2000 to 2010.

B. Soil sampling:

The soil samples were collected from the agricultural field of village Pakni, District Solapur. The upper layer (25 cm) of non saline and saline soil samples were collected in polythene bags. These soil samples were analysed for its physico-chemical parameters for the comparative study mainly in terms of the pH, electrical conductivity, sodium, potassium and other physico-chemical parameters using standard methods (Goel and Trivedi, 2000; Guptta, 2002). The tomato (*Lycopersicon esculentum* Mill.) seeds were procured from local market, germinated in normal non-saline agricultural soil and healthy seedlings were used for the present study.

C. Nature of Polyethylene Glycol:

Polyethylene glycol (PEG) is a form condensation polymers of ethylene oxide water with general formula $H(OCH_2CH_2)_n$ OH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. Polyethylene glycol is non-toxic, odourless, neutral, lubricating, non-volatile and non-irritating. It is used in variety of pharmaceuticals and in medications as solvent, dispensing agent, ointment and suppository bases, vehicle and tablet. Polyethylene glycol is water soluble, also soluble in organic solvents including aromatic hydrocarbons except aliphatic and is one of the amendments for saline soil (Chavan, 2014).

D. Experimental method:

The experimental work was carried out under laboratory and field conditions. Eighteen earthen pots of 30X25X25 cm in triplicate sets were used for the plant growth data collection and yield assessment. Each triplicate set consisted of six pots. These earthen pots were filled with the accurately weighted dry 600 gm saline soil except one triplicate set of pots which was filled with normal (non-saline) soil to serve as control set for comparison. Tomato *(Lycopersicon esculentum* Mill.*)* seedlings were raised under shelter for 28 days after seeding and healthy seedlings were transplanted (Jose et al, 2013) at the rate of 4 plants per pot. These experimental sets were then grown in ambient environmental conditions with manual weed control and periodical watering in these pots.

A set of pots in triplicate as control with normal soil without any treatments and another triplicate set for blank with saline soil only was arranged for comparison. Prior to pot experiments, ten different concentration of PEG varied from 10 ppm to 100 ppm were studied in comparison with saline soil as blank and concentrations 10 ppm to 50 ppm were finalized for ambient field studies as the treatment studies after the laboratory conditions. Triplicate test sets 1 to 04 in pot experiments were treated with different concentrations of PEG to test it as an amendment for saline soil viz. 10ppm, 20ppm, 30ppm and 40ppm based on laboratory trials along with the control and blank (Saline soil only). PEG was used as soil amendment for the treatment of saline alkaline black cotton soil. On a global scale, no toxic substance restricts plant growth more than salts causing soil salinity. Plant salt stress caused by excessive salts in soil solution can cause inhibition of plant growth or cause plant death (Rahdari and Hoseini, 2011) which was experienced in the triplicate blank set. The blank set having only saline soil could not support the growth, hence has been neglected in data analysis and presentation of results.

PEG was applied to the pot-grown plants in proposed concentrations and the observations were recorded. Data was collected on the number of leaves, branches, flowers and fruits. The root length, shoot length as well as total fresh and dry biomass were measured. The leaf samples were collected randomly from each set treated with PEG and Control set. Green pigments chlorophyll ‘a’ and Chlorophyll ‘b’ from fresh leaves were estimated after 4 weeks. Freshly collected leaves were rinsed in distilled water, dried with tissue paper and one gram of each plant leaf sample was crushed with pestle- mortar in presence of a pinch of $MgCO_3$ and A.R. grade 80% acetone. This solution was centrifuged, taken in glass container having black envelope/cover to strictly avoid exposure to light and kept in incubator for 24 hours. The volume of solution from each set was carefully adjusted to 100 ml with the 80% acetone and the green pigments, chlorophyll ‘a’ and chlorophyll ‘b’ contents were estimated with the measurement of absorbance at 663nm and 645nm (Arnon, 1949). The concentration of chlorophyll ‘a’ and chlorophyll ‘b’ are calculated using the known standard formula as below;

Chl ‘a’ = $12.7 \mathrm{x} A_{663} - 2.69 \mathrm{x} A_{645}$

Chl ‘b’= $22.9 \mathrm{x} A_{645} - 4.68 \mathrm{x} A_{663}$

Statistical analysis was performed using standard techniques and differences between the means were compared through Duncan’s multiple Significant Difference test [$P < 0.05$] using SAS release 9.1 software package (SAS, 2002).

