Responses of Ber (Zizyphus mauritiana Lamk.) Varieties to Different Level of Salinity

S.S. Verma*, R.P. Verma¹, S.K. Verma¹, A.L. Yadav¹ and A.K. Verma²

¹ College of Horticulture and Forestry, NDUAT, Faizabad-224 229, Uttar Pradesh, India
² ICAR- National Research Centre on Seed Spices, Ajmer-305206, Rajasthan, India

*Corresponding author

Abstract

The current work aims to assess response of ber cultivars to different level of salinity. The salinity level (0, 4.0, 8.0, 12.0, 16.0 dSm⁻¹ ECe) had detrimental effects on growth and mineral composition of transplanted six ber cultivars. High levels of salts tolerated by most of the varieties but severely limit plant growth. High soil salinity decreased the growth (plant height, stem diameter, number of leaves per plant and dry matter yield) and mineral composition of leaves above conductivity of 12 dSm⁻¹ ECe. The Na⁺ and Cl⁻ content of leaves were increased with increasing the levels of salinity, whereas N, P, K⁺, Ca²⁺ and Mg²⁺ content was decreased. Specific injury due to high accumulation of chloride and sodium in the plant foliage of ber cultivars seemed to be the chief effect of salinity. On the basis of salt tolerance limits, ber cultivars Banarsi Karaka, Narendra Ber Sel.-2 and Ponda can be placed in tolerant and cvs. Narendra Ber Sel.-1 and Gola as semi-tolerant group. This result may help in commercial cultivation of ber in salt pretentious areas.

Keywords

Ber, Cultivars, Leaf injury, Mineral composition, Salinity tolerance, Plant growth

Introduction

Ber (Zizyphus mauritiana Lamk.) is a hardy fruit tree belongs to family Rhamnaceae with the chromosome number 2n = 48. It can be successfully grown in arid and semi-arid zones of Indian states particularly Haryana, Rajasthan, Madhya Pradesh and Gujarat. India has a rich source of underutilized native and exotic fruit trees, which may have a high agro industrial potential and represent an important economic source for the local populations and ber fruit is one of them. It is considered poor man’s apple because its fruits are easily available at low cost of production, rich source of vitamin C, protein and minerals (Pareek and Yahia, 2013). The cultivation of ber is gaining popularity in arid and semi-arid region in India because of its low maintenance cost, wide adaptability, low water requirement, high yield, good returns, scope for value addition and suitability even under wastelands (Martinuzzo, 2006). Ber is remunerative fruit, which can be grown successfully even in marginal and saline soils with little care. Due to its hardy nature, adaptability to marginal conditions of soil and climate and the nutritive value of its fruit, it has now become the most
important fruit of arid regions (Singh and Yadav, 2017).

Salinity affects a large area of the world’s arable land making the landscape either barren or unproductive. It is estimated that about 20% of the earth’s land mass and nearly half of the total irrigated land is affected by salinity (Agrawal et al., 2013). Salinity is considered to be a significant factor affecting crop production and agricultural sustainability in many regions of the world and it reduces the value and productivity of the affected lands (Bolarin et al., 1993). Salinity are the major problems in arid and semiarid regions of the country, more prominently in the indus and Gangetic plains in the north. The process of salinization involves accumulation of soluble salts on the soil surface. High concentration of salt in the root zone reduces soil water potential and the availability of water (Arndt et al., 2000). As a result of this, reduction of the water content leading to dehydration at cellular level and osmotic stress is observed. The increased amount of sodium ($\text{Na}^+$) and chloride ($\text{Cl}^-$) in the environment affects the uptake of many indispensable nutrients through competitive interactions and by affecting the ion selectivity of membranes (Shiyab et al., 2013). Salt stress is a complex physicochemical progression, in which several biological molecules such as nucleic acids, proteins, carbohydrates, lipids, hormones, ions, free radicals, free amino acids and mineral elements are actively involved (Munns, 2002; Liu and Baird, 2004; Verma et al., 2018). Besides this, salt stress decrease the photosynthesis (Pradeep and Jumbhale, 2000), causes stomata closure (Hernandez and Almansa, 2002) and increases the concentration of activated oxygen species (AOS), such as superoxide radical (O$_2^-$), hydrogen peroxide (H$_2$O$_2$) and hydroxyl radical (OH$^-$) via enhanced leakage of electrons to oxygen (Arzani, 2008). The salinity tolerance of several fruit crops has been studied by various workers, but no information regarding salinity tolerance of ber is available. In view of these facts it was considered necessary to initiate investigation to study the salinity tolerance of *Zizyphus mauritiana* species of ber. The present report is an attempt to evaluate the effect of soil salinity on plant growth and mineral composition of six ber cultivars.

