Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6[10] September 2017 : 56-59
©2017 Academy for Environment and Life Sciences, India
Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Response of sodicity on growth performance of ber (*Zizyphus mauritiana* Lam.) cultivars

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ABSTRACT
The present investigation entitled "Response of sodicity on growth performance of ber (Zizyphus mauritiana Lam.) cultivars" was carried out at Nursery of Horticultural Crops, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi district of Uttar Pradesh during the year 2014-2016 in plastic pot to assess the growth performance of six commercially ber cultivars viz., Banarasi Peondi, Banarasi Karaka, Umran, Gola, Ponda and Narendra Ber Selection-2 with different level of sodicity (Normal Soil 15%, 30%, 45% and 60%). The experiment was laid out in factorial CRD with 3 replication. The data recorded on plant establishment and survival, plant height, stem diameter, plant spread and a number of leaves per plant. It was found that plant establishment and survival, plant height, stem diameter, plant spread and the number of leaves per plant of ber decreased with increasing levels of sodicity in all cultivars. However, the maximum plant establishment, survival and growth were recorded in Banarasi karaka and Ponda and it was minimum in cultivars Umran and Gola.
Keywords*: cultivar, establishment, survival, height, diameter and spread*

Received 21.04.2017 Revised 23.05.6017 Accepted 29.07.2017

INTRODUCTION

Ber *(Zizyphus mauritiana* Lam.) has been recognized as a useful edible fruit since antiquity in India. Jujubes are considered to be minor fruits and from research and development point of view have not received any major emphasis yet. However, the fruits are an integral part of the culture and way of life of millions of diverse peoples of India. However, if the original wild species was spread from India through Myanmar, then early domestication efforts would postdate that of the staple foods and possibly occurred when populations increased with the rise of tribal kingdoms across the Gangetic plains. *Zizyphus mauritiana* Lam. (Indian jujube) or ber belongs to the family Rhamnaceae. There is a consensus that the genus *Zizyphus* contains 86 species but others suggest there could be up to 135.The productivity of plants is greatly affected by various environmental stresses. Soil salinity affects plant growth and development by way of osmotic stress, injurious effects of toxic ions and nutrient imbalance caused by an excess of Na^+ and Cl^- ions. Indications are available that ber can survive well in sodic soils, but there is little information for its tolerance limit to sodicity. There are several cultivar/genotypes which are commercially grown in eastern part of Uttar Pradesh. But no systematic work has been done on the sodicity tolerance limit of these cultivars. Besides this, information pertaining to adaptability, survival, nutrient uptake and growth behaviour, etc. are also lacking

MATERIALS AND METHODS

The present investigation was carried out at Nursery of Horticultural Crops, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh during the 2014-2016. The ber was growing following the recommended package and practices. The experiment was laid out in a factorial completely randomized design with 30 treatment combinations which included five Sodicity levels (ESP) viz., Normal Soil (S_0), 15% (S_1), 30%(S_2), 45%(S_3) and 60% (S_4) and six commercial

cultivars viz., Banarasi Peondi (C_1), Banarasi Karaka (C_2), Umran (C_3), Gola (C_4), Ponda (C_5) and Narendra Ber Selection-2 (C_6), respectively which are replicated thrice. Uniform cultural operations were followed during the course of the investigation. The observation was recorded on plant establishment and survival, plant height, stem diameter, plant spread and a number of leaves per plant. The data collected were statistically analyzed.

