International Journal of Agricultural Sciences
Volume **14** | Issue 2 | June, 2018 | 413-418 ■ e ISSN-0976-5670
DOI:10.15740/HAS/IJAS/14.2/413-418
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RESEARCH PAPER

Effect of irrigation frequency and salinity levels of irrigation water on salt dynamics under drip irrigation in cabbage (*L. Brassica Oleracea* var. Capitata)

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Abstract : Use of poor quality water for agriculture production requires appropriate management strategies such as leaching of excessive salts, selection of salt tolerant crops, frequent application of water etc. Thus a field experiment was conducted at C.C.S. Haryana Agricultural University, Hisar to study the salt dynamics in soil under drip irrigation system on cabbage crop and to investigate the effect of frequency and salinity levels of irrigation water on cabbage. Two irrigation frequency: daily (F_1) and alternate day (F_2) irrigation and five salinity levels of irrigation water: canal water (S_1), EC_{iw}3 (S_2), 6 (S_3), 9 (S_4) and 12 (S_5) dS/m treatments were considered in the experiment. With movement away from the plant (radial or vertically), salt concentration increased in the rootzone. More electrical conductivity was observed at the wetting front of the rootzone. In daily irrigation under saline water of EC_{iw} 12 dS/m (F_1S_5), the EC_e values after 90 days of transplantation was increased by 206.4, 222.1, 244.4 and 264.1% on comparing with initial values in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively. In alternate day irrigation under saline water of 12 dS/m (F_2S_5), the EC_e values after 90 days of transplantation was increased by 279.2, 262.7, 270.1 and 280.2% on comparing with initial values in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively.

Key Words : Cabbage, Drip irrigation, Saline water, Salt dynamics

View Point Article : Sharma, Parmod, Kumar, Sanjay and Narender (2018). Effect of irrigation frequency and salinity levels of irrigation water on salt dynamics under drip irrigation in cabbage (*L. Brassica Oleracea* var. Capitata). *Internat. J. agric. Sci.*, **14** (2) : 413-418, **DOI:10.15740/HAS/IJAS/14.2/413-418.** Copyright@2018: Hind Agri-Horticultural Society.

Article History : Received : 31.03.2018**; Revised :** 10.05.2018**; Accepted :** 24.05.2018

INTRODUCTION

The availability of fresh water for agricultural use is declining in many areas of the world due to the increasing water needs from other sectors. Thus, agriculture faces challenges of using low quality waste water and saline water for crop production. Indian agriculture continues to depend heavily on its ground water especially in arid and semi-arid regions. Unfortunately, in the country, about 50% of underground waters are either marginal or poor in quality, whereas, in Rajasthan, Haryana and Utter Pardesh is even upto 84, 63 and 63%, respectively (Phogat *et al.*, 2010). Due to unavailability of good quality water for irrigation, saline water is an important source of supplemental irrigation

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in these areas. Many studies indicate that the part of the brackish water resources traditionally classified as unsuitable for irrigation can be used successfully to grow crops without long-term hazardous consequences to crops and soils if proper management strategies are established. These strategies include adopting advanced irrigation technology, selecting appropriate salt-tolerant crops, leaching salts below the crop root zone etc. (Rhoades *et al*., 1992; Shalhevet, 1994). The frequent water application in drip irrigation results better moisture condition in the crop root zone. Thus, drip irrigation is widely regarded as a suitable system for applying saline water to crops (Malash *et al*., 2008). So the present experiment was designed the effect of irrigation frequency and salinity levels of irrigation water on salt dynamics under drip irrigation in cabbage

MATERIAL AND METHODS

Treatment details :

The experimental was laid out with two irrigation frequency treatments: daily (F_1) and alternate day (F_2) irrigation and five salinity levels of irrigation water [canal water EC_{iw} = 0.5 (S_1), saline water EC_{iw} = 3.0 (S_2), saline water EC_{iw} = 6.0 (S_3), saline water EC_{iw} = 9.0 (S_4) and saline water EC_{iw} = 12.0 (S_5)]. Accordingly the following abbreviation will be used to denote the different treatments as given in the Table A.