**Materials and Methods**

The investigations were undertaken at the experimental orchard of the Department of Horticulture, Narendra Deva University of Agriculture and Technology, Faizabad, Uttar Pradesh (India) during the year (2012-2013) with six ber cultivars in cement pots (45x45x45cm size) containing sandy loam soil. The treatments included five level of salinity (0, 4.0, 8.0, 12.0, 16.0 dSm$^{-1}$ECe). The salinity levels were created by adding differential amounts of $\text{NaCl}$, $\text{Na}_2\text{SO}_4$, $\text{CaCl}_2$ and $\text{MgCl}_2\cdot6\text{H}_2\text{O}$ in the soil in such proportions, so as to obtain the Na: Ca+Mg ratio of 1:1 and 1:2, respectively. Salt solution containing above salts was prepared on the basis of saturation percentage of the soil. The soil thus treated was covered with polythene sheet for a two week to allow uniform distribution of salts. The salts solution was thoroughly sprayed with a fine nozzle sprayer. The soil was analysed for ECe before transplanting of ber cultivars. The observed salinity levels along with their designations are given in Table 1.

Three months old budded ber plants of uniform size were transplanted in each pot. Only one budded plants was allowed to grow in each pot. After 30 days of transplanting on the basis of visual observation and seeing the moisture conditions of the soil, the pots were irrigated with canal water. The irrigation was applied through a rose cane alternatively to facilitate the uniform distribution of salts,
there by maintaining the particular salinity in
the root zone. The recommended cultural
practices were followed throughout the growth
period of the ber cultivars.

Observation on growth characters viz plant
height, stem diameter at 15 cm above ground
level and number of leaves per plant at
monthly interval were recorded. Dry matter
yield of shoots and roots were taken at the
time of uprooting the plants, before harvesting
plants, leaf samples for mineral analysis were
obtained by collecting mature representative
leaves from each plant. Leaves were washed
with distilled water dried in an oven at 70ºC
and ground finally. Form each sample 0.5 g of
material was digested in the diacid mixture
(4:1 HNO₃; HClO₄) and N was analysed with
the help of micro Kjeldahl flask. For
determining Ca²⁺ and Mg²⁺ were determined
with Atomic Absorption Spectrophotometry
(AA); while K⁺ and Na⁺ was estimated with
flame emission. Chloride (Cl⁻) in plant tissue
extracts was determined by potentiometric
titration. The procedure involves extraction of
Cl⁻ from dried, powdered plant material in hot
deionized water. The concentrations were
determined directly by silver ion titration
using Eppendorf chloridometer (type 6610).
The Experiment was laid out in Completely
Randomized Design (CRD). Total twenty four
treatment combustions were used and each
treatment was replicated three times. The data
were evaluated with analysis of variance
(ANOVA).

Results and Discussion

Visible symptoms of salt injury

The plants grown in normal soil shows that no
injury symptoms were noticed in all varieties
of ber (Table 2), even though increasing the
salinity level up to the 8 dS/m no injury
symptoms (A) were shown. Further increase
in the salinity level from 8 dS/m to 12 dS/m
there was injury symptoms in the form of
changes in the leaves colour (B) and burning
and necrosis of apical portion of leaves (C)
were observed. Ber variety Narendra Ber Sel.-
3 shows B and C symptoms. Varieties
Narendra Ber Sel.-1, Ponda and Gola showed
B types of injury while Banarsi Karaka and
Narendra Ber Sel.-2 did not show any types of
symptoms (A) at the salinity level 12 dS/m.
When the salinity increased from 12 to 16
dS/m, all varieties showed injury symptoms
(B and C). Varieties Banarsi Karaka and
Narendra Ber Sel.-2 showed B types salinity,
while Narendra Ber Sel.-1, Narendra Ber Sel.-
3, Ponda and Gola shoes BC types of
symptoms. Similar results were recorded by
Singh et al., (2018 a, b) in guava (Psidium
guajava) and bael (Aegle marmelos) under
shallow saline watertable conditions.

