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Effect of Potassium Chloride Stress on Seed Germination And Growth Of *Capsicum Annuum* L.

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Abstract
The salt stress caused by potassium chloride on Capsicum annuum L. *adversely affected the seed germination. The rate of germination was decreased as the concentration of potassium chloride increased. The seeds when treated with different concentrations of KCl several changes were observed in the vegetative growth as well as in metabolisms. The mean length of root and shoot system and leaf area were found decreased on salt treatment. Photosynthetic efficiency and yield of carbohydrate was also significantly declined with increased salt concentrations.*
***Key words**: Potassium chloride, Capsicum annuum* L.*, salt stress, chlorophyll, photosynthesis, carbohydrates, amylase.*

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I. INTRODUCTION

Plant growth is favoured when the environment is favourable. Salinity is one of the factors that cause soil degradation and in return affect the plant growth. Salinity inhibition in plant growth is the result of osmotic and ionic effects and different plant species have developed different mechanism to cope up with these effects [14]. Although the relationship between osmotic regulation and salt tolerance is not clear there is evidence that the osmotic adjustment appears, at least partially, for salt tolerance of certain plant genotypes [16]. A high salt level interferes with the germination of seeds. Increased salinity prevents absorption mechanism of roots altering the osmotic stability and thereby affects the absorption of water and nutrients. Soil salinity is a major problem in agricultural world and salt tolerance in plants is an extremely important mechanism. Detrimental effect of high salinity on crops are multifaceted and affect the plants in several ways like drought stress, ion toxicity, nutritional disorders, alternation of metabolic process, membrane disorganisation and reduction in cell division. The adverse effects of salinity on plant growth and development may be the result of various factors like factors such as nutritional aspects, toxicity levels and osmotic equilibrium. The consequences of these complex effects are the reduction in vegetative characters, leading to a miniaturization of salt marsh and sand dune plants [5] & [6]. Delay in germination process and germination rate as well as consequent seedling establishment in the field are the main problems in direct seeded method, especially in the adverse environmental conditions of salinity stress [8]. It is reported that poor seedling establishment is one of major yield limiting constrains both in transplanted and direct seedling methods of farming, especially under stressful conditions. Harris *et al.,* [11] reported that, seed priming is one of the most important developments to help rapid and uniform germination and seedling development and to increase tolerance level in adverse environmental conditions. These prevent the seeds from absorbing enough water for radicle protrusion, thus suspending the seeds in the lag phase [18]. The arid and semi-arid conditions as well as less availability of fresh water inflict saline circumstances that threaten the productivity of crops. In general, seed germination and early seedling growth are considered as the most sensitive stages to salinity stress in most of the crops than the growth of established plants [4]. The seeds under the salt stress require higher amount of water uptake during germination because of accumulation of solutes around the seeds, which increases the osmotic pressure. This causes excessive uptake of the ions resulting in toxicity in the pant. Moreover, water potential gradient between the external environment and the seeds also inhibits the primary root emergence [7]. There is strong evidence that salt stress affects photosynthetic enzymes, chlorophylls and carotenoids. In addition, salinity causes disturbance of membrane integrity, activities of enzymes and damaged photosynthetic components.

Capsicum annuum L. is a native to southern North America and northern South America. Green chillies grow into shrubby perennial herb that comes under solanaceae family. In India chillies are used by all states and cultures. The objectives of the present study is to evaluate the effect salt stress (KCl) on germinating seeds and in the growth of the seedling.

II. MATERIALS AND METHODS

2.1. Germination studies

Seeds of *Capsicum annuum* L. were taken from horticulture centres. Before conducting the experimental works all the glass wares were sterilized. The seeds of *Capsicum annuum* L. collected are sterilized to get rid of pathogenic bacterial spore and other external impurities. 1%, 2% and 3% of potassium chloride solution was prepared in 100ml distilled water. Control was also maintained along with the test series and about 30 sterilized seeds were soaked in the solutions for 12 hours. After 12 hours the seeds were taken out and washed well in distilled water. Sterilized petri dishes, marked according to the concentrations were used to saw the seeds for germination. Petri dishes were lined with filter paper both on the dish and the lid, the filter paper were moisture with distilled water regularly. The length of radicle and plumule of the germinated seeds were measured regularly. By the end of second week leaves began to appear. The measurements were taken for three weeks and the percentage of seed germination and mean length of shoot and root system in different concentrations of KCl were recorded. The leaf area was measured at the end of second and third weeks.

