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ORIGINAL ARTICLE

Effect of Sodium Chloride on Seed Germination and Seedling Growth of Some Fruit Vegetables

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ABSTRACT
Soil salinity can lead to reduced emergence and poor seedling growth. A study was conducted to investigate on the effect of salinity treatment on seed germination and seedling growth of four different plants under different NaCl concentrations 0 (control), 0.1, 0.4, 0.7, 1.0%. Forty seeds of each species were germinated at room temperature in petri dishes lined with two layers of blotting paper, moistened with 5 ml of each contain NaCl solution (0 (control,) 0.1, 0.4, 0.7, 1.0% and ten seeds per species of crop vegetables were germinated at room temperature in germination paper, placed in solutions of different concentrated NaCl beaker(for 24 hrs) and forty seeds of each species were germinated at room temperature in soil tray each contain different concentration of NaCl solution. Salinity had significant affect on germination percentage, index of germination, primary root-shoot length and fresh and dry weight biomass. Number of seeds germinating every day after the initiation of the NaCl treatment was counted, and final germination percentage established. The shoot and root length and fresh dry weight biomass was determined at the end of the experiment. Sodium chloride solution reduced germination percentage fruit vegetables. Growth of seedlings and fresh dry weight there was less or no germination percent at NaCl concentration levels 0.7 and 1.0%. The control treatment had higher germination percentage as well as seedling growth and fresh dry weight as compare to 0.1 and 0.4%. The findings from the study indicate that seeds of fruit vegetables are sensitive to salt stress. It is recommended that cultivars should not use to grown salt sensitive crops in saline environment since it will give poor germination and seedling growth.
Keywords: *Capsicum annum, chlorophyll, Cucumis sativus, germination percentage, Lycopersicones culentum, NaCl ,Salinity, Solanum melongena.*

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INTRODUCTION

Salinity is one of the most important abiotic stresses limiting crop production in arid and semiarid regions, where soil salt content is high and precipitation is low [1]. Salt load in irrigation of water is due to over use of fertilizers and lack of proper drainage can be the main factors that contribute to this problem of salinity. Around 930 million ha.land of world-wide, 20% of total agriculture land, are affected by salinity [2]. Salinity limits crops production, especially the sensitive species and reduces the yield of major crops by more than 50% [9]. It affects morphological, and biochemical processes, including seed germination, plant growth and water and nutrient uptake plant [28]. The ability of seeds to germinate at high salt concentration in the soil is therefore of crucial importance for the survival and prolong the life of these species. In saline habitats, seed germination takes place after high precipitation, i.e., under condition of reduced soil salinity [16]. The ability of the soil seed bank to obtained quicesnt at a high salt level and to germinate immediately after salinity reduction [5]. Although salinity stress mostly reduces the germination percentage and delays the onset of germination, its effects are modified by interactions with other environmental factor such as temperature [19] and light [15]. Salinity can after germination by affecting the osmotic component, which influences water uptake, and by interfering with the ionic component i.e. Na^+ and Cl^- accumulation, nutritional imbalance or a combined effect. Reduction in osmotic

potential in salt stressed plant can be a result of inorganic ion (Na^+, Cl^-, and K^+) and complete organic solute (soluble carbohydrate, amino acid, proline, betaines etc.) accumulations [14].
According to Somani [25], seed germination and seedling growth is critical phase as the ability of a crop plant to germinate and establish seedlings frequently becomes a limiting factor in crop production. There are many reports which indicate that seeds of most plants attain their maximum germination in distilled water and are very sensitive to elevated levels of salinity at the germination and seedling phases of development [29]. NaCl is the predominant salt causing salinization and it is expected that plants have involved mechanisms to regulate its accumulation [24].

Fruit vegetables:

Chilli: (*Capsicum annum)*

An annual herb with dark green leaves solitary milky white flowers and hollow, many-seed berries. The fleshy sweet pepper is very popular as an ingredient of salads and is widely eaten fresh as a tasty and crunchy addition to any meal. The seeds and white membranous placenta inside the fruits are always removed. The paprika pepper is only slightly pungent and is dried and powdered. Paprika powder is widely used to flavor potatoes, cheese and eggs, and is an ingredient of the famous Hungarian goulash and many other dishes. Green peppers (especially the red types) are very rich in vitamins A and C.