RESULTS AND DISCUSSION:

The Physico-chemical parameters of saline alkaline-black cotton soil and the non-saline soil (control) used in the present study were studied. Salinity indicator parameters such as pH, electrical conductivity, calcium, sodium and magnesium contents, organic matter, organic carbon, and SAR were studied (Table 2).

The soil was alkaline with pH 8.72 and EC 0.88 having poor organic carbon (0.21%) and organic matter (0.362%) reflecting it as unfit for agricultural cultivation. The non-saline (control) soil was having pH 7.2, organic matter 0.383% and organic carbon 0.23% which was slightly higher than the experimental saline-alkaline black cotton soil. SAR values for saline-alkaline black cotton was 3.71 whereas for non-saline (control) soil, it was 4.75.

Table 1: Physico chemical Properties of saline alkaline black cotton soil and control soil

Parameter	Saline Soil	Control Soil

pH	8.72	7.2
EC	0.88	0.91
Organic carbon (%)	0.21	0.23
Organic matter(%)	0.362	0.383
Ca (cmol/kg)	1.32	1.21
Mg(cmol/kg)	0.46	0.52
Na(cmol/kg)	4.94	4.42
SAR	3.71	4.75

Most of the vegetables crops are highly sensitive to stress caused by soil salinity in the early seedling growth stages (Cardon, N.Y.). Once the crop grows and passes these seedling growth stages, it can often tolerate and grow well in higher salinity conditions (Rehman *et al.*, 1996). The soil amendments reduce the adverse impacts and growth sustains (Chavan, 2014). Polyethylene glycol was used for the treatment of saline soil in present investigation. Polyethylene glycol treatment indicated that it reduces the salt stress on tomato crop. Four different concentrations viz 10 ppm, 20 ppm, 30 ppm and 40 ppm along with blank and control sets in triplicate were studied simultaneously. Different test concentrations used for the treatment of saline soil were compared with the untreated soil as control. Highest growth was observed in control and set of saline soil treated with 10 ppm PEG concentration while no growth was observed in blank set. No any seedling survived in untreated saline-alkaline black cotton soil (blank). Hence, no data growth data was obtained from blank set and not considered for further data analysis. The results as mean and standard deviation values along with the statistical test of significance are presented in Table 3.

Table 3: Mean (±Standard Deviation) values of plant growth parameters per plant at different treatment concentrations of PEG in *Lycopersicon esculentum* Mill.

Plant growth parameter	**Tomato (*Lycopersicon esculentum* Mill) Growth at different concentrations of PEG (ppm)**				
Average values of 4 plants	Control (No PEG)	PEG 10	PEG 20	PEG 30	PEG 40