Effect of salinity on plant growth

A glance of results on effect of salt stress
revealed that higher concentration of soluble
salts in the soil had an adverse effect on the
growth of ber cultivars (Table 3, 4, 5, 6
and 7). The high levels of soil salinity decreased the
plant height of different cultivars of ber (Table
3). In the normal soil the plant height w
as
highest (157.65 cm) in Narendra Ber Sel.-2
followed by Banarsi Karaka (155.24
and Gola (152.38 cm). The lowest
plant height was recorded in Narendra
Ber Sel.-1. When the different concentrations
of salts added in the soil the plant height of
different cultivars were decreased and lowest
plant height was recorded at highest salinity
level (16 dS/m). Among the different cultivars
at highest salinity level (16 dS/m), maximum
plant height was recorded in Banarsi Karaka
(94.26 cm) followed by Narendra Ber Sel.-2
(91.83 cm) which were statistically at par the
each other. Lowest (76.19 cm) plant height
was observed in Narendra Ber Sel.-1. Data
presented in Table 4 revealed that stem
diameter deceases with the increased in the
Effects on chlorine content (%) 

In chloride dominated saline soils which were used for the experimentation the first injury symptom was the inhibition of plant growth followed by change in colour of leaves. Perusals of data presented in Table 8 reveals that increase level of salinity enhance the accumulation of chloride by the plants. The highest (0.93%) chloride accumulation was recorded in Narendra Ber Sel.-1 followed by Narendra Ber Sel.-2 (0.91%), while the minimum (0.79%) chloride accumulation was recorded in Banarsi Karaka at 16 dS/m. The increase in the leaf concentration of chloride seems to be fairly correlating with plant growth. The chloride content of foliage increased with the increasing levels of salinity and increase was more marked at and above the salinity level of 12 dSm⁻¹ECe per cent corresponding to 8 dSm⁻¹ECe does not seem to have more adverse effect on plant growth but on increase above this level of chloride accumulation had an adverse effect on plant growth.
Table 1 Showing desired and obtained salinity levels

| Desired ECe level | Initial level | pH |
|-------------------|---------------|----|
| Control (0)       | ECe (dSm⁻¹)   |    |
|                   | 0.81          | 7.3|
| 4                 | 3.98          | 7.5|
| 8                 | 8.10          | 7.6|
| 12                | 11.93         | 7.7|
| 16                | 15.67         | 8.0|

Table 2 Effect of salinity levels on leaf injury in relation to salinity of ber cultivars

| Cultivar          | Soil Salinity level (ECe)        |
|-------------------|---------------------------------|
|                   | Normal Soil | 4 | 8 | 12 | 16 |
| Banarsi Karaka    | A           | A | A | A  | B  |
| Narendra Ber Sel.-1 | A       | A | A | B  | B C|
| Narendra Ber Sel.-2 | A       | A | A | A  | B  |
| Narendra Ber Sel.-3 | A       | A | B | C  | B C|
| Ponda             | A           | A | A | B  | B C|
| Gola              | A           | A | A | B  | B C|
| A. No symptoms appeared, B. Change the leaves colour from dark green to yellowish or whitish green, C. Burning and necrosis of apical portion leaves

Table 3 Effect of salinity levels on plant height (cm) of ber cultivars

| Cultivar          | Soil salinity level (ECe) | Mean |
|-------------------|---------------------------|------|
|                   | Normal Soil | 4 | 8 | 12 | 16 |
| Banarsi Karaka    | 155.24       | 156.80 | 152.85 | 112.02 | 94.26 | 134.23 |
| Narendra Ber Sel.-1 | 133.78     | 134.23 | 113.25 | 94.23 | 76.19 | 110.34 |
| Narendra Ber Sel.-2 | 157.65     | 157.57 | 138.79 | 120.94 | 91.83 | 133.36 |
| Narendra Ber Sel.-3 | 142.25     | 138.16 | 119.15 | 97.61 | 79.46 | 115.33 |
| Ponda             | 144.30       | 139.85 | 129.85 | 106.22 | 83.51 | 120.75 |
| Gola              | 152.38       | 146.01 | 127.54 | 103.34 | 79.41 | 121.74 |
| Mean              | 147.60       | 145.44 | 13.24  | 105.73 | 84.11 |
| C.D. (P=0.05)     | 4.05         | 3.69  | 9.05   |

