EFFECT OF NaCl SALINITY ON INORGANIC CONSTITUENTS OF MULBERRY. VARIETY M5

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Abstract

Mineral elements are important constituents of protoplasm and cell wall. Mineral salts dissolved in the cell sap partially influence the osmotic pressure of the cell. Imbalance of mineral ions under saline condition generally results into poor crop growth and lesser productivity. The metabolic reactions also get affected due to disturbed ionic concentration. The minerals sodium and chloride are listed among essential trace elements, sodium regulates the transport of amino acids to the nucleus, whereas chloride plays an important role in the transfer of electrons from water to chlorophyll. Even though the higher levels of these elements alter the plant metabolism and reduce the yield. The other macronutrients such as Potassium, Calcium, Magnesium, Iron and micronutrients are essential for various metabolic activities. If all the necessary nutrients available in required amount, then the growth and yield of the plant will be optimum, if any disturbance in the nutrition disturbs the entire metabolic activity of the plant. The present investigation is to analyse the levels of various mineral nutrients in the different parts of NaCl treated Mulberry plants. because salinity is known to influence the ion uptake through change in the osmotic potential and ion interaction at root zone.

Key words: NaCl salinity, Mineral ions, Mulberry.

Introduction:

Soil salinity is one of the major abiotic stresses throughout the world. According to present statistics 1125 million hectares of land is affected by salinity in the world, of which 76.6 million hectares are by anthropogenic activities (Oldmen.,1991; Mashali,1995; Shahid et al.,2018). In India saline soil occupy 44% area covering 12 states and one union territory. According to Singh (1980) the introduction of irrigation projects has been the main cause of soil salinity in many countries. At present Agriculture sector has two threats that is population explosion and unavailability of cultivable land (Shahbaz and Ashraf 2013). In this context ICAR, Central soil salinity Research Institute and many States Agricultural Universities are engaged in the studies related to salt affected land and developing several innovative technologies in the country. Among them are screening and cultivation of salt tolerant crop varieties. Because Soil salinity reduce net cultivable area and also affects productivity and quality of the crop (Munns 2005, Jamil et al 2011). An estimate suggested the global economic losses are about 11.4 billion USD in an irrigated land and 1.2 billion USD in non-irrigated land per year (Ghassemi et al 1995) due to soil salinity. Salinity affects almost all parts of the plant and also growth and reproduction. They face osmotic and nutrient stress. The agriculture crops exhibit many complex responses and interaction of physiological, morphological and biochemical processes which ultimately leads to low quality and production (Ghassemi et al 1995). In addition to this soil salinization also affects physicochemical properties of the affected area which leads to ecological imbalances. Salinity stress leads to accumulation of various types of metabolites, these metabolites help to overcome the stress in plants by developing tolerance.The present study aimed to understand the influence of soil salinity on various organic metabolites under increasing concentration of salinity in two varieties of Mulberry.

Mulberry (*Morus alba. L*) is a deciduous woody tree, which has great economic importance and cultivated as commercial crop, the leaves are used to feed silkworms Bombyx mori. L to get superior quality of silk. The tender parts of the plant are used as fodder and also the ripe fruits are nutritious and edible. Mulberry is cultivated as both rainfed and irrigated crop. Mulberry cultivation is associated with rearing of silkworms known as sericulture. Sericulture is practised by small and marginal land holders; it gives economy and employment for rural women. The present study aimed to investigate effects of salinity on the inorganic constituents such as some macro and micro elements which may help to know the effect of increased sodium chloride on mineral ion concentration in different parts of the plants. Which may help to screen new salinity resistant varieties, this may help to utilize salt affected lands.

Materials and methods

During present investigation Mulberry cultivar M5 was selected. Mulberry cuttings were obtained from Regional Sericulture Research Station, Kadaganchi, Kalaburagi. Healthy cuttings with 15-18 cm length with 3-4 axillary buds were selected. The selected cuttings were immersed in 10ppm solution of NAA for 20-30 min to initiate rooting. The cuttings were planted in earthen pots (22 x 20 CMS) filled with equal quantities of (4 kg/pot) garden soil and sand. The saplings were established. The well-established three months old healthy and uniform saplings were transplanted to experimental pots, each pot with 4 saplings, after recovery of saplings due to transplantation shocks the pots were irrigated with 1 lit of tap water to control,1lit of 0.25 M,0.5 M, and 1.0 M NaCl solution to other experimental pots respectively. Three replications for each treatment were maintained. The salt treatment was given by the method of Black (1956) The plants were harvested and collected after 45 days for analysis of organic metabolites. EC and pH of soil extract was measured up to 45 days. After 45 days the plants were harvested, the different plant parts like Roots, Stems and leaves were collected and used for estimation of mineral ions. The acid digestion was carried as per the method of AOAC hand book (Horwitz 1975)