Brinjal: (*Solanummelongena)*

A perennial herb withthe fruits are very variable, from egg-shaped and white (hence the name eggplant) to oblong or sausage-shaped and bright to dark purple. The spongy flesh contains numerous small seeds. Wild brinjal is a spiny plant with bitter fruits, indigenous to India. The plants require a warm climate are harvested by hand when ripe. Ripe fruits are used.Brinjal are used as vegetables in a variety of dishes, especially in Eastern and Mediterranean cooking. The fruits a low energy value (30k.cal per 100 g), are rich in potassium and calcium but have only a modest quantity of proteins (1.2 %) and Vit. (5 mg. per 100 g).

Cucumber *(Cucumis sativus)*:

The well-known cucumber is a creeping or climbing annual with large, pointed, three-to five-angled leaves, unbranched climbing tendrils and small yellow flowers. Male and female flowers occur on the same plant. Cucumber is through to be indigenous to India. Cucumber is grown as a field crop in warm regions or more often under glass. Male flowers of the seedless types are mostly removed to prevent fertilization Cucumber consists of low (12 K.cal per 100 g), with modest amounts of protein, fat, minerals and vitamins B and C.

Tomato *(Lycopersicon esculentum*):

A short- lived perennial (usually Grown as an annual), today tomatoes ranks second only to importance as a vegetable.Tomatoes are grown in all parts of the world and are harvested by hand. Raw or cooked tomato is one of the most widely used and versatile food. Tomatoes have a low energy yield (23 k.cal per 100 g) and are rich in vitamins A, B. and C. The red pigments in tomatoes cancer in people who consume large amounts of cooked or processed tomatoes.

MATERIALS AND METHODS

Seed germination Assay:

Seeds of four species chilli, cucumber, brinjal, and tomatoes were collected from fields. The healthy seeds of four fruit vegetables were selected for present investigation. The seeds were washed firstly running tap water followed by distilled water 3 times. Then it was surface sterilized with 0.1% Mercuric chloride solution for 4-5 min., and 70% alcohol for 1min. respectively, again it was washed thrice after every treatment with sterile distilled water under laminar flow. Five pair of petri plates containing the blotting paper was sterilized with the help of autoclave at 15lb for 20 min. The different concentrations of sodium chloride (NaCl) were prepared with the help of sterile distilled water i.e. 0.1.0%, 0.4%, 0.7%, and 1.0%. From each concentration 10 ml solution was poured into the each sterilized petri dishes. The petri dishes without sodium salt were served as “control”. Forty seeds of each fruit vegetables were transferred into sterile petry dishes (100×100mm dimensions) between single layers blotting paper with 10 ml distilled water (control) or saline solution containing 0.1 0.4 0.7 1.0% NaCl and left to germinate at room temperature. Germinated seeds were recorded during 30 days.

Germination (%) = n/N×100

N: number of germinated seeds on the nth day.

N: total number of seeds.

The following parameters were used to study the response of sodium salt on seed germination.

i)Germination percentage of seeds. ii) Shoot length of seedlings.iii) Root length of seedlings.iv) Total seedling length. v) Fresh weight biomass.vi) Dry weight biomass

Growth assay:

Seeds were sterilized for 2 min in mercuric chloride solution 0.1, 0.4, 0.7, 1.0% and then wash in 70% alcohol and they were rinsed 3 times with distilled water. Few seeds from each species were sowed in plastic tray (diameter 36×25×7) containing soil at 5 cm depth trays were put in laboratory under room under day night at room temperature and natural light after emergence, one seedling per tray was conserved. For 60 days, plants were watered with distilled water (control) or a saline solution containing 0.1, 0.4, 0.7, 1.0%NaCl. Ten sterilized seeds of each species were placed in solution of different NaCl concentration beaker for 24 hrs and then transfer in germination paper at room temperature. These germination paper with seeds placed in different concentration NaCl beaker (i.e. control, 0.1, 04, 0.7, 1.0%). Germinated seeds were recorded at 14^{th} day. The plant height (cm), root length (cm), fresh weight and dry weight of plant were measured. Dry weight was measured after drying into oven at 80^0 C for 3- 4 h.

