Effect of Irrigation Frequency and Salinity Levels of Irrigation on Water Dynamics under Drip Irrigation in Cabbage (L. Brassica oleracea var. capitata)

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A B S T R A C T

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 CCS 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 of irrigation water on cabbage. Two irrigation frequency: daily (F₁) and alternate day (F₂) irrigation and five salinity levels of irrigation water: canal water (S₁), ECᵢw 3 (S₂), 6 (S₃), 9 (S₄) and 12 (S₅) dS/m treatments were considered in the experiment. In daily irrigation, comparing the contours of Figures 3.1 to 3.5 for 30 days after transplanting, it was observed that the pattern of moisture content in the rootzone was almost same in all treatments. Whereas, contours for 90 days after transplanting has shown more depletion in moisture content upto ECᵢw of 6 dS/m and thereafter, depletion was reduced which may be due to accumulation of salt in the rootzone. In alternate day irrigation, on comparing the contours of Figures 3.6 to 3.10 for 30 days after transplanting, it is observed that the pattern of moisture content in the rootzone is almost same in all treatments i.e. F₂S₁, F₂S₂, F₂S₃, F₂S₄ and F₂S₅. Whereas, contours for 90 days after transplanting has shown similar variation in the moisture content as in daily irrigation frequency. More depletion in moisture content upto ECᵢw of 6 dS/m and thereafter, depletion were reduced with increasing levels of ECᵢw.

Keywords
Cabbage, Drip irrigation, Saline water, Salt dynamics

Introduction

Irrigation is essential for crop production in arid and semi-arid regions. However, it is being felt that the irrigated agriculture is facing the problem of water scarcity. Not enough water of good quality is available to irrigate whole of cropped area of our country. Unfortunately, in the country, about 50% of underground waters are either marginal or poor in quality, whereas, in Rajasthan, Haryana and Uttar Pradesh is even up to 84, 63 and 63%, respectively (Phogat et al., 2010). In the current water crisis situation, sufficiently available fresh water recourses are becoming the binding constraint for food production. Therefore, it is imperative to use marginal quality water for irrigation.
However, it is important to know that development of excess soil salinity in the root zone, as a result of use of saline water, may also inhibit normal crop growth and development (Kelley, 1951). Drip irrigation is also considered a suitable option to utilize marginal quality water for crop production due to movement of salt away from effective root zone. So the present experiment was designed to study the effect of irrigation frequency and salinity levels of irrigation water on water dynamics under drip irrigation in cabbage.

Materials and Methods

Treatment details

The experimental was laid out with two irrigation frequency treatments: daily (F1) and alternate day (F2) irrigation and five salinity levels of irrigation water [canal water ECiw = 0.5 (S1), saline water ECiw = 3.0 (S2), saline water ECiw = 6.0 (S3), saline water ECiw = 9.0 (S4) and saline water ECiw = 12.0 (S5)]. Accordingly the following abbreviation will be used in the subsequent chapters of the report to denote different treatments:

Layout of the experiment

The experiment was laid out in 2.0 x 2.0 m plot as per the following plan. 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.

Soil moisture content

The soil moisture content was measured using gravimetric method. 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. The soil samples were collected in air tight aluminum containers and weighed. The weighted samples were dried in an oven at 105°C for about 24 hour. After removing from oven they were cooled slowly to room temperature and weighed again. The difference in weight was the amount of moisture present in the soil. To study the spatial and temporal distribution of moisture content, contour maps were prepared with the help of ‘SURFER-8’ software which was developed by US GOLDEN company.

From the measured values of soil moisture content at different depths and days, spatial and temporal graphs were plotted for 30 days, 60 days and 90 days after transplanting. Horizontal axis of the figures shows radial distance from the plant and vertical axis shows depth from the soil surface. Thus the wetting patterns were characterized by the radial distance and the depth of wetting front from the plant (dripper).