Shoot length (cm)	15.3^{*} (±0.6)	15.4^{**} (±0.8)	13.6^{*} (±0.6)	11.0^{**} (±0.9)	$08.6^{\#}$ (±1.2)
Root length (cm)	16.2^{*} (±2.8)	17.2^{**} (±1.8)	13.4^{**} (±2.4)	12.3^{*} (±0.9)	07.4^{*} (±0.8)
No. of leaves	82.2^{*} (±3.9)	$78.5^{\#}$ (±4.2)	$76.2^{\#}$ (±4.1)	66.5^{**} (±3.1)	46.3^{*} (±2.7)
No. of branches	12.4^{*} (±0.9)	13.6^{**} (±1.0)	10.3^{*} (±1.2)	08.9^{**} (±0.5)	$06.8^{\#}$ (±0.8)
No. of fruits	11.3^{*} (±1.1)	11.4^{*} (±1.4)	08.1^{**} (±0.5)	06.2^{**} (±0.6)	04.1^{*} (±0.3)
Fresh Plant Biomass(g)	16.5^{*} (±1.2)	15.1^{**} (±1.4)	$13.6^{\#}$ (±1.4)	$09.2^{\#}$ (±1.2)	06.2^{*} (±1.1)
Dry Plant Biomass(g)	0.61^{*} (±0.15)	0.58^{*} (±0.13)	0.32^{*} (±0.09)	0.06^{*} (±0.02)	0.04^{**} (±0.02)
Chlorophyll ‘a’ (mg/g)	4.38^{*} (±0.81)	4.34^{*} (±0.76)	4.24^{*} (±0.82)	3.32^{*} (±0.66)	3.18^{*} (±0.46)
Chlorophyll ‘b’(mg/g)	5.36^{*} (±0.74)	5.26^{*} (±0.68)	4.38^{*} (±0.62)	3.4^{*} (±0.71)	2.38^{*} (±0.64)

Bracket values represent SD; #, * and ** represent for Non-significant, Significant or Significant at $P<0.05$ respectively.

Salinity and water deficiency are reported to lead to decrease plant metabolic activities and finally decrease the plant growth in terms of different growth parameters (Hussein et al., 2007; Hamed Kaveh, 2011). It occurs due to the mechanism of dry matter partitioning in stress conditions created by soil salt or any other external chemical constituents which exceeds a particular growth concentration. Seedling send more assimilates to roots to improve uptake ability and so the seedling above ground growth may be declined.

The effect of Polyethylene glycol on mean root length, shoot length and biomass in 10 ppm was the highest and comparable with the growth in non-saline (control) soil. The mean value of root length was 17.2(±1.8) cm in the set treated with 10 ppm concentration of PEG, while in control it was 16.2(±2.8) cm. Likewise, shoot length in 10 ppm was 15.4(±0.8) cm, while in control set without PEG treatment the average shoot length was 15.3(±0.6) cm. There was considerable decrease in the root length and shoot length with the increase in higher PEG treatment concentration than 10% (Fig. 3). Similar significant increase in growth is well demonstrated elsewhere (Rafiq Ahmad and Nusrat Jabeen, 2009) with the application of vermi-compost and biogas slurry under non saline soil expressed in terms of plant height, leaf area, stem and disc diameter, fresh and dry biomass for vegetative parameters which was reported in sunflower (Helianthus Annuus L.). The effect of Polyethylene glycol on root length, shoot length of *Lycopersicon esculentum* Mill indicated that highest growth in 10 ppm followed by the growth in control set and decrease in all other treatment sets. The root length and shoot length in the set treated with 10 ppm PEG were 17.2(±1.8) and 15.4(±0.8) which were higher than their growth in all other concentrations including the control set. The growth of root and shoot was drastically decreased with the increase in PEG treatment concentrations. The overall impact on Root/Shoot length in *Lycopersicon esculentum* Mill.grown in saline soil treated with different concentrations of PEG is represented in Fig. 3.

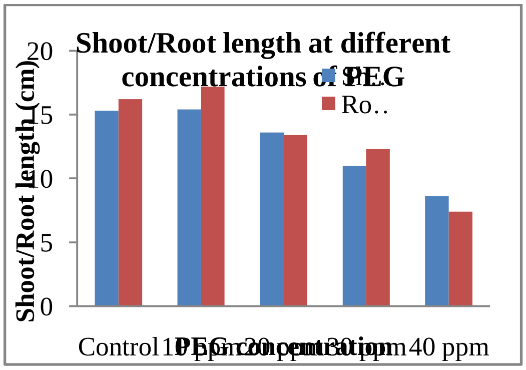


Fig. 3: Effect of polyethylene glycol on root and shoot length in *Lycopersicon esculentum* Mill.

The mean of number of leaves per plant was highest in control set followed a decreasing trend for the PEG treatment with its increasing concentrations (Fig. 4) indicating the hindering effect of higher concentrations of PEG but the survival insured the suppression of salt stress.