Estimation of Chlorophyll:

Chlorophyll (a and b) were determined according to Arnon**,** [2] method. Samples of fresh leaves (1 gm) were ground with 20 ml acetone in a mortar. The absorbance of the extracts was measured by spectrophotometer at 645 and 663 nm.

The chlorophyll amount were calculated according to the following equations

Chl a. g/tissue: 12.7(OD663)- 2.63 (OD645)

Chl b. g/tissue: 22.9 (OD645)-4.86 (OD663)

Total chl. (a+b) g/tissue: 8.02(OD663)-20.2(OD645)

K^+, Na^+, Cl^- root and shoot content were analyses by Spectrophotometer.

RESULT AND DISCUSSION

Seed germination percentage & germination time:

This study conducted in petry dishes to examine seed germination percentage. Effect of NaCl concentration on the percentage of germination in the four different fruit vegetables during 30 days is shown in Table 1. In control treatment seeds germinated from three days (cucumber) or six days (chilli, Brinjal, Tomato) & total recorded germination ended after 30 days. Salinity stress modified germination process by increasing germination time & decreasing germination percentage. Under the highest concentration of NaCl seed germinated after 9 days (chilli), 12 days (Brinjal), to 15 days (Cucurbit) & no germination in Tomato. There was no germination at NaCl concentration levels of 1% (Brinjal, Cucurbit, and Tomato). The maximum germination percentage was observed in chilli & the lowest germination in Cucurbit. Zhani, [30] had obtained similar results in other Tunisian pepper cv where NaCl decreased germination percentage to 70 & 20% at 1% concentration of NaCl. NaCl affected seed germination by creating external osmotic potential which causes difficulties in absorption of the necessary water quantities for the germination process [1]. Guerrier,[13] reported that salt stress causes also specific toxicity by higher accumulation of Na^+& Cl^- ions in the embryo in addition to a mineral imbalance. In extreme case, death of embryo can take place due to an inhibition of metabolic processes [7].

Shoot Length:

This study was conducted in germination paper to examine shoot length as well as root length properly. Root length and the shoot length are the most important parameter for studying salt stress, after seed germination percentage. Roots plays important role in the growth of the shoot under saline conditions as it is the first organ exposed to salinity [18].The mean of shoot length varied between 5.2 cm. (control) to 0.3 cm (1.0%NaCl) (Table 2). The longest shoot length was observed in the control of (6.2cm) & shortest in (0.3 cm) in (1.0%NaCl). When NaCl concentration increased, shoot length of chilli, brinjal& Tomato decreased significantly at concentration of NaCl 0.7% respectively to 4.3, 3.1 & 2.4cm. Bijeh Keshavarzi *et.al.*,[6] suggested that, salinity leads to reduce water uptake which interferes with cell division & differentiation, thereby affecting the shoot length.

Root Length:

The mean of root length was between 7.1 cm (control) to 0.1 cm (1.0%NaCl). As expected control condition & the highest level (1.0%NaCl) induce the longest & the shortest length respectively.(Table.2). Generally, root length decreased as salt stress increased. In the control, it varied from 5.6 cm (chilli) to 4.6cm (Brinjal) to 6.2 cm (Tomato). Such a decrease in root length and stem length may be due to NaCl toxicity and disproportion in nutrient absorption by the seedlings, as suggested by Bybordi and Tabatabaei [10].At the highest stress level, chilli, Brinjal & showed a respective decrease of root length 1.8

cm, 0.1cm respectively. Kerkeni [15] obtained a similar result in potato. There is no result in Tomato at highest stress. Turan *et.al.*[26] reported that in maize, shoot growth was much more affected than root growth under saline condition.

Total length of Seeding:

The length of seeding is considered as a useful criterion to understand the effect of salinity is at seeding growth stage. Turkyilmaz *et.al.*[27] while working on barley suggested that seeding length is very sensitive trait related to salinity. In chilli, Brinjal & Tomato there is almost 60-70 % reduction in the length of seeding at 0.7% NaCl concentration as compared to control (Fig.1-3).The mean of seeding length varied between 9.1 cm (chilli) to 8.5cm (Brinjal) to 13.3 cm (Tomato). The longest seedling length was observed in the control of Tomato (13.3cm) & shortest length at highest stress (0.7% NaCl) in Brinjal (0.1cm). According to Nawaz *et.al*.[21] salt salinity stress reduces the ability of plants to absorb water which leads to reduction in growth. In this experiment there is no germination of Cucumber in germination paper.