Table 4 Effect of salinity levels on stem diameter (cm) of ber cultivars

| Cultivar          | Soil salinity level (ECe) | Mean |
|-------------------|---------------------------|------|
|                   | Normal Soil | 4 | 8 | 12 | 16 |
| Banarsi Karaka    | 1.98         | 1.92 | 1.74 | 1.39 | 1.11 | 1.63 |
| Narendra Ber Sel.-1 | 1.82       | 1.86 | 1.60 | 1.30 | 1.00 | 1.52 |
| Narendra Ber Sel.-2 | 1.98       | 1.97 | 1.60 | 1.29 | 1.07 | 1.58 |
| Narendra Ber Sel.-3 | 1.86       | 1.86 | 1.71 | 1.34 | 1.00 | 1.55 |
| Ponda             | 1.91         | 1.95 | 1.68 | 1.22 | 1.04 | 1.56 |
| Gola              | 1.77         | 1.64 | 1.52 | 1.22 | 1.01 | 1.43 |
| Mean              | 1.89         | 1.87 | 1.64 | 1.29 | 1.04 |
| C.D. (P=0.05)     | 0.03         | 0.03 | 0.04 | 0.05 | 0.08 |
Table 5 Effect of salinity levels on number of leaves/plant of ber cultivars

| Cultivar          | Soil salinity level (ECe) | Mean   |
|-------------------|---------------------------|--------|
|                   | Normal Soil | 4     | 8     | 12    | 16  |        |
| Banarsi Karaka    | 292.33       | 291.67| 257.00| 189.00| 151.00| 236.20|
| Narendra Ber Sel.-1| 233.33       | 225.00| 194.67| 143.00| 114.33| 182.07|
| Narendra Ber Sel.-2| 301.33       | 290.33| 253.67| 188.33| 140.67| 234.87|
| Narendra Ber Sel.-3| 245.33       | 239.33| 190.67| 160.33| 131.33| 193.40|
| Ponda             | 263.00       | 262.00| 238.00| 178.00| 138.00| 215.80|
| Gola              | 245.33       | 241.33| 189.00| 167.00| 110.00| 190.53|
| Mean              | 263.44       | 258.28| 220.50| 170.94| 130.89|        |

C.D. (P=0.05) 5.51 5.03 12.32

Table 6 Effect of salinity levels on dry weight of shoots (g) of ber cultivars

| Cultivar          | Soil salinity level (ECe) | Mean   |
|-------------------|---------------------------|--------|
|                   | Normal Soil | 4     | 8     | 12    | 16  |        |
| Banarsi Karaka    | 184.00       | 176.33| 177.90| 151.80| 124.67| 162.94|
| Narendra Ber Sel.-1| 170.30       | 164.47| 146.20| 125.50| 118.00| 144.89|
| Narendra Ber Sel.-2| 181.30       | 178.50| 159.53| 143.23| 119.80| 156.47|
| Narendra Ber Sel.-3| 163.03       | 159.90| 143.87| 122.07| 106.30| 139.03|
| Ponda             | 167.90       | 163.90| 146.80| 131.77| 111.90| 144.45|
| Gola              | 157.97       | 154.07| 140.07| 123.03| 106.70| 136.37|
| Mean              | 170.75       | 166.19| 152.40| 132.90| 114.56|        |