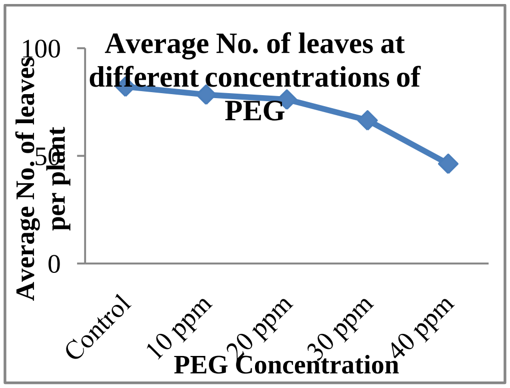


Fig. 4: Effect of polyethylene glycol on number of leaves per plant in *Lycopersicon esculentum* Mill.

Effect of polyethylene glycol on mean of branches and flowers per plant in *Lycopersicon esculentum* Mill indicated that average number of branches were highest with mean value 13.6(±1.0) in the set treated with 10 ppm PEG concentration as compared with the other higher concentrations including control with mean value 12.4(±0.9). The decrease in number of branches and flowers per plant in higher concentrations of PEG was attributed to toxic effect of PEG even after overcoming the salt stress.

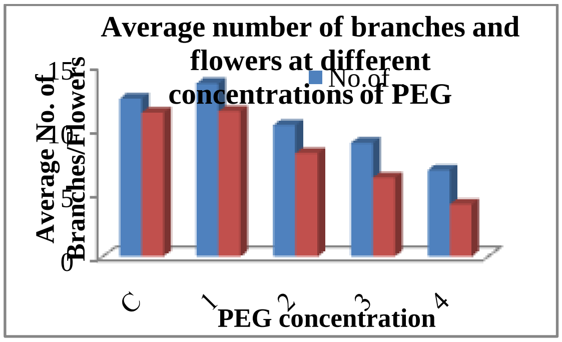


Fig. 5: Effect of polyethylene glycol on number of branches and flowers per plant in *Lycopersicon esculentum* Mill.

In the present investigation, saline-alkaline black cotton soil treated with the polyethylene glycol at 10 ppm concentration indicated considerable improvement in growth evidenced by mean of total fresh biomass and dry biomass which was comparable with the control set than in higher concentrations of PEG. The fresh biomass was 15.1(±1.4) gm per plant in set treated with 10% PEG concentration and 16.5(±1.2) gm per plant in control. Dry weight in control was 0.58(±0.13) gm per plant in 10% PEG treated set and was 0.61(±0.15)gm per plant in control set (Table 3). The decrease in fresh biomass (Fig.6) and dry biomass (Fig.7) in the treatment sets of higher concentrations of PEG indicates the adverse effects at higher concentrations as compared with the lower concentration (10 ppm).

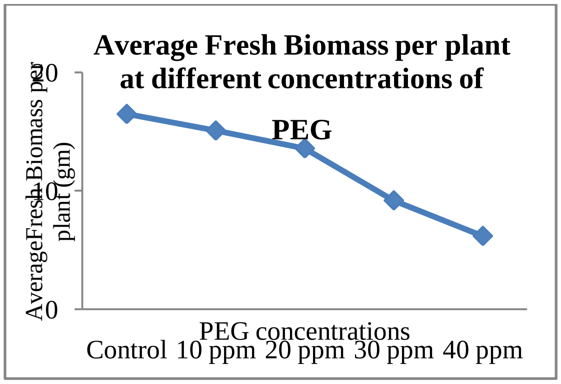


Fig. 6: Effect of polyethylene glycol on Fresh Biomass in *Lycopersicon esculentum* Mill.

The lowest total fresh biomass per plant 6.2 gm was observed in set treated with 40% PEG concentration. The Fresh and dry biomass weights in *Lycopersicon esculentum* Mill grown in saline soil treated with different concentrations of PEG are represented in Fig. 6 and Fig. 7.