Growth of plantlet

This study was conducted in tray containing soil to examine plantlet growth properly.In cucumber highest growth of plantlet at control and lowest at 1.0% NaCl.In cucumber plantlet growth decreasing as increasing salt concentration. Root absorbs water from soil which is transloacated through shoots to the rest of the plant [3]. But in tomato higher growth in contro, 0.1 % and 1.0% as compared to 0.4% and 0.7%. In chilli higher plantlet growth at control and 0.4% and lower in 0.1, 0.7,1.0% NaCl Concentrations.

Table 1 Effect of NaCl Conc. (Control, 0.1, 0.4, 0.7, 1%) on seed germination percentage of Fruit vegetables in petry dishes.

Fruit vegetables		**Days (Germination percentage)**									
S. No.	**Conc.OfNaCl (%)**	**3rd**	**6th**	**9th**	**12th**	**15th**	**18th**	**21st**	**24th**	**27th**	**30th**
Chilli											
1	Control	0	20	25	50	85	90	97.5	100	100	100
2	0.1	0	0	25	37.5	50	62.5	87.5	90	95	100
3	0.4	0	0	25	37.5	90	90	92.5	95	97.5	100
4	0.7	0	0	50	75	97.5	97.5	97.5	100	100	100
5	1	0	0	22.5	25	27.5	62.5	87.5	100	100	100
Brinjal											
1	Control	0	5.0	7.5	12.5	20.5	35	47	68	85	100
2	0.1	0	0	0	2.5	5	5	10	7.5	10	15
3	0.4	0	0	0	5	5	5	10	7.5	10	10
4	0.7	5	5	5	10	12	15	36	52	75	100
5	1	0	0	0	0	0	0	0	0	0	2.5
Cucumber											
1	Control	0	15	25	45	62	77.5	80	93.5	100	100
2	0.1	0	0	0	0	0	0	0	0	0	0
3	0.4	0	0	0	5	7.5	7.5	7.5	20	25	37.5
4	0.7	0	0	0	0	2.5	2.5	2.5	7.5	7.5	10.5
5	1	0	0	0	0	0	0	0	0	0	0
Tomato											
1	Control	37.5	37.5	40.5	50	55	62.5	92.5	100	100	100
2	0.1	5	5	5	5	10	10.5	12.5	15.2	20.7	25
3	0.4	0	2.5	2.5	2.5	5	5	7.5	7.5	10.5	12.5
4	0.7	5	5	10.2	10.2	25	25.5	30.5	40.5	50.8	70.5
5	1	0	0	0	0	0	0	0	0	0	0

Fresh weight biomass and dry weight biomass of the seedlings

Fig. 1-3 shows a decrease in the fresh as well as dry weight of 14 days old seedlings of these four fruits vegetables. According to Mahmood and Athar [20], as salt concentration increases in medium, plants absorbs lesser water causing physiological desiccation. The mean of fresh weight was varied between 0.103 gm (control) to 0.010 gm (1.0%NaClconc). In the control, it varied from 0.103 gm (Brinjal) to 0.074 gm (Chilli) to 0.058 gm (Tomato). At the highest stress level chilli, brinjal, showed decrease in fresh weight 0.010 gm, 0.14 gm. respectively. At all concentration there is no germination in Cucumber. The mean of dry weight was observed between 0.062 gm (control) to 0.0002 gm (1.0%NaCl). According to Atak *et.al*.[4], reduction in dry weight is relatively dependant on the decrease in shoot length & root length. Dadkhah and Grrifiths [12] attributed such a decrease in dry weight to greater reduction in uptake & utilization of mineral nutrients by plant under salt stress. In the control dry weight varied from 0.62 gm

(Brinjal) to 0.052 gm (Chilli) & 0.063gm (Tomato). At the highest salinity stress level chilli, Brinjal (1.0%NaCl) & Tomato (0.7 NaCl) showed decreases in dry wt. 0.0 012gm & 0.0002 gm & 0.037 gm respectively.Cha-um and Kirdmanee [11] observed a decrease in fresh weight. as well as dry weight in maize seedlings under NaCl salinity. According to them, salinity leads to water deficit in plants thereby causing a decrease in fresh weight & dry weight which may be observed in present study.