Sodium and Potassium elements were determined by using Flame photometer (Jackson 1956) Calcium was estimated by titrimetric EDTA method (Richards 1954). The minerals like Fe, Mn, Zn, Cu and Mg were analysed by Atomic spectrophotometer, at the regional sophisticated instrumentation center, IIT Bombay. Chloride was estimated by the method of Volhard (1956).

Results:

Table – 1

Effect of NaCl on mineral components of Leaf

NaCl (M)	Na	K	Ca	Mg	Fe	Mn	Zn	Cu	Cl	Na/K	Na/Ca	K/Ca
Control	28.0 ±0.06	14.1 ±0.04	78.1 ±0.13	8.7 ±0.03	1.19 ±0.09	0.11 ±0.008	0.012 ±0.003	0.02 ±0.002	7.2 ±0.03	0.019	0.35	18.21
0.25	40.0 ±0.05	13.4 ±0.06	106.1 ±0.14	11.3 ±0.03	1.91 ±0.03	0.15 ±0.002	----	0.02 ±0.002	11.6 ±0.05	0.029	0.037	12.71
0.5	56.0 ±0.06	18.0 ±0.05	128.2 ±0.25	18.3 ±0.04	2.42 ±0.03	0.14 ±0.005	----	0.02 ±0.003	29.9 ±0.18	0.031	0.43	14.06
1.0	150.0 ±0.02	24.0 ±0.08	108.1 ±0.12	16.8 ±0.05	0.07 ±0.002	0.20 ±0.01	0.015 ±0.003	0.03 ±0.003	72.3 ±0.03	0.061	1.38	22.66

Values are expressed as mg/g of dry weight

Values are significant at 1% level

--Values are Negligible.

In table 1 shows various inorganic contents of leaf. The sodium and chloride as usual increased with increase in salinity level. The potassium accumulation was stimulated at 0.25M level but gradually decreased with the increase in salinity level. Calcium accumulation increased upto 0.5 m level but lowered at 1m level, Magnesium accumulation was lowered at 0.25 M level but increased at higher Nacl leveliron content remained same in control and 0.25 level whereas at higher concentration iron level increased and more or less remained same.Manganese was low at lower concentration but high at higher concentration.Salinity did not affect uptake of Zinc and copper to a large extent.Na/K and Na/Ca ratio showed increasing tendency but K/Ca ratio increased at 0.25M and 1M but declined at 0.5 m NaCl level.

Table – 2

Effect of NaCl on mineral components of Stem

NaCl(M)	Na	K	Ca	Mg	Fe	Mn	Zn	Cu	Cl	Na/K	Na/Ca	K/Ca
Control	47.6 ±0.03	14.4 ±0.05	66.1 ±0.14	10.9 ±0.08	0.87 ±0.05	0.07 ±0.008	--	0.02 ±0.001	1.2 ±0.003	0.033	0.72	21.85
0.25	70.8 ±0.06	12.5 ±0.08	60.0 ±0.07	12.2 ±0.02	0.92 ±0.03	0.08 ±0.009	---	0.01 ±0.001	2.0 ±0.10	0.057	1.19	20.70
0.5	114.2 ±0.06	14.1 ±0.05	27.2 ±0.12	12.6 ±0.12	1.94 ±0.06	0.09 ±0.005	---	0.02 ±0.003	16.3 ±0.06	0.080	4.17	51.92
1.0	156.1 ±0.10	88.4 ±0.01	38.1 ±0.06	81.9 ±0.06	2.4 ±0.11	0.08 ±0.007	----	0.02 ±0.005	18.8 ±0.04	0.017	4.12	32.10

Values arte expressed as mg/g of dry weight

Values are significant at 1% level

--- Values are negligible.