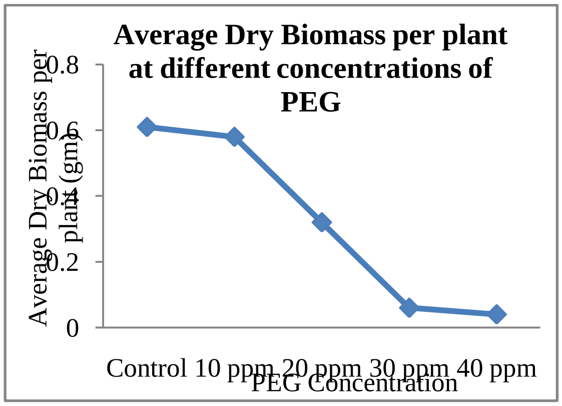


Fig. 7: Effect of polyethylene glycol on Dry Biomass in *Lycopersicon esculentum* Mill.

Similar reductions in fresh weight and dry weight have been reported by Stephen and Kurt (2004) in their studies on Effects of Saline Soil, Irrigation, and Seed Treatments on Sugar beet Stand Establishment. According to Ayers (1952) such impacts including the delayed seedling emergence can result from water stress and water stress results from increasing salinity, ultimately affects the crop growth. This is in good agreement with the present observations and results of this work.

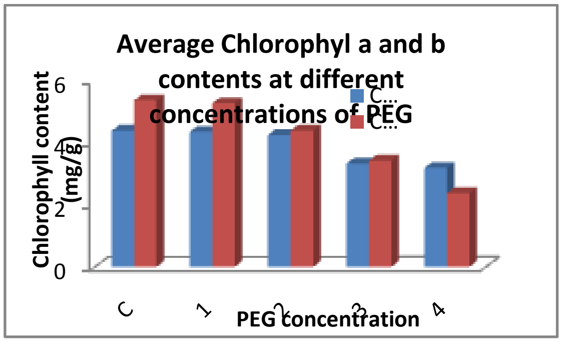


Fig. 8: Effect of polyethylene glycol on Chlorophyll 'a' and Chlorophyll 'b' in *Lycopersicon esculentum* Mill.

Plant pigments content were determined in different treatments concentrations of PEG in tomato which is tolerant and sensitive vegetable crop plant variety to the soil salts. Chlorophyll a and chlorophyll b are main photosynthetic pigments which play important role in photosynthetic process. The changes in the amount of pigments system were evaluated as the changes in photosynthesis. Net photosynthesis is significantly affected by salt stress due to changes in chlorophyll content which was reflected in present investigation. The mean of chlorophyll a and b in control were 4.38 mg/g and 5.36 mg/g whereas in 10 PEG treatment set these were 4.34 and 5.26 mg/g respectively. Decrease in photosynthetic pigments reduces the photosynthetic rate. An increase in PEG concentration could decrease the plant capacity to overcome the stress caused by soil salinity (Verma et al., 2010) which is reflected in the data generated and is mainly related to the decrease in chlorophyll a and chlorophyll b contents. The salt stress causes damage of photosynthetic apparatus and chloroplast structure (Doganlar et al, 2010). Similar results were observed when plant pigment contents were determined in different tolerant and sensitive plant varieties at wide range of salt concentrations (Sarwat and El-Sherif, 2007). Changes of pigment system contents are studied as parameter for growth condition in tomato which is similar to the studies conducted or selection of tolerant and sensitive cultivars in crop plants and reported elsewhere (Eryilmaz, 2007; Pinheiro et al, 2008).