Chlorophyll content in leaves

Chl. a+b amounts in leaves were the highest in control shown in Table3. Cucumber leave were reaches (135.3 gm/lit) where as Tomato leaves were the poorest (2.89 gm/ lit) at control. NaCl decreased chl (a+b) synthesis in these four species and this decrease was the most important at the highest NaCl concentration (1.0%) i.e. Chilli, Brinjal, Cucumber & Tomato chlorophyll (a+b) was 11.6, 2.55, 1.97, 0.88 gm/lit. respectively shown in Table 3.At control treatment leaves of cucumber had the highest amount of both chl.a (8.42 gm/lit) &chl.b (12.14 gm/lit), while the lowest amount were observed in Chilli (1.0 gm/lit & 22.51 gm/lit) Tomato (1.78 gm/lit & 1.57 gm/lit) & Brinjal (5.29 gm/lit & 0.78 gm/lit.) respectively At highest salinity leaves of cucumber had the chl.a (3.89 gm/lit) & chl.b (0.92 gm/lit) &Chilli (0.58 gm/lit. and 11.6 gm/lit.) & Tomato (1.18 gm/lit.& 3.81gm/lit.) & Brinjal (0.05 gm/lit.& 2.55gm/lit.)respectively (Fig-4). Researcher reported that at higher salinity (12 ms/cm) chl.a was totally eliminated in mesophyll of Mulberry because of total destruction of chloroplast structure [8].

Table 2 Effect of NaCl (Control, 0.1, 0.4, 0.7, 1.0%) on shoot length, root length and total seedling length in germination paper.

S. No	Conc. of NaCl (%)	Shoot length (cm)	Root length (cm)	Total length (cm)	Fresh weight (gm)	Dry weight (gm)
Chilli						
1	Control	5.6	3.5	9.1	0.074	0.0052
2	0.1	5.2	3	8.3	0.043	0.0047
3	0.4	4.8	2.5	7.3	0.037	0.0031
4	0.7	4.3	1.8	6.1	0.031	0.0024
5	1	0.2	0.1	0.3	0.0010	0.0002
Brinjal						
1	Control	5.5	3.0	8.5	0.103	0.062
2	0.1	4.6	2.7	7.3	0.082	0.0032
3	0.4	4	2.6	6.6	0.065	0.0027
4	0.7	3.1	1.2	4.3	0.043	0.0021
5	1	0.3	0.1	0.4	0.14	0.0012
Cucumber						
1	Control	----	----	----	----	----
2	0.1	----	----	----	----	----
3	0.4	----	----	----	----	----
4	0.7	----	----	----	----	----
5	1	----	----	----	----	----
Tomato						
1	Control	6.2	7.1	13.3	0.058	0.0063
2	0.1	5	5.5	10.5	0.040	0.0052
3	0.4	3.7	3.2	6.9	0.045	0.0048
4	0.7	2.4	2	4.4	0.031	0.0037
5	1	00	00	00	00	00

Table 3 Effect of NaCl conc. (Control, 0.1, 0.4, 0.7, 1.0%) on chlorophyll (a+b) content (gm/lit) of fruit vegetables in soil.

S. No.	Fruit vegetables	Concentration of NaCl (%)				
		Control	0.1 %	0.4 %	0.7 %	1 %
1	Chilli	19.55	0.02	22.42	19.67	11.6
2	Brinjal	9.26	0.040	2.56	6.30	2.55
3	Cucumber	135.3	0.35	2.58	3.53	1.97
4	Tomato	2.89	0.73	0.54	0.77	0.88