Layout of the experiment :

The experiment was laid out in 2.0 x 2.0 m plot as shown in Fig. A. The spacing between plant to plant and lateral to lateral was kept 45 cm.

Irrigation scheduling :

Same amount of water was applied in all the treatments as per the pan evaporation (IW/CPE ratio = 1). In daily irrigation treatment, amount of water equal to pan evaporation of the previous day was applied, whereas, in alternate day irrigation treatment amount of water equal to previous two days pan evaporation was applied.

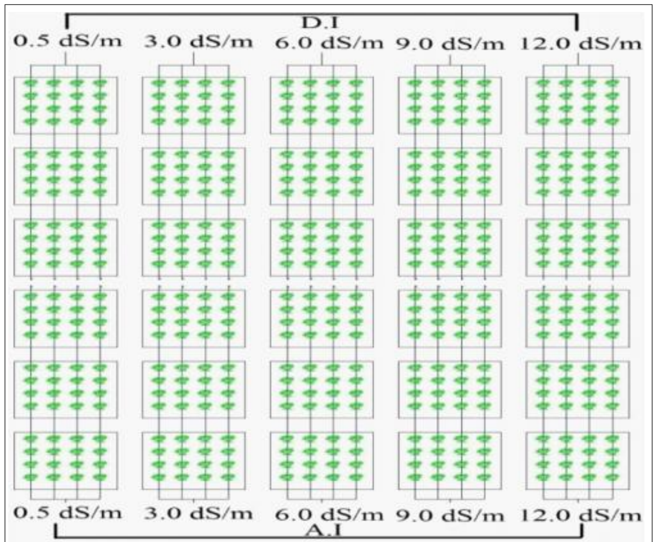

Fig. A : Layout of the experimental field plots

Soil salinity (EC_e) :

The soil samples from each treatment were collected at a radial distance of 7.5 and 22.5 cm from the plant and at different depths (0-15, 15-30, 30-45 and 45-60 cm) in the soil profile at fifteen days intervals after transplanting during the experiment with the help of tube auger. Electrical conductivity was determined in 1:2 soils and water suspension using soluble bridge conductivity meter as per description in UDSA hand book no. 60 (1954).

From the observed values of electrical conductivity

Table A : Treatment wise abbreviation used

Sr. No.	Treatments	Abbreviation
1.	Daily irrigation with canal water (EC_{iw} = 0.5 dS/m)	F_1S_1
2.	Daily irrigation with EC_{iw} of 3.0 dS/m	F_1S_2
3.	Daily irrigation with EC_{iw} of 6.0 dS/m	F_1S_3
4.	Daily irrigation with EC_{iw} of 9.0 dS/m	F_1S_4
5.	Daily irrigation with EC_{iw} of 12.0 dS/m	F_1S_5
6.	Alternate day irrigation with canal water (EC_{iw} = 0.5 dS/m)	F_2S_1
7.	Alternate day irrigation with EC_{iw} of 3.0 dS/m	F_2S_2
8.	Alternate day irrigation with EC_{iw} of 6.0 dS/m	F_2S_3
9.	Alternate day irrigation with EC_{iw} of 9.0 dS/m	F_2S_4
10.	Alternate day irrigation with EC_{iw} of 12.0 dS/m	F_2S_5

(EC_e) at different depths and dates, spatial and temporal graphs were plotted for 30, 60 and 90 days after transplanting. EC_e patterns were characterized by the radial distance and the depth from the plant (dripper) of the EC_e front.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

EC_e distribution under daily irrigation treatment :

Fig. 1 to 5 show the EC_e distribution pattern under daily irrigation with different saline water treatment *i.e.* F_1S_1, F_1S_2, F_1S_3, F_1S_4 and F_1S_5, after 30 days, 60 days and 90 days of transplanting. On comparing the contours of these figures for 30 days after transplanting, it was observed that the value of ECe in the rootzone is increasing slightly with increasing levels of EC_{iw}. Whereas, contours for 90 days after transplanting has shown steep increase in EC_e of the rootzone with increasing levels of EC_{iw}.