Chlorophyll a and chlorophyll b contents showed increase at 10 ppm concentration of PEG and decrease at higher treatment concentrations (Fig. 8). The reduction of chlorophyll a and chlorophyll b amounted to PEG in higher concentration causing harm which is similar to the other studies reported in many plants such as *Zea mays*, *Carthamus tinctorius*, Bean and

Paulownia imperiallis for salt concentrations which is due to increasing of destructive enzymes called chlorophyllase (Rahdari et al, 2012). Pigments system reduction is attributed to a stess induced weakening of protein-pigment-lipid complex or due to the increased chlorophyllase enzyme activity (Turan *et al*, 2007). But, also an increase in pigment content was observed in salinity stressed plant such as Rice (Doganlar *et al*, 2010) and Purslane (Rahdari et al, 2012), that has observed at 10 ppm PEG concentration in the present study. This increment may be due to increase in the number of chloroplast in the plant leaves as reported elsewhere (Chaum and Kirdmanee, 2009).

The comparison of results obtained indicated that successive increase in PEG treatment concentrations beyond 10 ppm were associated with significant decrease of mean of the growth in terms of root length, shoot length, seedling fresh and dry weights, number of branches, number of flowers and the concentration of green pigments in all sets.

CONCLUSION:

Present study revealed that the impact of PEG on soil salinity for the growth of *Lycopersicon esculentum* Mill is fruitful only at the lower concentrations of PEG. The higher concentrations of PEG are toxic and do serve poor for saline-alkaline soil reclamation. The experimental results indicated that the root, shoot length and fresh weight were higher at 10ppm and the overall root length and shoot length was decreasing at higher concentrations or more indicating the toxic effect evidenced by poor the growth in *Lycopersicon esculentum* Mill.

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REFERENCES:

- FAO (1992). The use of saline water for crop production irrigation and Drainage paper, (Eds. J.D. Rhoades, A. Kandiah & A.M. Mashali) FAO(Food and Agricultural Organization) report, 48 Rome.

- Amezketa, E. and Aragues, R. (1995) Hydraulic conductivity, dispersion and osmotic explosion I arid-zone soils leached with electrolyte solutions. Soil Sci. 159: 287-293.
- Abdurrahman Hanay (2004). A research on the effects of municipal compost and barnyard manure on some physical and chemical properties of soils and soil-water relations. Doga-Trnsaction. Agric. Forestry, 16:91-102 Ankara, Turkey.
- M.J. Khan, A.U. Khan, M.T. Jan, M. Arif and M. Shafi (2010). Management of saline sodic soils through cultural practices and gypsum, Pak. J. Bot., 42(6); 4143-4155.
- Chavan, B.L (2014). Treatment of saline-alkaline black cotton soil with PEG for germination and growth of Triticum aestivum seedlings, Int. J. Res.in Mgmt. & Bus. Stud. 1(4), available also at www.ijrmbs.com.
- Zahow, M.F. and Amrhein, C. (1992). Reclamation of saline sodic soil using synthetic polymers and gypsum. Soil Science Society of America Journal 56, pp. 1257-1260.
- Almansouri, M., J.M. Kinet and S. Lutts (2001). Effect of salt and osmotic stresses on germination in durum wheat (Triticum durum Desf.). Plant Soil, 231, 243-254.
- Goel, P.K. and Trivedi, R.K. (2000).Methods in environmental analysis water, soil, air. Handbook, Environmental Publication, Karad.
- Guptta, P.K. (2002). Methods in environmental analysis water, soil and air. Handbook, Agro-bios publication, Jodhpur, Rajasthan, India.
- Bohm, W. (1979). Methods of studying root systems. Springer-Verlag. Berlin.
- Rafiq Ahmad and Nusrat Jabeen Fiq. Ahmad (2009). Demonstration of growth improvement in sunflower (Helianthus Annuus L.) by the use of organic fertilizers under saline conditions, Pak. J. Bot., 41(3): 1373-1384, 2009.
- Stephen Kaffka and Kurt Hembree (2004). The Effects of Saline Soil, Irrigation, and Seed Treatments on Sugarbeet Stand Establishment, Journal of Sugar Beet Research Vol.41 No.3, pp. 61-72.
- Ayers, A. D. (1952). Seed germination as affected by soil moisture and salinity, Agron. J., 44(1): pp. 82-84.
- Rehman, S., Harris P.J.C, Bourne W.F. and Wilkin J. (1996). The effect of sodium chloride on germination and the potassium and calcium content of Acacis seeds. Seed Sci. and Technol., 25: 45-57.