Table -2 shows the effect of NaCl on uptake of various inorganic components in stem tissues Na and Cl both ions accumulation increased with increase in salinity level. Potassium uptake decreased slightly at 0.25M and 0.5 M level but at 1m salinity caused sudden increase.The calcium has shown the increasing tendencyat 0.5 m NaCl level and affected by NaCl.The magnesium uptake increased upto 0.5 M but large accumulation was found in !m salt concentration.iron content showed gradual increase in increased salinity levels.Manganese and copper did not show much difference compared to control and salt treated stem but Zinc was found in traces.Na/K ratioincreased upto 0.5M but decreased at 1m,,Na/Ca and K/ca ratio showed the increasing tendency

Table – 3

Effect of NaCl on mineral components of Root

NaCl(M)	Na	K	Ca	Mg	Fe	Mn	Zn	Cu	Cl	Na/K	Na/Ca	K/Ca
Control	35.2 ±0.03	100.1 ±0.11	38.0 ±0.05	6.9 ±0.05	31.3 ±0.10	0.16 ±0.03	0.06 ±0.004	0.07 ±0.003	5.1 ±0.07	0.35	0.92	2.63
0.25	30.4 ±0.02	103.1 ±0.03	32.0 ±0.07	5.3 ±0.04	26.7 ±0.02	0.14 ±0.01	0.04 ±0.006	0.06 ±0.005	7.2 ±0.03	0.29	0.95	3.22
0.5	28.1 ±0.02	57.8 ±0.05	36.0 ±0.11	7.6 ±0.03	43.5 ±0.03	0.16 ±0.02	0.03 ±0.003	0.06 ±0.01	17.1 ±0.05	0.48	0.78	1.60
1.0	27.1 ±0.04	92.64 ±0.05	66.0 ±0.08	7.5 ±0.02	27.3 ±0.04	0.12 ±0.01	0.02 ±0.002	0.04 ±0.003	5.1 0.05	0.29	0.41	1.40

Values are expressed as mg/g of dry weight

Values are significant at 1% level

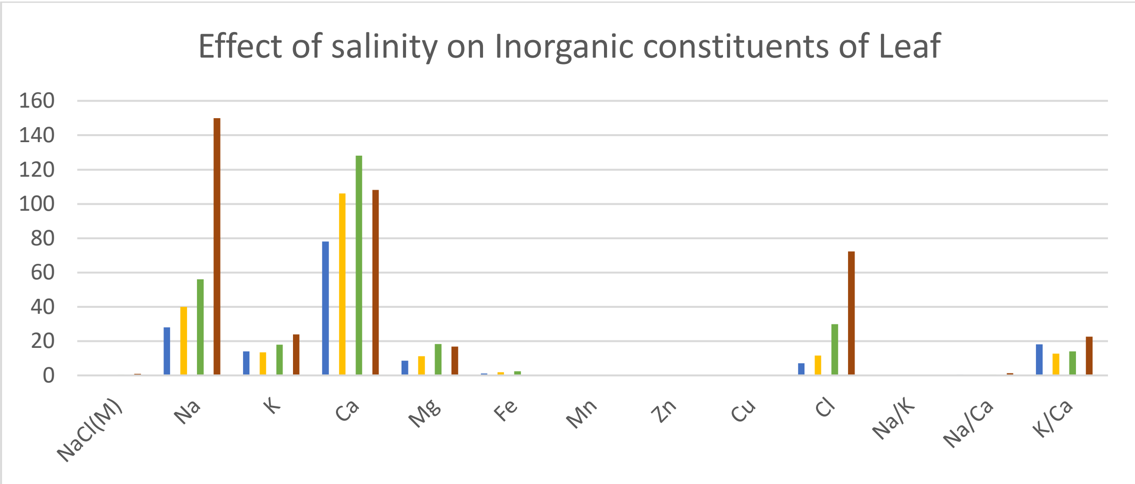
Table–3 depicts the accumulation of inorganic components in Root at different NaCl concentration. Sodium uptake decreased with increasing concentrations of salinity, whereas chloride uptake increased upto 0.5 M but declined suddenly at 1M.potassium uptake is more compared to Na and Cl, Calcium accumulation decreased upto 0.5M but enhanced accumulation has been seen at 1Msalinity.Magnesium content decrease at 0.25M and increased at 0.5 and 1M nacl level.Iron content remained the same at 0.25 and 1 M but increased at 0.5 m concentration.Magnesium remained constant but Zinc and copper decreased steadily. Na?K declined aty 0.25 and 1M NaCl level, increased at 0.5 level .Na/Ca and K/Ca ratio high at 0.25 but decrease at 0.5 and 1M salinity levels.