In F_1S_1 treatment, it was observed that the salinity in the rootzone decreased with time. On comparing the EC_e values after 90 days of transplantation with initial in different layers, a decrease of 39.4, 29.0 and 18.0% was observed in 0-15, 15-30 and 30-45 cm layers, respectively and no change in 45-60 cm layer. In F_1S_2 treatment, a little change in the existing pattern of EC_e was observed in the rootzone with time. During cropping season, its value was remained between 2.1 to 3.0 dS/m in the top layer (Fig. 2). On comparing the EC_e values after 90 days of transplantation with initial in different layers, a increase of 13.7, 9.03, 12.20 and 13.5% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively. In F_1S_3 treatment, an increase in the EC_e was observed in the rootzone with time. During cropping season, its value was varied from 2.2 to 6.6 dS/m in the top layer. On comparing the EC_evalues after 90 days of transplantation with initial in different layers, a increase of 115.3, 124.9, 144.7 and 190.5% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively. In F_1S_4 treatment, a steep increase in the EC_e was observed in the rootzone with time. During cropping season, its value was varied from 2.8 to 7.8 dS/m in the top layer. On comparing the EC_e values after 90 days of transplantation with initial in different layers, a increase of 171.2, 153.3, 170.0 and 197.2% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively. In F_1S_5 treatment, an abrupt increase in the EC_e was observed in the rootzone with time. During cropping season, its value was varied from 3.4 to 9.6 dS/m in the top layer. On comparing the EC_e values after 90 days of transplantation with initial in different layers, a increase of 206.4, 222.1, 244.4 and 264.1% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively.

Table 1 : Average EC_e (dS/m) in the root zone at different radial distance from the plant after 30, 60 and 90 days of transplanting of the crop in daily irrigation

Treatments	Distance from plant		Distance from plant		Distance from plant	
	7.5 cm	22.5 cm	7.5 cm	22.5 cm	7.5 cm	22.5 cm
	30 days		60 days		90 days	
F_1S_1	1.83	2.06	1.64	1.96	1.57	1.78
F_1S_2	1.95	2.48	2.00	2.65	2.08	2.84
F_1S_3	2.08	2.89	2.58	2.73	4.20	6.27
F_1S_4	2.53	4.19	4.21	5.95	4.68	7.12
F_1S_5	2.93	4.98	4.09	6.79	5.48	8.94

Table 2 : Average EC_e (dS/m) in the rootzone at different radial distance from the plant after 30, 60 and 90 days of transplanting of the crop in alternate day irrigation

Treatments	Distance from plant		Distance from plant		Distance from plant	
	7.5 cm	22.5 cm	7.5 cm	22.5 cm	7.5 cm	22.5 cm
	30 days		60 days		90 days	
F_2S_1	1.85	2.10	1.70	2.03	1.57	1.81
F_2S_2	2.04	2.48	2.10	2.76	2.28	3.31
F_2S_3	2.18	3.01	2.73	5.07	4.05	7.11
F_2S_4	2.26	4.37	3.84	6.08	5.15	7.89
F_2S_5	3.03	5.17	4.16	6.94	5.83	10.35