- Kadam A. V. (2013). M.Sc. project for the partial fulfillment of M.Sc. degree in Environmental Science, under the guidance of Prof. B. L. Chavan, in the faculty of Science, Solapur University, Solapur
- G.E. Cardon, J.G. Davis, T.A. Bauder, and R.M. Waskom, (NY), Managing Saline Soils, Colorado University Extension Fact Sheet No. 0.503, pp.2
- Arti Verma, Ashish Tewari and Abdullah Azami, (2010), An impact of simulated acid rain of different pH-levels on some major vegetable plants in India, Reports and opinion, 2(4), 38-40.
- Arnon, D.I. 1949. Copper enzyme in isolated chloroplast. I. Polyphenol oxidase in Beta vulgaris. Plant Physiol., 24: 1-16.
- Hussein, M.M., Balbaa, L.K. and Gaballah, M.S. (2007). "Salicylic Acid and Salinity Effects on Growth of Maize Plants". Research Journal of Agriculture and Biological Sciences, 3(4): 321-328.
- Hamed Kaveh, Hossein Nemati, Mohammad Farsi and Safieh Vatandoost Jartoodeh, (2011) How Salinity Affect Germination and Emergence of Tomato Lines. J. BIOL. ENVIRON. SCI., 5(15), 159-163.
- Eryilmaz F (2007). The relationships between salt stress and anthocyanin content in higher plants. Biotechnol. J. 20(1): 47-52.
- FAO (2000). Global network on integrated soil management for sustainable use of salt affected soils. Available in: http:/ www.fao.org/ ag/ AGL/Spush/ intro. Htm.
- B. Kahlaoui, M. Hachicha, S. Rejeb, M.N. Rejeb, B. Hanchi and E. Misle (2011) EFFECTS OF SALINE WATER ON TOMATO UNDER SUBSURFACE DRIP IRRIGATION: NUTRITIONAL AND FOLIAR ASPECTS. J. Soil Sci. Plant Nutr. 11 (1): 69 – 86.
- Parvaneh Rahdari and Seyed Meysam Hoseini (2011) Salinity Stress: A Review, Tech J Engin & App Sci., 1 (3): 63-66 & also available online at www.tjeas.com
- Pinheiro HA, Silva JV, Endres L, Ferreira VM, Camara CA, Cabral FF, Santos BG (2008). Leaf gas exchange, chloroplastic pigments and dry matter accumulation in Caster bean (Ricinus communis L.) seedlings to salt conditions. Crop. J. 27: 385-392.
- SAS. SAS/STAT® user's guide, SAS Institute, Cary, N.C., USA., **2002,** 9.1.

- Munns R, Tester M (2008). Mechanisms of salinity tolerance. Plant Biol. J. 59: 651-681.
- Cheong MS, Yun DJ (2007). Salt stress signaling. Plant.J. Biol. 50(2): 148-155.
- Doganlar ZB, Demir K, Basak H, Gul I (2010). Effects of salt stress on pigment and total soluble protein contents of the three different Tomato cultivars. Afr.J. Agri. 5(15): 2056-2065.
- Sarwat MI, El-Sherif MH (2007). Increasing salt tolerance in some Barley genotypes (Hordeum vulgare) by using kinetin and benzyladenin. World. J. Agric. Sci. 3(5): 617-629.
- Rahdari P, Tavakoli S, Hosseini SM (2012). Studying of salinity stress effect on germination, proline, sugar, protein, lipid and chlorophyll content in Purslane (Portulaca oleraceae L.) leaves. Stress Physio and Bio. J. 8(1): 182-193.
- Chaum S, Kirdmanee C (2009). Effect of salt stress on proline accumulation, photosynthetic ability and growth characters in two Maize cultivars. Pak. J. Bot. 41(1): 87-98.
- Ashraf, M.Y., K. Akhtar, G. Sarwar and M. Ashraf. 2002. Evaluation of arid and semi-arid ecotypes of guar (Cyamopsis tetragonoloba L.) for salinity (NaCl) tolerance. J. Arid Environ.,52: 473-482.
- Cramer, G.R., E. Epstein and A. Lauchli. 1990. Effect of sodium, potassium and calcium on salt stress barley, I. Growth analysis. Physiol. Plant., 80: 83-88.
- Tester, M. and R. Devenport. 2003. Mechanism of salinity tolerance: Na+ tolerance and Na+ transport in higher plants. Ann. Bot., 91: 503-527.
- Khan, A.A., S.A. Rao and T.M. McNilly. 2003a. Assessment of salinity tolerance based upon seedling root growth response functions in maize (Zea mays L.). Euphytica. 131: 81-89.
- Khan, A.S., M.A. Asad and Z. Ali. 2003b. Assessment of genetic variability for NaCl tolerance in wheat. Pak. J. Agri. Sci., 40: 33-36.
- Munns, R. and R.A. James. 2003. Screening methods for salinity tolerance: a case study with tetraploid wheat. Plant. Soil, 253: 201-218.