Results and Discussion

Wetting pattern under daily irrigation treatment

Figures 1 to 5 show the wetting pattern (moisture content) under daily irrigation with different saline water treatment i.e. F1S1, F1S2, F1S3, F1S4 and F1S5, after 30 days, 60 days and 90 days of transplanting. In canal water irrigation, the soil moisture content was not affected with the time in the upper layers but
in lower layers it was depleted with time (Fig. 1). The contour of 13.6% moisture content was just at a depth of 52.5 cm just below the plant after 30 days. This contour rises up with time and reached to 44 and 39 cm just below the plant after 60 and 90 days of transplanting, respectively. The upward movement of contour or depletion in the moisture content with time indicates that the extraction of more water by the roots as the length and density of the roots increases with time. Less depletion is shown by contour in the upper layer which may be due to daily supply of water through the drip system and simultaneously extracted by the roots before reaching to the lower part of the root zone. On comparing the contours of figures 1 to 5 for 30 days after transplanting, it is observed that the pattern of moisture content in the rootzone is almost same in all treatments i.e. F_1S_1, F_1S_2, F_1S_3, F_1S_4 and F_1S_5.Whereas, contours for 90 days after transplanting, has shown more depletion in moisture content upto EC_{iw} of 6 dS/m and thereafter, depletion was reduced which may be due to accumulation of salt in the rootzone. The likely increase in osmotic stress due to salinity at higher EC_{iw} may restrict the water availability to the crop resulting in less depletion in moisture content (Phogat et al., 2008). After 90 days of transplanting, total moisture in rootzone at 7.5 cm distance from the plant was 12.38, 12.47, 12.86, 13.22 and 13.42 cm in F_1S_1, F_1S_2, F_1S_3, F_1S_4 and F_1S_5 treatments, respectively (Table 1). Whereas, at 22.5 cm distance, its respective values were 10.56, 10.65, 11.00, 11.27 and 11.54 cm..

### Table 1: Total residual moisture (cm) in the rootzone (0-60 cm) in different treatments at different days after transplanting

| Treatments | 30 days after transplanting | 60 days after transplanting | 90 days after transplanting |
|------------|----------------------------|-----------------------------|----------------------------|
|            | 7.5 cm | 22.5 cm | 7.5 cm | 22.5 cm | 7.5 cm | 22.5 cm |
| Daily irrigation |             |             |             |             |             |
| F_1S_1     | 12.98  | 11.14    | 12.60    | 10.72    | 12.38  | 10.56  |
| F_1S_2     | 13.09  | 11.02    | 12.69    | 10.80    | 12.47  | 10.65  |
| F_1S_3     | 12.78  | 10.72    | 12.78    | 10.89    | 12.86  | 11.00  |
| F_1S_4     | 12.50  | 11.00    | 12.86    | 10.98    | 13.22  | 11.27  |
| F_1S_5     | 12.78  | 10.87    | 12.95    | 11.07    | 13.42  | 11.54  |
| Alternate day irrigation |             |             |             |             |             |
| F_2S_1     | 12.87  | 11.23    | 12.31    | 10.47    | 11.84  | 10.30  |
| F_2S_2     | 12.95  | 10.98    | 12.39    | 10.55    | 12.15  | 10.36  |
| F_2S_3     | 12.76  | 10.70    | 12.47    | 10.64    | 13.13  | 11.25  |
| F_2S_4     | 12.35  | 10.89    | 12.56    | 10.72    | 13.59  | 11.60  |
| F_2S_5     | 12.73  | 10.81    | 12.65    | 10.81    | 13.68  | 11.87  |
**Fig. 1** Spatial and temporal movement of moisture content in $F_1S_1$ treatment

**Fig. 2** Spatial and temporal movement of moisture content in $F_1S_2$ treatment
**Fig. 3** Spatial and temporal movement of moisture content in F1S3 treatment

**Fig. 4** Spatial and temporal movement of moisture content in F1S4 treatment
**Fig. 5** Spatial and temporal movement of moisture content in F$_1$S$_3$ treatment

**Fig. 6** Spatial and temporal movement of moisture content in F$_2$S$_1$ treatment
**Fig. 7** Spatial and temporal movement of moisture content in $F_2S_2$ treatment

**Fig. 8** Spatial and temporal movement of moisture content in $F_2S_3$ treatment
Fig. 9 Spatial and temporal movement of moisture content in F$_2$S$_4$ treatment

Fig. 10 Spatial and temporal movement of moisture content in F$_2$S$_5$ treatment
Wetting pattern under alternate day irrigation treatment

