International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 11, 2018, pp.-6244-6246.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EFFECT OF IRRIGATION FREQUENCY AND SALINITY LEVELS OF IRRIGATION WATER ON YIELD OF CABBAGE UNDER DRIP IRRIGATION

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Received: June 01, 2018; Revised: June 09, 2018; Accepted: June 10, 2018; Published: June 15, 2018

Abstract: A field experiment was conducted on the sandy loam soils of CCS Haryana Agricultural University, Hisar, Haryana, India to study the effect of irrigation frequency and salinity levels of irrigation water on yield attributes of cabbage under drip irrigation. 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)). In daily irrigation treatment, the relative value of plant height was 104.1, 88.4, 70.7 and 58.2% in F_1S_2, F_1S_3, F_1S_4 and F_1S_5 treatments, respectively, as compared to canal water irrigation (F_1S_1). In alternate day irrigation, the relative value of plant height was 105.9, 87.0, 69.4 and 53.1% in F_2S_2, F_2S_3, F_2S_4 and F_2S_5 treatments, respectively, as compared to the yield recorded in canal irrigation (F_2S_1). On comparing drip irrigation frequency treatments, 3.2, 2.9, 8.7, 16.1 and 50.2% higher crop yield in daily irrigation as compared to alternate day irrigation of respective treatments (canal water, EC_{iw} 3, 6, 9, 12 dS/m) was observed. This indicates that increase in irrigation frequency can manage saline water in a better way. On comparing drip irrigation frequency treatments, 3.2, 2.9, 8.7, 16.0 and 50.4% higher water use efficiency in daily irrigation as compared to alternate day irrigation of respective treatments (canal water, 3, 6, 9, 12 dS/m) was observed.

Keywords: Cabbage, Drip irrigation, Saline water, Yield

Citation: Sharma Parmod, *et al*., (2018) Effect of Irrigation Frequency and Salinity Levels of Irrigation Water on Yield of Cabbage under Drip Irrigation. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 11, pp.- 6244-6246.

Introduction

One of the most important groups of vegetable crops which are widely grown and popular in almost all the regions of the country is cole crop. Cabbage (*L. Brassica oleracea var. capitata*), a member of Brassicaceae family, is one of the important winter vegetable crops cultivated in India and throughout the world almost round the year. The area under cultivation of cabbage in the world is 2073x10^3 ha with an annual production of 50.71 mt. India is one of the important cabbage growing countries in world since the area under cabbage in India is 369 x 10^3 ha with an annual production of 7.95 mt and an average productivity of 21.5 t/ha. The area under cultivation of cabbage in Haryana is 13.8 x 10^3 ha with an annual production of 0.26 mt [1]. Scarcity of good quality water is becoming a constraint to irrigation throughout the world. It would be a feasible way to use saline water in irrigating the plants such as cabbage which is moderately tolerant of salinity, if appropriate practices were applied [2]. Drip irrigation is able to apply water at low discharge rate and high frequency over a long period of time, resulting in a condition to maintain high soil water content in root zone all the time and minimize salinity levels in the soil water due to leaching. Meanwhile, because of the point source characteristic of drip irrigation the salt along with water can be pushed toward the fringes of wetting area & forming a desalinization zone in the centre of wetting area, in close proximity to the dripper. Therefore, the drip irrigation is widely regarded as a suitable system for applying saline water to crop. So, the present experiment was designed the effect of irrigation frequency and salinity levels of irrigation water on yield attributes of cabbage under drip irrigation [3].

Materials 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)). So, the following abbreviation will be used to denote different treatments as given in [Table-1].

Table-1 Treatment wise abbreviation used.

SN	Treatment	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

Layout of the Experiment

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

Cultural practices

Raising of nursery

The testified seed golden acre of cabbage was obtained from Hisar local market. The seeds were sown in raised nursery beds on October 12, 2011. The seed rate used was 500-600 g/ha. The seeds were sown in corrugated furrows made by wooden sticks and covered by small layer of farm yard manure and then irrigated by good quality canal water.