C.D. (P=0.05) 2.03 1.85 4.55

Table 7 Effect of salinity levels on dry weight of roots (g) of ber cultivars

| Cultivar          | Soil salinity level (ECe) | Mean   |
|-------------------|---------------------------|--------|
|                   | Normal Soil | 4     | 8     | 12    | 16  |        |
| Banarsi Karaka    | 98.30        | 99.20 | 82.93 | 73.47 | 58.50| 82.48 |
| Narendra Ber Sel.-1| 90.73        | 85.53 | 75.40 | 65.10 | 49.70| 73.29 |
| Narendra Ber Sel.-2| 99.53        | 99.17 | 82.43 | 70.80 | 56.17| 81.62 |
| Narendra Ber Sel.-3| 90.37        | 90.88 | 78.50 | 66.23 | 54.83| 76.16 |
| Ponda             | 93.33        | 91.93 | 80.33 | 66.80 | 55.27| 77.53 |
| Gola              | 94.00        | 88.83 | 76.50 | 66.37 | 48.80| 74.90 |
| Mean              | 94.38        | 92.59 | 79.35 | 68.13 | 53.88|        |

C.D. (P=0.05) 1.37 1.25 3.07
Table 8 Effect of salinity levels on chlorine content in leaves (%) of ber leaves in different cultivars

| Cultivar      | Normal Soil | Soil Salinity level (ECe) | Mean |
|---------------|-------------|---------------------------|------|
|               |             | 4  | 8  | 12 | 16 |
| Banarsi Karaka| 0.25        | 0.30 | 0.36 | 0.56 | 0.79 | 0.45 |
| Narendra Ber Sel.-1 | 0.25 | 0.32 | 0.47 | 0.63 | 0.93 | 0.52 |
| Narendra Ber Sel.-2 | 0.21 | 0.25 | 0.38 | 0.58 | 0.91 | 0.46 |
| Narendra Ber Sel.-3 | 0.24 | 0.27 | 0.41 | 0.62 | 0.86 | 0.48 |
| Ponda         | 0.23        | 0.28 | 0.40 | 0.59 | 0.82 | 0.46 |
| Gola          | 0.28        | 0.30 | 0.38 | 0.56 | 0.85 | 0.47 |
| Mean          | 0.24        | 0.28 | 0.40 | 0.59 | 0.86 |      |

Cultivar (C) | ECe Level (S) | Interaction (C X S) | C.D. (P=0.05) |
-------------|----------------|---------------------|---------------|
         | 0.016          | 0.0.14              | 0.035         |

Table 9 Effect of salinity levels on N, P and K composition of ber leaves in different cultivars (dry weight basis)

| Cultivar      | Nitrogen (%) | Phosphorus (%) | Potassium (%) |
|---------------|--------------|----------------|---------------|
|               | Normal Soil  | Soil Salinity level | Mean | Normal Soil  | Soil Salinity level | Mean | Normal Soil  | Soil Salinity level | Mean |
|               | 4  | 8  | 12 | 16 | 4  | 8  | 12 | 16 | 4  | 8  | 12 | 16 |
| Banarsi Karaka| 4.28 | 4.24 | 4.17 | 3.95 | 3.66 | 4.06 | 0.013 | 0.012 | 0.029 | 0.013 | 0.012 | 0.029 | 0.85 | 0.83 | 0.79 | 0.74 | 0.66 | 0.77 |
| Narendra Ber Sel.-1 | 4.15 | 4.14 | 4.01 | 3.62 | 3.29 | 3.84 | 0.03  | 0.03  | 0.08  | 0.03  | 0.03  | 0.08  | 0.74 | 0.74 | 0.71 | 0.65 | 0.46 | 0.66 |
| Narendra Ber Sel.-2 | 4.24 | 4.26 | 4.10 | 3.89 | 3.54 | 3.84 | 0.013 | 0.012 | 0.029 | 0.013 | 0.012 | 0.029 | 0.83 | 0.80 | 0.76 | 0.70 | 0.59 | 0.74 |
| Narendra Ber Sel.-3 | 4.11 | 4.13 | 3.92 | 3.73 | 3.38 | 3.85 | 0.03  | 0.03  | 0.08  | 0.03  | 0.03  | 0.08  | 0.79 | 0.74 | 0.73 | 0.60 | 0.43 | 0.66 |
| Ponda         | 4.19 | 4.17 | 3.99 | 3.82 | 3.47 | 3.93 | 0.013 | 0.012 | 0.029 | 0.013 | 0.012 | 0.029 | 0.80 | 0.79 | 0.73 | 0.68 | 0.52 | 0.70 |
| Gola          | 4.17 | 4.13 | 4.00 | 3.72 | 3.39 | 3.88 | 0.03  | 0.03  | 0.08  | 0.03  | 0.03  | 0.08  | 0.79 | 0.73 | 0.70 | 0.60 | 0.48 | 0.66 |
| Mean          | 4.19 | 4.18 | 4.03 | 3.79 | 3.45 |      | 0.013 | 0.012 | 0.029 | 0.013 | 0.012 | 0.080 | 0.77 | 0.74 | 0.66 | 0.66 | 0.52 |