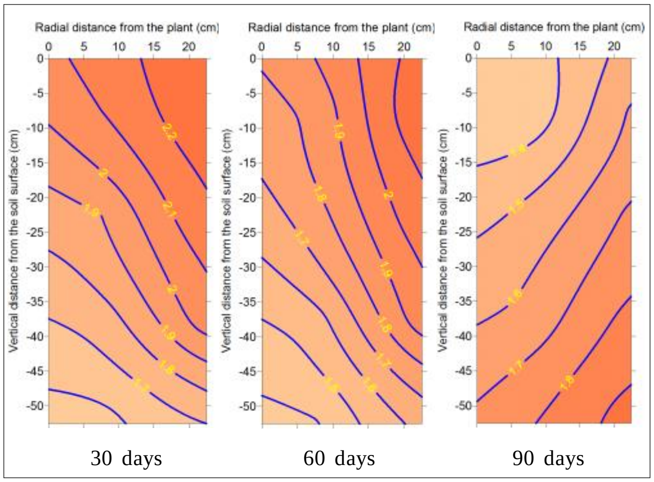

Fig. 1 : Spatial and temporal movement of salt in F_1S_1 treatment

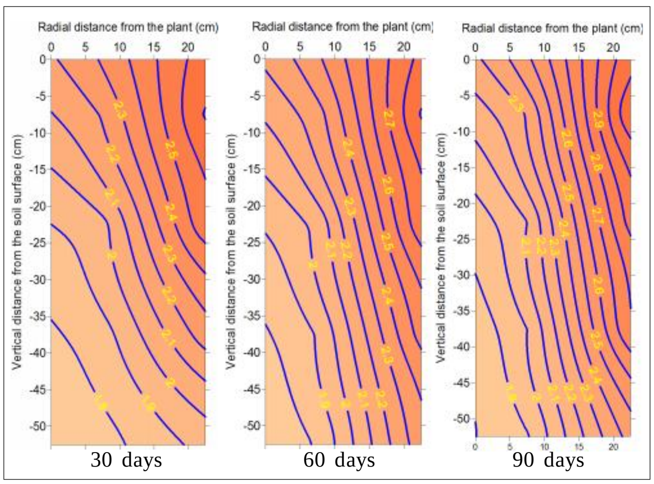

Fig. 2 : Spatial and temporal movement of salt in F_1S_2 treatment

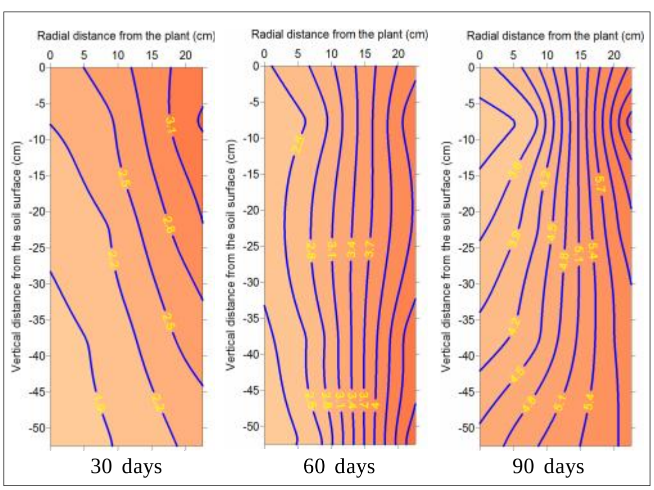

Fig. 3 : Spatial and temporal movement of salt in F_1S_3 treatment

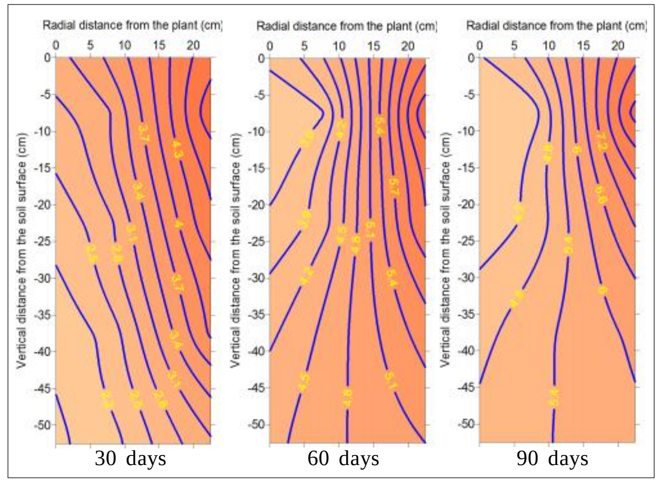

Fig. 4 : Spatial and temporal movement of salt in F_1S_4 treatment

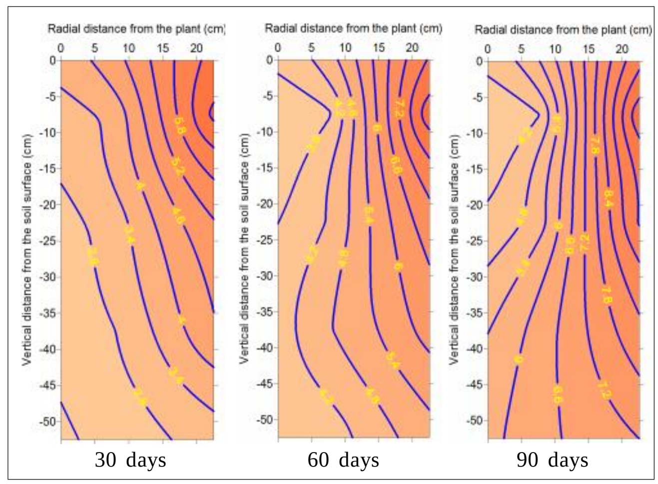

Fig. 5 : Spatial and temporal movement of salt in F_1S_5 treatment

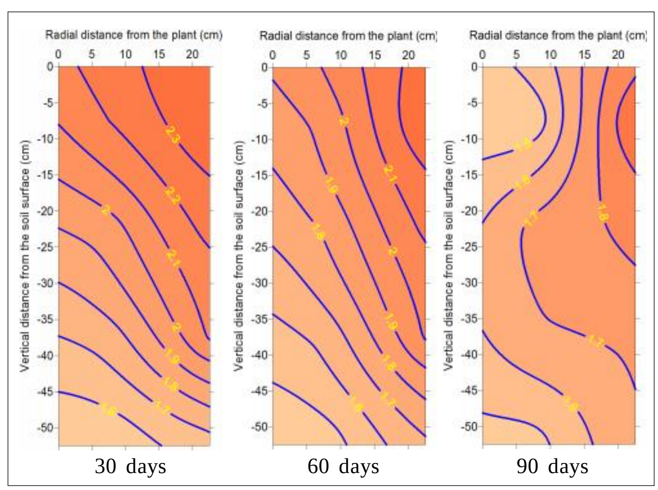