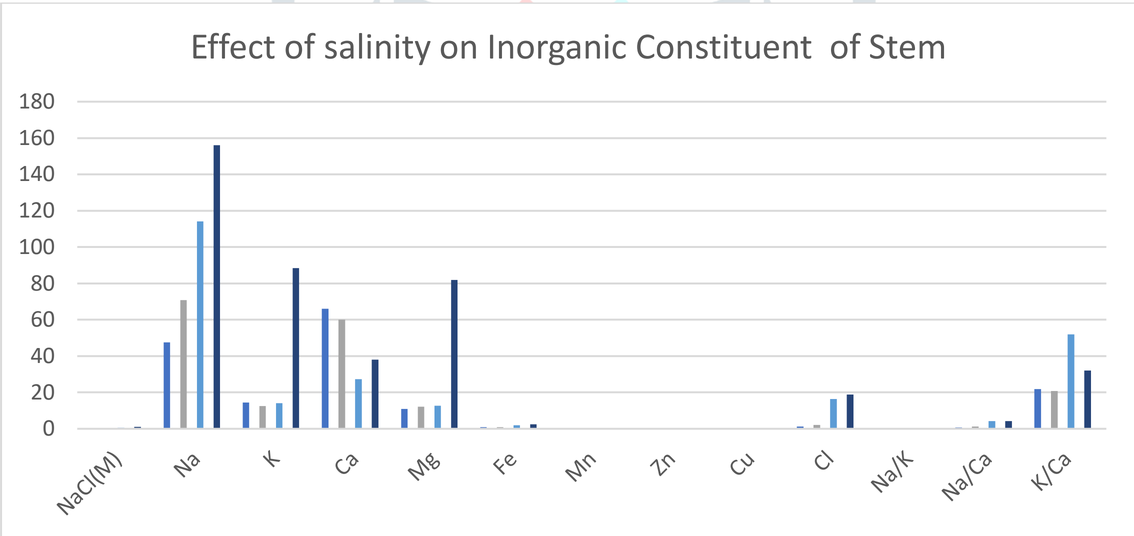
Discussion:

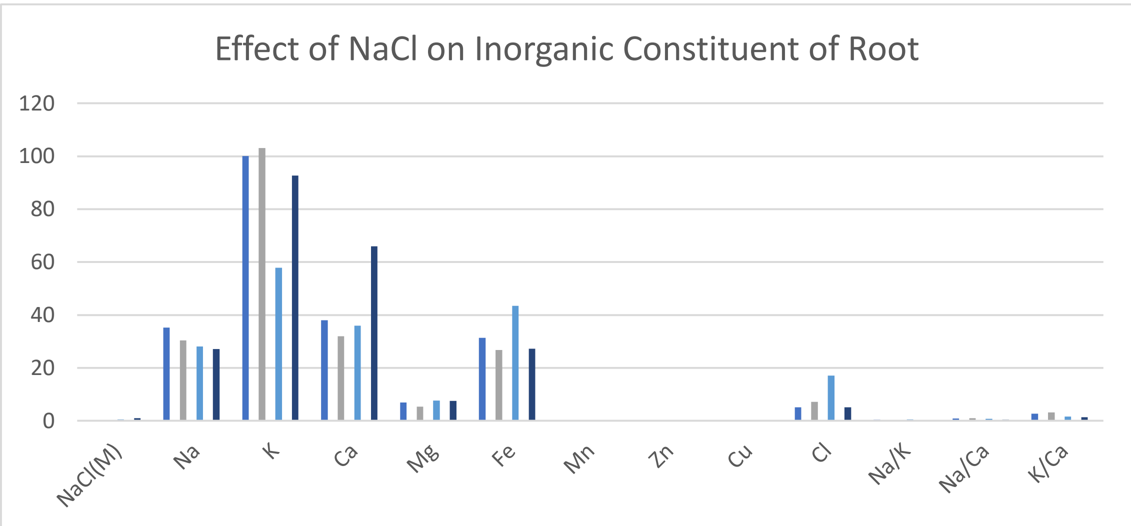
Salinity can damage the plant through osmotic effects of ions and by disturbing uptake of essential nutrients. According to Greenway and Munns (1980) salt sensitivity in non-halophytes may results from, injury caused by ions which are absorbed by the cell and are not compartmentalized. Disturbed inorganic nutrition is one of the factors responsible for the suppression of plant growth in saline or alkaline soil (Singh and Singh,1985).