Cultivar (C) | ECe Level (S) | Interaction (C X S) | C.D. (P=0.05) |
-------------|----------------|---------------------|---------------|
         | 0.03           | 0.03                | 0.08          |

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Table.10 Effect of salinity levels on $\text{Na}^+$, $\text{Ca}^{++}$ and $\text{Mg}^{++}$ composition of ber leaves in different cultivars (dry weight basis)

| Cultivar         | Sodium (%) | Calcium (%) | Magnesium (%) |
|------------------|------------|-------------|---------------|
|                  | Soil Salinity level | Mean | Soil Salinity level | Mean | Soil Salinity levels | Mean |
|                  | Normal Soil  | 4  | 8  | 12 | 16 | Normal Soil  | 4  | 8  | 12 | 16 | Normal Soil  | 4  | 8  | 12 | 16 | Normal Soil  | 4  | 8  | 12 | 16 |
| Banarsi Karaka   | 0.36        | 0.37| 0.42| 0.49| 0.61| 0.45               | 2.56| 2.57| 2.47| 2.34| 2.07| 2.40               | 0.83| 0.78| 0.72| 0.65| 0.53| 0.70          |
| Narendra Ber Sel.-1 | 0.38    | 0.39| 0.44| 0.51| 0.60| 0.46               | 2.36| 2.42| 2.34| 2.21| 1.85| 2.24               | 0.69| 0.66| 0.62| 0.55| 0.42| 0.59          |
| Narendra Ber Sel.-2 | 0.40    | 0.40| 0.44| 0.53| 0.60| 0.47               | 2.52| 2.53| 2.42| 2.23| 1.92| 2.33               | 0.77| 0.72| 0.69| 0.59| 0.47| 0.65          |
| Narendra Ber Sel.-3 | 0.41    | 0.40| 0.47| 0.54| 0.62| 0.49               | 2.36| 2.37| 2.28| 2.19| 1.86| 2.21               | 0.67| 0.67| 0.63| 0.54| 0.40| 0.58          |
| Ponda            | 0.39        | 0.38| 0.45| 0.53| 0.59| 0.47               | 2.41| 2.41| 2.41| 2.22| 1.92| 2.27               | 0.71| 0.70| 0.66| 0.57| 0.43| 0.62          |
| Gola             | 0.40        | 0.41| 0.47| 0.57| 0.65| 0.50               | 2.34| 2.39| 2.26| 2.14| 1.83| 2.19               | 0.71| 0.64| 0.61| 0.52| 0.39| 0.57          |
| Mean             | 0.39        | 0.39| 0.45| 0.53| 0.61| 0.45               | 2.43| 2.45| 2.37| 2.22| 1.91| 0.73               | 0.70| 0.66| 0.57| 0.44|    |               |

C.D. (P=0.05) 0.015 0.014 0.034 0.029 0.026 0.064 0.013 0.012 0.029
In the higher level of chlorine content in the plants, the general yellowing, marginal and tip burning were observed which progressed towards the mid rib and base of leaves. Severely injured leaves become dry and absceded. Such type of leaf injury might be due to high osmotic pressure of salt substrate, which inhibits the uptake of water by the plant roots on the other hand; this may be due to accumulation of chloride (Cl\(^-\)) ions in plants at toxic levels. The findings on plant chloride content in ber cultivars were similar to the findings reported by Agrawal et al., (2013) and Sherani et al., (2017) in Ziziphus mauritiana; Al-Abi et al., (2003) in Olive europaea; Rao and Singh (2004) in Emblica officinalis.