Fig. 6 : Spatial and temporal movement of salt in F_2S_1 treatment

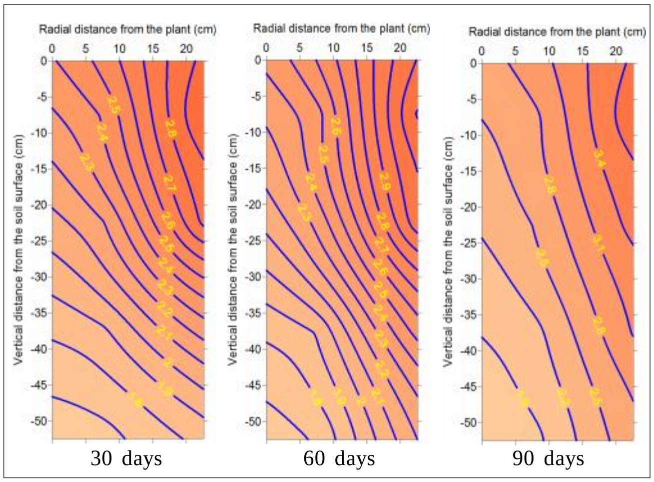

Fig. 7 : Spatial and temporal movement of salt in F_2S_2 treatment

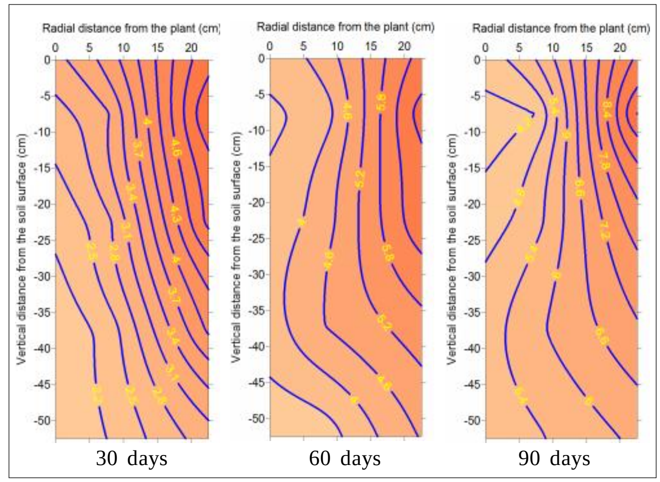

Fig. 9 : Spatial and temporal movement of salt in F_2S_4 treatment

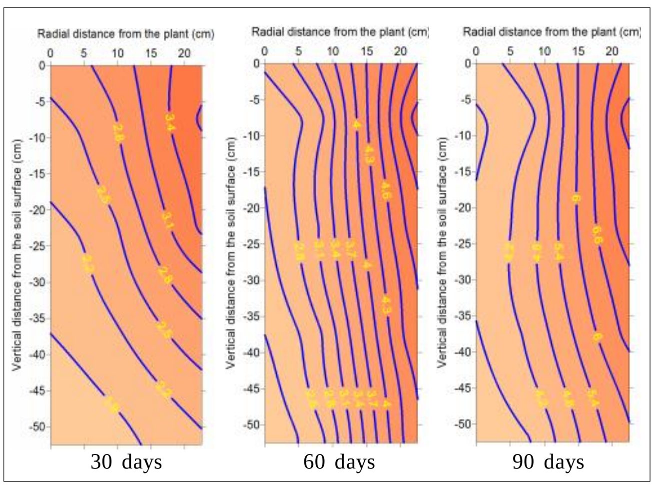

Fig. 8 : Spatial and temporal movement of salt in F_2S_3 treatment

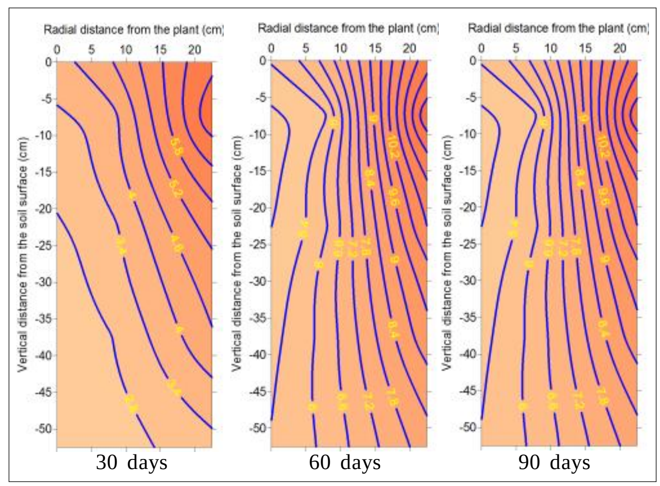

Fig. 10 : Spatial and temporal movement of salt in F_2S_5 treatment

Average EC_e in the rootzone before the execution of the experiment was 2.17 dS/m. After 30 days of transplantation, at 7.5 cm distance from the plant, average EC in the rootzone (0-60 cm) was 1.83, 1.95, 2.08, 2.53 and 2.93 dS/m in F_1S_1, F_1S_2, F_1S_3, F_1S_4, and F_1S_5, whereas, at 22.5 cm its value was 2.06, 2.48, 2.89, 4.19 and 4.98 dS/m, respectively (Table 1). After 90 days of transplantation, at 7.5 cm distance from the plant, average EC_e in the rootzone (0-60 cm) was 1.57, 2.08, 4.20, 4.68 and 5.48 dS/m in F_1S_1, F_1S_2, F_1S_3, F_1S_4, and F_1S_5, whereas, at 22.5 cm its value was 1.78, 2.84, 6.27, 7.12 and 8.94 dS/m, respectively.