2.2. Study of Photosynthetic efficiency

The amount of various photosynthetic pigments were estimated according to the method of Arnon [2]. Amount of chlorophyll a, chlorophyll b, carotenoids and total chlorophyll content were estimated. The rate of photosynthesis was calculated as the number of milli moles of potassium ferricyanide reduced per mg chlorophyll in unit time [9]. The leaves were harvested from plants of 3 weeks growth for the estimation of carbohydrates. The specific activity of α – amylase enzyme was assayed by estimating the amount of product formed in unit time [17].

III. RESULT AND DISCUSSION

3.1. Effect of KCl on Germination and development of seeds of *Capsicum annuum* L.

The present study showed that the seeds of *Capsicum annuum* L. were adversily affected by the of potassium chloride treatments. The seeds were treated with with 1%, 2% and 3% KCl showed remarkable difference in the rate of germination and development. The rate of germination was decdreased with increasing concentration of KCl. (Fig. 1). The effect of salt stress on the seed germination is attributed to various factors such as reduction in water availability, changes in mobilization of reserve food and affecting structural organization of proteins and enzymes [1].

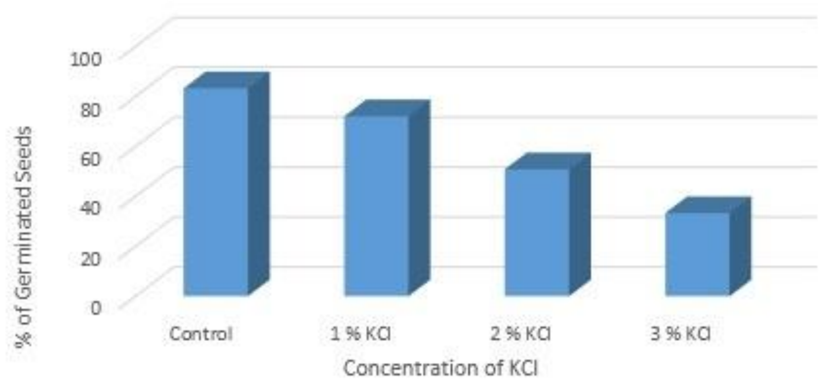

Fig. 1: Germination Rate of Treated Seeds

The seeds that were kept as control produced the radicle on the first day. The length of radicle and plumule were taken each day. It was observed that growth in control was at higher rate than 1%, 2% and 3% KCl. The growth of root system and shoot system was marked highest in control followed by 1%, 2% and 3% KCl. The average growth of root system and shoot system was marked very poor in 3% KCl (Fig. 2). From this it is clear that as the concentration of KCl increases the growth of root and shoot system decreased [13]. According to various studies it is clear that chilly is much affected by high salinity stress especially at seed germination and early seedling growth [10] & [12].

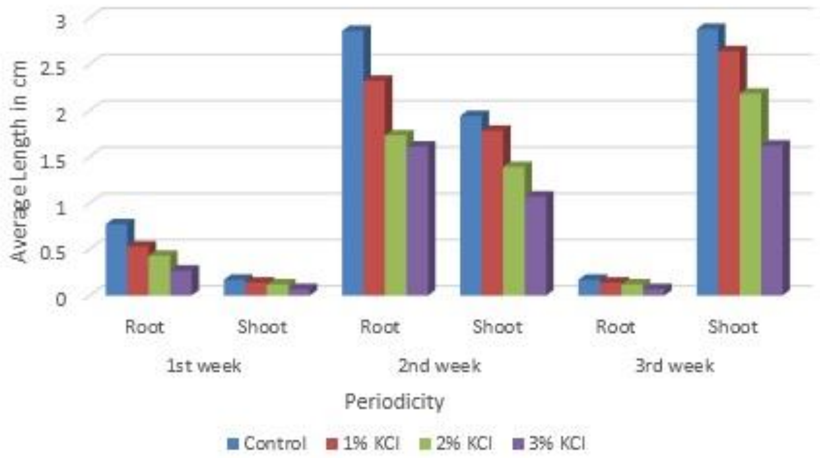

Fig. 2: Lengths of root and shoot of treated plants

The leaf area of the plants was found high in control and lower concentration of KCl compared plants treated with high salt concentration (Table 1). Plants that were treated with different concentrations of KCl exhibited significant reduction in the number and of area leaves. The salt stress also produced changes in the leaf colour, which may be due to the deterioration of the pigments and inhibition of process of photosynthesis and other metabolic activities. In general, the reduction in growth of plants under salt stress can cause severe damage to the plant [15].

