International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 9, Issue 47, 2017, pp.-4796-4799.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EFFECT OF SALINEWATER DRIP IRRIGATION ON ROOT PARAMETERS OF BHENDHI

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Received: October 14, 2017; Revised: October 16, 2017; Accepted: October 17, 2017; Published: October 18, 2017

Abstract- A study was conducted to test the root parameters of Bhendi under saline environment. Roots are the directly affected parts of crop, which has intimate contact with surrounding saline environment. Effect of different irrigation frequency and varied quantity of saline water on root distribution of bhendi crop was studied. The highest tap root length of 30.4 cm was recorded in F_3Q_3 treatment. Increased wetted depth of once in three days irrigation increased the length of tap root in F_3Q_3 treatment largest root spread diameter of 42.3 cm and highest number of roots 40 were observed in twice a day irrigation with 140 per cent CWN (F_4Q_3). Higher diameter of root spread and more number of roots help to absorb more water and nutrients for plant growth. Hence drip irrigation of twice a day with 140 per cent CWN was found to be the best combination of frequency and quantity of irrigation as it is maintaining lower salinity in the root zone for better root development which directly affects the growth and yield parameters of bhendi crop.

Keywords- Saline water, drip irrigation, Bhendi, root parameters, Rootzone.

Citation: Sharmiladevi R., et al., (2017) Effect of Saline Water Drip Irrigation on Root Parameters of Bhendhi. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 9, Issue 47, pp.-4796-4799.

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Academic Editor / Reviewer: Vanitha Subramani

Introduction

The distribution of salts in irrigated saline soils varies both spatially and temporally. Depending upon the method, frequency of irrigation and the leaching fraction, salt distribution may be fairly uniform or non-uniform, with salinities ranging from a low level not greatly exceeding the salinity of applied irrigation water to levels many times higher in parts of the root zone. If the salinisation process is allowed to continue the problem grows to an extent where the land eventually has to be abandoned. Out of the total of 230 m. ha of irrigated land around the world, some 45m. ha suffer from severe irrigation induced salinity problems. The annual increase in salt affected land in the world is approximately 2.5 to 5 million acres [1].

Under suitable irrigation procedures and crop management, many vegetable crops could be cultivated successfully with saline water [2,3]. Roots are the directly affected parts of crop, which has intimate contact with surrounding saline environment. Hence a study was formulated to find the effect of irrigation frequency and irrigation quantity on root parameters of okra under drip irrigation with moderate saline ground water.

Experiment was conducted in precision farming development centre farms (Eastern Block-NA4) of Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. The farm is located at 11°N latitude and 77°E longitude with at an altitude of 427 m above MSL.

Materials and Methods

Weather and Climate

The mean annual rainfall is 674.2 mm. The mean maximum and minimum temperatures are 32.7°C and 21.7°C, respectively. The relative humidity ranges from 21 per cent (14.22 hrs) to 92 per cent (07.22 hrs). The mean monthly evaporation ranges from 3.5 to 7.6 mm. The sunshine hours ranges from 3.4 to 10.6 hrs day^{-1}.

The weekly weather data recorded during the crop study period (September – January). During the period of study, the mean weekly maximum and minimum temperatures were found as 32.9°C and 18°C, respectively. The relative humidity was from 94 per cent (07.22 hrs) to 42 per cent (14.22 hrs). Mean weekly evaporation was found between 2 and 5.3 mm. The wind velocity was in the range of 2.4 and 5 km h^{-1}. The maximum and minimum sunshine hours were recorded as 8.3 to 2.1 hrs day^{-1}, respectively. The climatic condition was favourable for raising a bhendi crop.

Soil Properties

The soil of the experimental field is sandy clay loam in texture having pH 9.25 and electrical conductivity of 0.17 dS m^{-1}. The average depth of soil is about 25 to 30 cm.

The physio-chemical properties of the soil are furnished in [Table-1]. The available nutrient contents in the soil were found as 250 kg ha^{-1} N, 10 kg ha^{-1} P and 500 kg ha^{-1} K.

Crop and variety

Bhendi (*Abelmoschusesculentus*(L) Moench) variety M-10 was raised as the test crop. The duration of the crop is 90 –110 days.