EC_e distribution under alternate day irrigation treatment :

Fig. 6 to 10 show the EC_e distribution pattern under alternate day irrigation with different saline water treatment *i.e.* F_2S_1, F_2S_2, F_2S_3, F_2S_4 and F_2S_5, after 30 days, 60 days and 90 days of transplanting. On comparing the contours of these figures for 30 days after transplanting, it was observed that the values of EC_e in the rootzone is increasing slightly with increasing levels of EC_{iw} as in daily irrigation frequency. Similarly, contours for 90 days after transplanting has shown steep increase in EC_e of the rootzone with increasing levels of EC_{iw}.

In F_2S_1 treatment, it was observed that the salinity in the rootzone decreased with time. On comparing the EC_e values after 90 days of transplantation with initial in different layers, a decrease of 29.2, 22.5, 19.4 and 15.8% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively. In F_2S_2 treatment, a little change in the existing pattern of EC_e was observed in the rootzone with time. During cropping season, its value was remained between 2.3 to 3.7 dS/m in the top layer (Fig. 7). On comparing the EC_e values after 90 days of transplantation with initial in different layers, a increase of 37.1, 30.8, 23.6 and 20.2% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively. In F_2S_3 treatment, an increase in the EC_e was observed in the rootzone with time. During cropping season, its value was varied from 2. to 7.2 dS/m in the top layer (Fig. 8). On comparing the EC_e values after 90 days of transplantation with initial in different layers, a increase of 148.5, 164.1, 163.7 and 152.2% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively. In F_2S_4 treatment, a steep increase in the EC_e was observed in the rootzone with time. During cropping season, its value was varied from 2.8 to 9.0 dS/m in the top layer (Fig. 9). On comparing the EC_e values after 90 days of transplantation with initial in different layers, a increase of 198.4, 190.7, 208.9 and 205.8% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively. In F_2S_5 treatment, an abrupt increase in the EC_e was observed in the rootzone with time. During cropping season, its value was varied from 3.6 to 11.4dS/m in the top layer (Fig. 10). On comparing the EC_e values after 90 days of transplantation with initial in different layers, a increase of 279.2, 262.7, 270.1 and 280.2% was observed in 0-15, 15-30, 30-45 and 45-60 cm layers, respectively.

After 30 days of transplantation, at 7.5 cm distance from the plant, average EC_e in the rootzone (0-60 cm) was 1.85, 2.04, 2.18, 2.26 and 3.03 dS/m in canal water, 3.0, 6.0, 9.0 and 12.0 dS/m, whereas, at 22.5 cm its value was 2.10, 2.48, 3.01, 4.37 and 5.17 dS/m, respectively (Table 2). After 90 days of transplantation, at 7.5 cm distance from the plant, average EC_e in the rootzone (0-60 cm) was 1.57, 2.28, 4.05, 5.15 and 5.83 dS/m in canal water, 3.0, 6.0, 9.0 and 12.0 dS/m, whereas, at 22.5 cm its value was 1.81, 3.31, 7.11, 7.89 and 10.35 dS/m, respectively. Similar work related to the present investigation was also carried out by Badr and Taalab (2007); Dehghanisaij *et al.* (2006); Mangal *et al.* (1990) and Rajput and Patel (2006).

Conclusion :

Based on the results of the study the following conclusions were drawn

– The salt built up in the root zone as a result of use of saline water was lesser near the point of water application (near plants) and increased as the distance from the plants increased thereby demonstrating the ability of the drip irrigation to push salts towards the outer periphery of the wetted zone.

– Higher amount of salt built up in the root zone under alternate day irrigation as compared to daily irrigation suggested that increasing irrigation interval under drip irrigation while keeping the same amount of water application may cause salt built up in the root zone if the amount of water application is equal to crop water requirement as was in the present study.

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