RESULTS AND DISCUSSION

Plant establishment and survival

The table shows that the plant establishment varied non- significantly from 96.66 to 86.66 percent. However, Banarasi Karaka and Ponda recorded 96.66 percent establishment while, Umran and Gola both showed minimum (86.6 percent) establishment. The overall effect of different ESP levels revealed that cent percent plant establishment was recorded for all ber cultivars in normal soil and at 15 and 30 ESP levels which were significantly superior to 45 ESP and 60 ESP levels. However, per cent establishment of plant decreased as the sodicity increased from 45 ESP (83.33 percent) to 60 ESP (75.00 percent). The plant survival was observed statistically non-significant for all cultivars.The maximum 93.33 percent plant survival was noted in Ponda and Banarasi karaka and it was minimum 80.00 percent in cultivars Umran and Gola.The sodicity effect showed considerable variation. The cent percent plant survival was obtained in normal soil and 15 ESP level which were significantly superior to rest of sodicity levels of soil, whereas, it reduced to 94.44, 77.77 and 66.66 percent at 30, 45 and 60 ESP levels of sodicity respectively. Poor plant establishment and survival at a higher level of sodic soil may be due to sudden shock which the plant could not bear as a result of poor soil structure leading to aeration problem, moisture stress, nutrient imbalance and ionic toxicities of $Nacl_2$ and CO_3. These factors adversely affected the root growth and metabolic processes within the plant. Interaction effect owing to cultivars and sodicity levels had a significant influence on plant establishment and survival. Rao and Singh [1] recorded lower plant establishment and survival at higher sodicity levels. Similar results were also recorded by Dubey *et al*., [2] and Srivastava, *et al*., [3].

Growth studies

Plant height

The maximum 134.60cm plant height was observed in Banarasi Karaka which is significantly higher than thereof other cultivars. Cultivar Ponda showed intermediate 129.93cm plant height. The minimum 105.95cm plant height was recorded in Umran. In case of soil type, plant height showed a significant response to the increasing level of sodicity. The maximum 148.67cm plant height was recorded in the normal soil which was significantly higher than that of 15 ESP (138.02cm) and 30 ESP (125.51cm). The minimum 80.75cm plant height was recorded at 60 ESP.

Stem diameter

Data on the effect of sodicity on stem diameter of ber cultivars showed that stem diameter among cultivars varied greatly from1.59 to1.42cm. The maximum 1.59cm stem diameter was noted in Banarasi Karaka which was significantly at par with Ponda (1.58cm). The minimum 1.42cm stem diameter was noted in cultivar Umran. In respect to soil types, it was discerned that higher sodicity level caused a significant reduction in stem diameter. It was noted from 1.82 cm in the normal soil which declined to 1.77cm at 15 ESP, 1.67cm at 30 ESP, 1.30cm at 45 ESP and 1.01cm at 60 ESP levels.

Plant spread

Data pertaining to plant spread have been shown, the maximum 62.74cm plant spread was observed in Banarasi Karaka which was significantly higher than those of Ponda (59.39cm), Banarasi Peondi (57.56cm), Narendra Ber selection-2 (56.78cm) and Gola (54.08cm). The minimum 49.75cm plant spread was recorded in cultivar Umran. In case of sodicity levels, the highest 75.07cm plant spread was noted under normal soil which was significantly at par with 15 ESP soil. The plant spread significantly reduced to 34.80cm at 60 ESP of sodicity level.

Number of leaves per plant

The data showed that the cultivar response with respect to a number of leaves per plant differed significantly. The maximum 231.07 numbers of leaves were noted in Banarasi Karaka followed by Ponda (222.5) and Banarasi Peondi (212.28) while, the minimum 147.25 number of leaves were recorded in cultivar Umran. The sodicity levels also had an interesting influence on the number of leaves. The highest 245.46 number of leaves was noted in the normal soil which was significantly higher than those of other ESP levels. The number of leaves decreased with increase in sodicity level-up to 60 ESP. The reduction of leaves ranges between 242.50 to 125.14 from control to 60 ESP level respectively. The growth suppression in sodic soil may be due to poor soil structure, inadequate aeration, low water availability, production of toxic substances within the plants and nutritional imbalance. These factors reduced the

metabolic processes within the plant and also checked root growth. Interaction effect owing to cultivars and sodicity levels had significant influence in respect to growth except for stem diameter. Above findings also supported by several workers [3, 4-9].