According to Pitman (1975) ion distribution within plant is dependent on two main factors namely uptake and its radical and its radical and long distance transport,

NaCl stress has been related to increase contents of Na, Cl or both ions in the cytosol(Lauchil and Wiencke,1979) and to a decreased internal availability of nutrient arising from a lower uptake rate and the competition between nutrient ions and Na or Cl (Black,1956;Greenway,1962).The ionic imbalances affects plant metabolism through repression or induction (Hason-Porath and Poljakoff Mayber,1969;Boucaud and Billard, 1979)







The maintenance of internal positive turgor potential of plants exposed to saline conditions is an important factor for maintaining growth. This accomplished by uptake of ions, chiefly K, Na and Cl as well as by synthesizing organic metabolites (Yeo,1983). Potassium is the most abundant cat ion in the cytoplasm and in glycophytes plays an important role in osmotic adjustment (Marschner,1986).and maintenance of photosynthetic activity (Bal et al.,1978; Behboudian and Anderson,1990).Mg is an integral constituent of chlorophyll pigments and Ca is required essentially for maintenance of physicochemical nature, permeability and structural configuration of membranes(Greenway and Munns,1980) The role of Ca as second messenger in plants or of calcium containing proteins has been well documented in literatures.

Large differences in ion concentrations occurs between species. The increase in Na in salt tolerant species grown at 100mM is generally associated with a decrease in K.In contrast salt sensitive species which includes Na from their shoots usually increase in K by 20 to 30% (Greenway et al.,1981)There are also differences in ion concentration between different parts of the same plant.

Generally the different plant parts like leaf,stem and rootshowed a differential rate of uptake of both macro and micro nutrients and also the rate of accumulation or exclusion of minerals show varietal differences. Salinity generally decreased mineral transport especially Fe, Mn ,Mg and Cufrom seed to seedlings, except for potassium. Transport Fe, Mg and Ca to the aerial part was also markedly reduced in sunflower (Sanchez Raya and Delgado,1996).The rasponce of moderately tilerant genotypes hadhigher concentration of Na and Cl in the shoot tissue and also showed lower K/Na ratio under stress as compared to tolerant genotypes. The ratio of K/Na was decreased progressively on salinization.

Kulkarni and Karadage (1991) have reported that Ca suppressed Na uptake and probably contributed to the ionic balance under stress conditions. Uptake and distribution of Mg was favourable, Fe and Mn were accumulated to the toxic level atb100mM NaCl in moth bean, Mn uptake tended to be higher. .Ruiz et al.,(1997) have found that a significant effect on the leaf concentration of Cl ,Na ,K, Ca ,Mg ,P ,Fe ,Mn and Zn in citrus after 60 days of salinization.

In contrast to this there are several reports showing decreased ratio of Na/K and Na/Ca. Datta et al,.(1991) have reported decreased K/Na ratio in three tropical foliage crops under salinity (Maiza , Sudan grass ,Teosinte). Lahiri et al (1996) has showed the moderately tolerant genotypes of cluster bean had lower K:Na ratio under stress. The ratio of K/Na was decreased progressively on salinization in sunflower plants by Gadallah (1996). The soil sodicity decreased K/Na and Ca/Na ratio in plants in tissues considerably (Porcelli et al .,1995). El-Agrodi (1991) has found the K/Na in plant decreased with increasing soil salinity in sorghum.The decreased K/Na in seven flax cultivers under saline treatement was reported by Beke and Graham (1995).

In the present investigation accumulation of mineral constitution under salt stress in mulberry, variety M5 showed that the Na and Cl accumulation was more in stem and leaves than in roots. It seems that root has excluded the accumulation of toxic ions .It has effectively translocated the toxic ions to stem and leaves. More amount of Na and Cl was found in stem than the leaf. This shows that stem has accumulated more Na and Cl. At the same time the Ca accumulation in stem and leaf increased and decreased in root. Whereas roots have accumulated more K and the K content was less in stem and leaf.These variable distribution of mineral ions namely Na ,K ,Ca , and Cl seems to have role in the salt tolerance metabolism of mulberry . Roots have developed higher tolerance than aerial parts.

Conclusions: The present investigation may help to know the uptake and accumulation of various minerals in different parts of the saline treated plants. Which may help to screen salt tolerant varieties which in turn helps to undertake mulberry cultivation in the salt affected marginal lands.

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