Table 1: AREA OF LEAF OF TREATED PLANTS IN 2nd AND 3rd WEEKS

CONCENTRATION	LEAF AREA (mm^2) (Mean ± SD of 30 samples)	
	Second week	Third week
CONTROL	11. 3 ± 0.00	14.7 ± 0.04
1%	8. 4 ±0.03	10.6 ± 0.07
2%	8.1 ± 0.00	9.7 ± 0.39
3%	7.4 ± 0.01	8.2 ± 0.04

3.2. Analysis of photosynthetic efficiency

Total chlorophyll content was much less in plants grown in 2% and 3% KCl compared to control. (Fig. 3). The decreased levels in chlorophyll content under saline stress is a commonly reported phenomenon and established that it may be due to different reasons; one of them is related to membrane deterioration [3]. The periodic estimations of chlorophyll pigments and carbohydrates showed a decrease with increase of salt concentration. The amount of carotenoids was found to be increasing with increase in concentration of KCl. The chlorophyll a/b ratio also showed considerable variation. The increase in the chlorophyll a/b ratio and amount of carotenoids indicated the decrease in photosynthetic efficiency. It was confirmed with the analysis of Hill reaction. The rate of ferricyanide reduction was gradually decreasing with increasing concentration of KCl (Table 2). The reduction in the photosynthetic efficiency of plants may be due to poor development of light harvesting chlorophyll protein complexes (LHCP) [9].

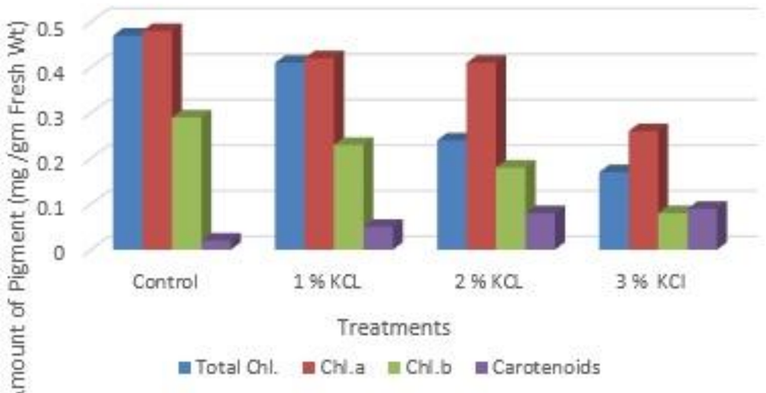

Fig. 3: Amount of Photosynthetic Pigments in Treated Plants

TABLE 2: PHOTOSYNTHETIC EFFICIENCY OF TREATED PLANTS		
Concentration of KCl	µ moles of ferricyanide reduced/mg chl./h (Mean ± SD)	Chl. a/b ratio (Mean ± SD)
CONTROL	86.5 ± 0.07	1.66 ± 0.00
1%	81.4 ± 0.02	1.83 ± 0.07
2%	73.3 ± 0.04	2.27 ± 0.04
3%	56.5 ± 0.09	3.25 ± 0.02

The results of amylase enzyme activity in the treated plants revealed that the metabolic rate of germinating seeds are reduced. The specific activity of amylase enzyme was high in control and lower concentration of KCl. The specific activity was found decreasing with high concentration of KCl (Table3). Amylase enzyme has a significant role in conversion of reserve carbohydrates to soluble forms, which is used up for germination.

TABLE 3: ESTIMATION OF CARBOHYDRATES AND ASSAY OF AMYLASE ENZYME		
Concentration of KCl	Amount of carbohydrate (mg/gm fresh wt.) (Mean ± SD)	Specific activity of amylase enzyme (mg product/mg enzyme/hr) (Mean ± SD)
CONTROL	57.5 ± 0.04	1.68 ± 0.00
1%	52.4 ± 0.02	0.89 ± 0.07
2%	46.3 ± 0.08	0.03± 0.04
3%	33.5 ± 0.03	0.02 ± 0.02

IV. CONCLUSION

Salt stress is one of the major abiotic stresses limiting the crop production. Osmotic stress caused by increasing the amount of salt in soil, decreases the amount of water that the plants use and as a result physiological drought occurs. The present study underlines the reduction in growth rate of *Capsicum annuum* L. on increasing amount of KCl. It was found that with increased concentration of KCl the metabolic activities were adversely affected. The stress caused by KCl affected the rate of germination, photosynthetic efficiency and enzyme activity of the plant under study. Thus it is concluded that increase in the concentration of KCl had adverse effects on the germination seeds and development of seedlings *Capsicum annuum* L.

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