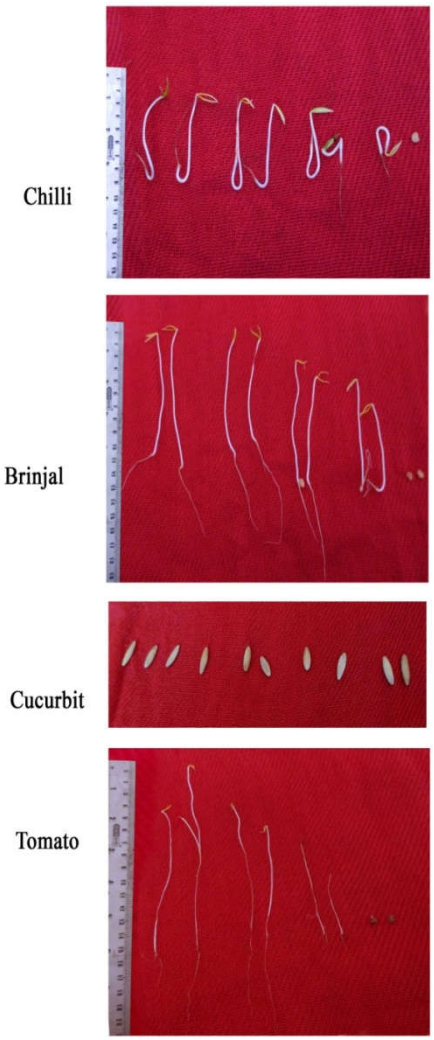

Fig. - Growth of seedling (Chilli,Brinjal.Cucurbit,Tomato) in Germination Paper After 14 th D

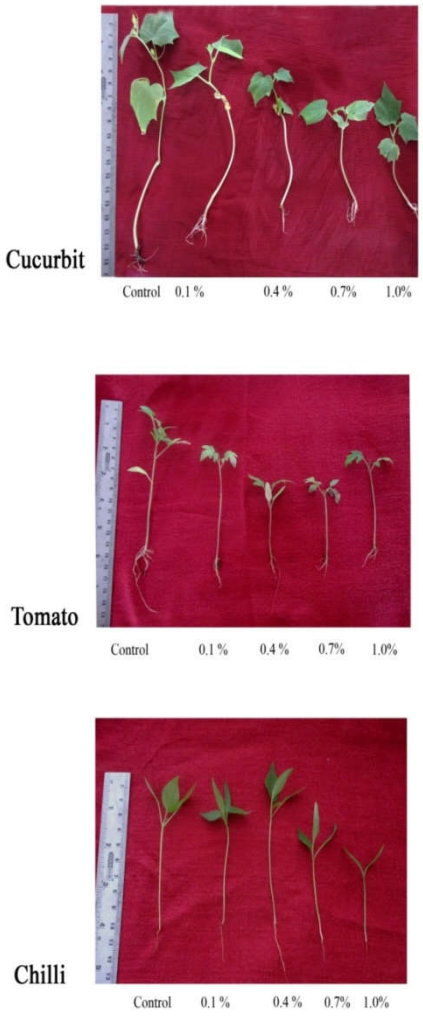

Fig. - Growth of seedling (Cucurbit,Tomato,Chilli) in soil.

CONCLUSIONS

Results of this study demonstrate that NaCl affects some of the physiological process in fruit vegetables. The increase of salinity level decreased all studied parameters except Na+ and Cl- concentrations in aerial parts and in roots. Present study concluded that fruit vegetables are sensitive to NaCl salinity. Increasing concentration of NaCl in the growth medium adversely affected the percentage germination, delayed the process of germination. Salinity also adversely affected growth as there was decrease in root length, shoot length, fresh weight and dry weight of the seedlings. Result showed that seeds of Chilli, Brinjal, Cucumber, Tomato germinated at Control and low concentrations of NaCl (0.1%, 0.4%), while at higher concentrations (0.7%) seeds of these species were inhibited. However, none of seeds germinated if kept in concentrations of 1.0% of NaCl. The seedlings length decreased as salt stress increased. The mean of fresh weight was varied between 0.103 gm (control) to 0.010 gm (1.0% NaCl conc.).At control dry weight varied from 0.62 gm (Brinjal) to 0.052 gm (Chilli) & 0.063 gm (Tomato). At the highest salinity stress level chilli, Brinjal (1.0% NaCl) & Tomato (0.7 NaCl) showed decreases in dry wt. 0.0 012gm & 0.0002 gm & 0.037 gm respectively.

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