Figures 6 to 10 show the wetting pattern (moisture content) under alternate day irrigation with different saline water treatment i.e. F₂S₁, F₂S₂, F₂S₃, F₂S₄ and F₂S₅, after 30 days, 60 days and 90 days of transplanting. Under this frequency in canal water irrigation, the soil moisture content was not too affected with the time in the upper layers but in lower layers it was depleted with time (Fig. 6). The contour of 13.6% moisture content was just at a depth of 52.5 cm just below the plant after 30 days. This contour rises up with time and reached to 41 and 20 cm just below the plant after 60 and 90 days of transplanting, respectively. On comparing the contours of Figures 6 to 10 for 30 days after transplanting, it is observed that the pattern of moisture content in the rootzone is almost same in all treatments i.e. F₂S₁, F₂S₂, F₂S₃, F₂S₄ and F₂S₅. Whereas, contours for 90 days after transplanting has shown similar variation in the moisture content as in daily irrigation frequency. More depletion in moisture content upto EC<sub>iw</sub> of 6 dS/m and thereafter, depletion were reduced with increasing levels of EC<sub>iw</sub>. After 90 days of transplanting, total moisture in rootzone at 7.5 cm distance from the plant was 11.84, 12.15, 13.13, 13.59 and 13.68 cm in F₂S₁, F₂S₂, F₂S₃, F₂S₄ and F₂S₅ treatments, respectively (Table 1). Whereas, at 22.5 cm distance, its respective values were 10.30, 10.36, 11.25, 11.60 and 11.87 cm.

In both irrigation frequencies, the residual moisture content in the root zone after 90 days of transplanting showed increasing trend with increasing level of salinity of irrigation water beyond EC<sub>iw</sub> 3 dS/m (Table 1). Equal amount of water application coupled with information on residual moisture content in the rootzone suggested that cabbage plants utilized lesser amount of water with increasing level of salinity beyond EC<sub>iw</sub> 3.0 dS/m. There was low moisture content in 30, 60 and 90 days after transplanting in alternate irrigation treatment in comparison to daily irrigation treatment (Table 1) except F₂S₃, F₂S₄ and F₂S₅ (in 90 days) because of less infiltration opportunity time and more evaporation. After 90 days of transplanting, in F₂S₃, F₂S₄ and F₂S₅ treatments the result is reverse i.e. moisture content in alternate irrigation treatment is more as comparison to daily irrigation. This may be due to reduced uptake of water by plants under alternate day irrigation as compared to daily irrigation. Less variation in the moisture content was observed near the plant in daily irrigation as compared to alternate day irrigation. The residual moisture content in the rootzone after 90 days of transplanting was almost same upto EC<sub>iw</sub> 3.0 dS/m of irrigation water suggested that water uptake by the cabbage was not influenced by irrigation salinity upto 3.0 dS/m.

References

Anonymous (2010-11) Economic Survey, Ministry of Finance and Company Affairs, Economic Division, Govt. of India, pp. 135-149.

Badr, M.A. and Taalab, A.S. (2007) Effect of drip irrigation and discharge rate on water and solute dynamics in sandy soil and tomato yield. *Australian Journal of Basic and Applied Sciences*, 1(4), 545-552.

Earl, K.D. and Jury, W.A. (1977) Water movement in bare and cropped soil under isolated trickle emitters. *Soil Science Society of America Proceedings*, 41(1), 856-861.

Gupta, A.P., Acharya, M.S. and Singh, A.K. (1990) Dynamics of soil water movement is sandy clay loam soil under point source. *Proceedings XI International Congress use of plastic in agriculture*, pp. 101-110.

Lekakis, E.H., Georgiou, P.E., Pavlatou-Ve, A.V. and Antonopoulos, Z. (2011) Effects of fixed partial root-zone drying irrigation and soil texture on water and solute dynamics in calcareous soils and
corn yield. *Agricultural Water Management*, 101, 71-80.
Malash, N., Flowers, T.J. and Ragab, R. (2008) Effect of irrigation methods, management and salinity of irrigation water on tomato yield, soil moisture and salinity distribution. *Journal of Irrigation Science*, 26, 313-323.
Phogat, V., Sharma, S.K. Kumar, Sanjay, Satyavan and Gupta, S.K. (2010) Vegetable cultivation with poor quality water. Technical Bulletin. Dept. of Soil Science, CCS Haryana Agricultural University, Hisar. pp 1-72.
Rahimzadegan, R. (1977). Water movement in field from a point source. *M.Sc. Thesis, GP Pant University of Agriculture and Technology, Pantnagar.*
Rajput, T.B.S. and Patel, Neelam (2006). Water and nitrate movement in drip-irrigated onion under fertigation and irrigation treatments. *Agricultural Water Management*, 79, 293-311.
Remadevi, A.N. (1980) Influence of soil moisture and salt distribution characteristics on crop growth and yield under point source of water application. *Ph.D. Thesis, IARI, New Delhi.*

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