- Khan, M.A., M.U. Shirazi, M. Ali, S. Mumtaz, A. Sherin and M.Y. Ashraf. 2006. Comparative performance of some wheat genotypes growing under saline water. Pak. J. Bot., 38: 1633-1639.
- Ashraf, M.Y., K. Akhtar, F. Hussain and J. Iqbal. 2006. Screening of different accession of three potential grass species from Cholistan desert for salt tolerance. Pak. J. Bot., 38: 1589-1597.
- Chavan B. L. and Pawar S.H.(2011) "Effect of 2-Phosphono Butane 1, 2, 4, Tricarboxylic Acid on germination and seedlings growth of Vigna sinensis, Research paper accepted for International Journal of Physical and Social Sciences, 2 (2), 221-231.
- Koppen W (1936) Das geographische System der Klimate. In: Koppen W, Geiger R (eds) Handbuch der Klimatologie. Gebrüder Borntraeger, Berlin, p 1−44.
- FAO. (2005). Salt-affected soils from sea water intrusion: Strategies for rehabilitation and management. Report of the regional workshop. Bangkok, Thailand, 62 pp.
- Ali, Z., A.S. Khan and M.A. Asad. 2002. Salt tolerance in bread wheat: genetic variation and heritability for growth and ion relation. Asia. J. Plant Sci., 1: 420-422.
- Kamal, A., M.S. Qureshi, M.Y. Ashraf and M. Hussain. 2003. Salinity induced changes in growth
- and some physio-chemical aspects of two soybean (Glycine max L.) genotypes. Pak. J. Bot.,35: 93-97.
- Azhar, F.M. and T.M. Khan. 1997. The response of nine sorghum genotypes to NaCl salinity at early growth stages. J. An. Plant Sci., 7: 29-31.
- Shannon, M.C., J.D. Rhoades, J.H. Draper, S.C. Scardaci and M.D. Spyres.1998. Assessment salt tolerance in rice cultivars in response to salinity problems in California. Crop Sci., 38: 394-398.
- Azhar, F.M. and R. Ahmad. 2000. Variation and heritability of salinity tolerance in upland cotton at
- early stage of plant development. Pak. J. Bio. Sci., 3: 1991-1993.

- Flowers, T.J. and A.R. Yeo. 1995. Breeding for salinity tolerance in crop plants- where next? Aust.

- J. Plant Physiol., 22: 875-884.
- http://solapur.gov.in/htmldocs/demog.pdf.
- http://solapur.gov.in/htmldocs/glance.pdf.
- Jose A. Monte, Daniel F. de Carvalho, Leonardo O. Medici, Leonardo D. B. da Silva & Carlos (2013), Pimentel Growth analysis and yield of tomato crop under different irrigation depths, R. Bras. Eng. Agríc. Ambiental, 17(.9), 926–931.

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