Transplanting

Forty eight days old cabbage seedlings were transplanted on November 30, 2011 in the experimental plots. The spacing between plant to plant and row to row was kept as 45 cm.

Application of fertilizer

The fertilizer was applied @ 125 kg N, 50 kg P_2O_5 and 100 kg K_2O/ha (in 3 equal splits).

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.

Plant height and Crop Yield Parameters

The plant height was measured from point of root shoot interaction to the top of main raceme with scale at different growth stage periods for cabbage crop. Crop yield was recorded as per harvesting date in the different treatments to observe the effect of frequency and salinity on the maturity date of the crop [4].

Results and Discussion

Plant height

The variation in the average plant height for cabbage at different growth stage periods under daily and alternate day irrigation frequency are presented in the [Fig-1] and [Fig-2].

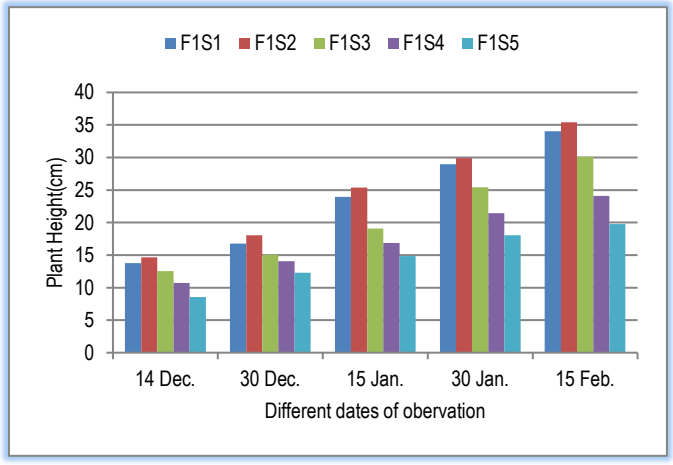

Fig-1 Plant height at different dates under daily irrigation treatment

The significant decrease in the plant height of cabbage crop in different treatment with increasing salinity at different dates could be attributed the effect of EC_{iw}. In daily irrigation, there is no significant difference in plant height among canal water and saline water of EC_{iw} 3.0 dS/m. In daily irrigation treatment, the relative value of plant height was 104.1, 88.4, 70.7 and 58.2% in F_1S_2, F_1S_3, F_1S_4 and F_1S_5 treatments, respectively, as compared to canal water irrigation (F_1S_1). In alternate day irrigation, the relative value of plant height was 105.9, 87.0, 69.4 and 53.1% in F_2S_2, F_2S_3, F_2S_4 and F_2S_5 treatments, respectively, as compared to the yield recorded in canal irrigation (F_2S_1). This clearly shows that irrigation water of EC_{iw} = 3 dS/m was most favorable to plant growth under both daily and alternate day irrigation. Moreover, the crop growth of cabbage, as indicated by plant height, was better under daily irrigation as compared to alternate day irrigation.