Table 1: Effect of cultivars and soil sodicity levels on plant establishment, survival and growth parameter of ber

Factors and their interaction	Plant establishment (Per cent)	Plant survival (Per cent)	Plant height (cm)	Stem diameter (cm)	Plant spread (cm)	Number of leaves per plant
Cultivars (C)						
Banarasi Peondi(C_1)	93.33	90.00	116.17	1.52	57.56	212.28
Banarasi Karaka(C_2)	96.66	93.33	134.60	1.59	62.74	231.07
Umran(C_3)	86.66	80.00	105.95	1.42	49.75	147.25
Gola(C_4)	86.66	80.00	116.98	1.48	54.08	173.18
Ponda(C_5)	96.66	93.33	129.93	1.58	59.39	222.50
NarendraBer Selection-2(C_6)	90.00	90.00	108.66	1.50	56.78	180.67
C.D. (P=0.05)	N.S.	N.S.	2.406	0.021	1.477	3.015
Soil types (S) ESP						
Normal Soil(S_0)	100.00	100.00	148.67	1.82	225.52	386.98
15(S_1)	100.00	100.00	138.02	1.77	220.41	373.64
30(S_2)	100.00	94.44	125.51	1.67	192.04	346.62
45(S_3)	83.33	77.77	100.63	1.30	135.48	290.48
60(S_4)	75.00	66.66	80.75	1.01	129.90	244.78
C.D. (P=0.05)	9.96	11.01	2.196	0.019	2.752	3.55
Interaction						
S_0C_1	100.00	100.00	140.15	1.81	75.71	253.78
S_0C_2	100.00	100.00	166.45	1.93	81.81	284.94
S_0C_3	100.00	100.00	131.48	1.69	63.37	184.34
S_0C_4	100.00	100.00	153.10	1.78	71.62	252.07
S_0C_5	100.00	100.00	162.19	1.90	77.93	272.11
S_0C_6	100.00	100.00	138.63	1.81	75.073	225.52
S_1C_1	100.00	100.00	130.89	1.75	71.83	250.59
S_1C_2	100.00	100.00	153.51	1.83	77.63	276.14
S_1C_3	100.00	100.00	121.65	1.69	61.85	179.15
S_1C_4	100.00	100.00	143.56	1.72	70.97	245.37
S_1C_5	100.00	100.00	152.97	1.84	71.04	266.11
S_1C_6	100.00	100.00	125.52	1.77	75.08	220.41
S_2C_1	100.00	100.00	121.24	1.64	53.66	234.08
S_2C_2	100.00	100.00	143.93	1.73	60.50	254.56
S_2C_3	100.00	83.33	108.93	1.60	51.59	147.56
S_2C_4	100.00	83.33	117.07	1.65	58.04	142.52
S_2C_5	100.00	100.00	147.04	1.75	57.44	253.37
S_2C_6	100.00	100.00	114.83	1.65	54.30	192.04
S_3C_1	83.33	83.33	100.21	1.34	48.33	182.08
S_3C_2	100.00	83.33	115.07	1.38	52.48	189.18
S_3C_3	66.67	66.67	98.60	1.21	39.50	124.99
S_3C_4	66.67	66.67	98.63	1.24	38.33	124.56
S_3C_5	100.00	83.33	101.30	1.36	51.19	175.56
S_3C_6	83.33	83.33	89.95	1.28	44.64	135.48
S_4C_1	83.33	66.67	88.37	1.02	38.25	140.86
S_4C_2	83.33	83.33	94.04	1.08	41.24	150.50
S_4C_3	66.67	50.00	69.07	0.91	32.45	100.22
S_4C_4	66.67	50.00	72.52	1.00	31.45	101.37
S_4C_5	83.33	83.33	86.12	1.05	39.33	145.74
S_4C_6	66.67	66.67	74.38	0.99	34.80	129.90
C.D. (P=0.05)	26.35	29.15	5.380	N.S.	3.303	6.742

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CITATION OF THIS ARTICLE

Lavkush Singh, S.P. Singh, P.K. Sharma, and Avnish Pandey. Response of sodicity on growth performance of ber (*Zizyphus mauritiana* Lam.) cultivars. Bull. Env. Pharmacol. Life Sci., Vol 6[10] September 2017: 56-59