**Effects on mineral constituents**

Data presented in Table 9 and 10 shows that soil salinity affected the mineral constituents of the leaves differently. The concentration of all the salinity ions (Na\(^+\) and Cl\(^-\)) in the leaves of different ber cultivars increased whereas N, P, K\(^+\), Ca\(^{++}\) and Mg\(^{++}\) decreased with increasing level of salinity (from 4 to 16 dS/m). The salt stress decreases the N, P and K\(^+\) content in the ber leaves, as he salinity increases in all varieties of ber (Table 8). In normal soil, maximum (4.28%) nitrogen content was recorded in Banarsi Karaka while applying salt stress the nitrogen content reduced to 3.66% at 16 dS/m. Similarly, P and K\(^+\) content were recorded highest in Banarsi Karaka i.e. 0.012% and 0.66%, respectively. Lowest level (0.43%) of K\(^+\) was recorded in Gola and Narendra Ber Sel.-1. The sodium accumulation showed an increase with increasing levels of salinity (from 4 to 16 dS/m) while Ca\(^{++}\) and Mg\(^{++}\) showed decreasing trend (Table 10). The Na\(^+\) content was increased with increase in the salinity level and recorded maximum (0.65) at 16 dS/m in Gola followed by Narendra Ber Sel.-3 (0.62%), Banarsi Karaka (0.61%), Narendra Ber Sel.-1 and 2 (0.60%) and Ponda (0.59%). In contrast with Na\(^+\), Ca\(^{++}\) and Mg\(^{++}\) were deceased with increase in the salinity level. Maximum (2.07%) Ca\(^{++}\) content were recorded in Banarsi Karaka while, lowest were recorded in Gola (1.83%). Similar results also recorded with respect to Mg\(^{++}\) content, maximum Mg\(^{++}\) content were recorded in Banarsi Karaka (0.70%), whereas, lowest were recorded in Gola (0.57%).

Plants require different macro and micronutrients for metabolic activities such as photosynthesis and the production of secondary metabolites. Salinity-induced decrease in soil osmotic potential and increased concentrations of toxic ions (Na\(^+\) and Cl\(^-\)) restrain the uptake of water and essential nutrients by plants. Salinity almost invariably leads to reduced N availability in plants (Feigin, 1985). Similarly, in most of the cases, salt-stressed plants show deficient P levels with adverse consequences for photosynthesis and other energy-dependent growth processes (Overlach et al., 1993). Elevated Na\(^+\) levels in growing medium usually suppress K\(^+\) supply to plants. K\(^+\) not only acts as an essential cofactor for many enzymes but also plays critical roles in cellular osmotic balance and stomatal regulation (Munns, 2005). Available evidence suggests that some crop genotypes tend to preferentially accumulate K\(^+\) to partly overcome Na\(^+\) toxicity (Baatour, et al., 2010). In majority of the crop plants, salinity lowers Ca\(^{++}\) levels leading to membrane permeability, EL and other harmful effects (Ashraf et al., 2004). A decreased in the concentration of all the primary and secondary nutrients in leaves of ber cultivars viz, N, P, K\(^+\), Ca\(^{++}\) and Mg\(^{++}\) in the foliage with increasing levels of salinity in different plants may be due to their presence of high concentration of salinity ions in the soil. A decrease in N, P and K\(^+\) content of foliage has also been reported (Awasthi, 1995; Shukla
and Singh, 1996). Same decreasing trend in Ca$^{++}$ and Mg$^{++}$ was reported by Al-Abdoulhadi et al., (2011, 2012) and Singh et al., (2016). In saline soils, availability of micronutrients such as Fe, Zn, Mn, and Cu may either increase or decrease (Moreno et al., 2000). Na$^{+}$ accumulation in plant foliage and their relation with growth in the present investigation are in agreement with the findings of Grieve et al., (2007); Garcia-Sanchez et al., (2003).

From the observation on the effect of salinity on growth and mineral composition, it may be concluded that in ber specific injury from Cl$^{-}$ and Na$^{+}$ accumulation in the foliage and nutrient imbalance caused due to high concentration of salinity ions in soil and plant tissues are the chief effects of salinity. Ber cultivars Banarsi Karaka, Narendra Ber Sel.-2 and Ponda can be placed in tolerant group and recommended for commercial cultivation in salt affected areas.

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