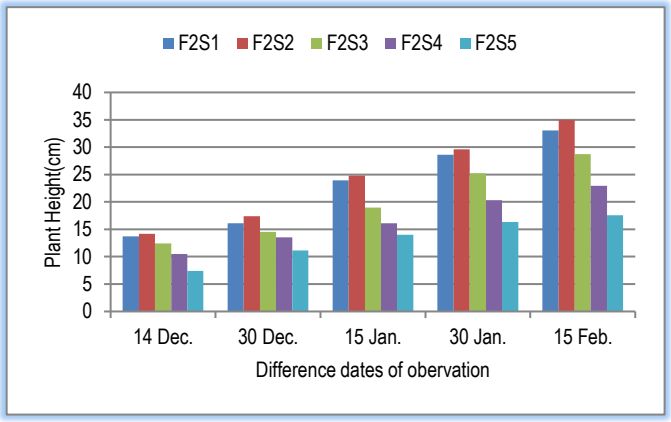

Fig-2 Plant height at different dates under alternate day irrigation treatment

Yield of cabbage crop

Delay in maturity of fruits observed with increasing level of salinity as well as decreasing irrigation frequency. Use of highly saline water (EC_{iw} > 6 dS/m) resulted into delay of first harvesting by about 20 days as compared to the use of relatively good quality water suggested that use of good quality and saline water in different parts of the fields may be effectively be used to prolong the productive season of cabbage. A significant decrease in cabbage yield was observed with decrease in irrigation frequency as well as increase in salinity of irrigation water. From EC_{iw} 0.5 dS/m to EC_{iw} 3 dS/m salinity of irrigation water, there was an increase in crop yield under both the frequencies but it is non-significant. But with further increase in EC_{iw}, a significant decrease in yield was observed. This identifies that the cabbage crop can be grown safely with saline water of EC_{iw} 3.0 dS/, may even perform a little better. On comparing drip irrigation frequency treatments, 3.2, 2.9, 8.7, 16.1 and 50.2% higher crop yield in daily irrigation as compared to alternate day irrigation of respective treatments (canal water, ECiw 3, 6, 9, 12 dS/m) was observed. This indicates that increase in irrigation frequency can manage saline water in a better way. Crop water use efficiency was estimated as per the total water applied in the crop during the growing season. Amount of irrigation water was same in F_1S_1, F_1S_2, F_1S_3, F_2S_1, F_2S_2 and F_2S_3 treatments but different in F_1S_4, F_1S_5, F_2S_4 and F_2S_5, depending upon the maturity/harvesting dates of the crop. More irrigation water in treatments F_1S_4, F_1S_5, F_2S_4 and F_2S_5 was applied as compared to other treatments because of delays in the maturity period of crop. Water use efficiency for daily irrigation varied from 12.60 to 34.06 q/ha-cm with the lowest value (12.60) in F_1S_5 and the highest value (34.06) in F_1S_2 treatment. Water use efficiency for alternate day irrigation varied from 8.38 to 33.01 q/ha-cm with the lowest value (8.38) in F_2S_5 and the highest value (33.01) in F_2S_2 treatment. The water use efficiency increased up to EC_{iw} 3 dS/m after that its value decreased with further increase in the salinity of irrigation water. On comparing drip irrigation frequency treatments, 3.2, 2.9, 8.7, 16.0 and 50.4% higher water use efficiency in daily irrigation as compared to alternate day irrigation of respective treatments (canal water, 3, 6, 9, 12 dS/m) was observed.

Conclusion

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

- The crop growth of cabbage, as indicated by plant height, was better under daily irrigation as compared to alternate day irrigation.
- Initial increase in irrigation water salinity from 0.5 dS/m (canal water) to 3.0 dS/m favoured plant growth of cabbage as indicated by the plant height. Further increase in the salinity of irrigation water adversely affected the plant growth of cabbage.
- Higher yield of cabbage under daily irrigation as compared to alternate

day irrigation for different levels of salinity of irrigation water suggested the importance of high frequency of irrigation for the use of saline water.

- The date of first harvesting was also affected by the quality of irrigation water. Use of highly saline water (EC > 6 dS/m) resulted into delay of first harvesting by about 20 days as compared to the use of relatively good quality water suggesting that use of good quality and saline water in different parts of the fields may be effectively used to prolong the productive season of cabbage.

Application of research: Short period of irrigation frequency and use of saline water upto 3EC is suitable for cabbage crop.

Research Category: Drip Irrigation

Abbreviations:
ECiw: Electrical conductivity of irrigation water

Acknowledgement / Funding: Author thankful to Chaudhary Charan Singh Haryana Agricultural University, Hisar, 125 004, Haryana, India

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Research project name or number: M. Tech. Thesis

Author Contributions: All author equally contributed

Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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