Irrigation source

The experimental field was irrigated by a bore well. Quality of irrigation water is moderately saline. The details of quality of irrigation water are presented in [Table-2]. Moderately saline water is used for irrigation.

The irrigation water is having pH of 7.25 and electrical conductivity 5.53 dS m^{-1}, carbonate is absent. Bicarbonates, chlorides and sulphates were 14.80, 29.60,

and 10.27meq. litre^{-1}. Calcium, magnesium, sodium, and potassium were 14.4, 14.8, 25.65 and 0.72 meq. litre^{-1}, respectively. Sodium adsorption ratio was found to be 6.71.

Table-1 *Soil characteristics of the experimental field*

S. No	Particulars	Composition
A.	**Textural Composition**	**15 cm depth**
1.	Sand, (per cent)	67.60
2.	Silt, (per cent)	7.75
3.	Clay, (per cent)	24.65
4.	Textural class	Sandy clay loam
B.	**Chemical properties**	
1.	Available N, (kg ha^{-1})	250
2.	Available P, (kg ha^{-1})	10
3.	Available K, (kg ha^{-1})	500
4.	pH	9.25
5.	Electrical conductivity, (dS m^{-1})	0.17
6.	Organic carbon, (per cent)	0.50
7.	Organic matter, (per cent)	0.862
C.	**Physical properties**	
1.	Bulk density, (gm cc^{-1})	1.33
2.	Field capacity, (per cent)	18.8
3.	Permanent wilting point, (per cent)	12.8

Table-2 *Quality of irrigation water*

S. No	Properties	Values
1	pH	7.25
2	Electrical Conductivity (dS m^{-1})	5.53
3	Anions (meq.litre^{-1})	
	i) Carbonates	-
	ii) Bicarbonates	14.80
	iii) Chlorides	29.60
	iv) Sulphates	10.27
4	Cations (meq.litre^{-1}.)	
	Calcium	14.40
	Magnesium	14.80
	Sodium	25.65
	Potassium	0.72
5	Sodium Adsorption Ratio (SAR)	6.71

Layout of drip system

From water source, water was pumped through 7.5 hp motor and it was conveyed to the field using 50 mm PVC pipe after filtering through disc filter. From the main line, sub main lines of 40 mm diameter PVC pipes were taken off. From the sub main lines lateral lines of 16 mm LLDPE pipes were taken to irrigate the plots. 4 lph inline drippers spaced at 40 cm were used. FAO

Treatments

The experiment was conducted by adopting the following treatments.

Main plot: Irrigation frequency (Four)

F_1 = Daily irrigation

F_2 = Alternate day irrigation

F_3 = Every third day irrigation

F_4 = Two irrigation in a day

Sub plot : Irrigation quantity (Three)

Q_1 = Crop water need (100 per cent CWN)

Q_2 = Crop water need + 20 per cent excess of Crop water need (120 per cent CWN)

Q_3 = Crop water need + 40 per cent excess of Crop water need (140 per cent CWN)

The experiment was laid out in strip plot design with three replications.

Dibbling of bhendi seeds

Well-treated Mahyco-10 hybrid bhendi seeds were dibbled at 30 × 40 cm spacing. The seeds were dibbled with a recommended seed rate of 7.5 kg ha^{-1}.

Irrigation

Irrigation was given to all the treatments immediately after dibbling the seeds. Irrigation was given as per the treatment schedule according to the crop growth stages. Irrigation was given based on daily evaporation rate recorded from class A open pan evaporimeter. Drip operating time was calculated according to different treatments. Flow through each lateral was controlled by separate valves.

Water requirement for single plant was calculated by the method given below [4].

$$ET_{crop} = E_{pan} \times K_p \times K_c$$

Where,

ET_{crop} = Crop evapotranspiration or Crop water need (mm day^{-1})

E_{pan} = Pan evaporation in mm day^{-1},

K_p = Pan factor (0.85 collected from TNAU Meteorological Department)

K_c = Crop factor,

Water required per emitter is calculated by

$$WR/Day/Emitter = (ET_{crop}) \times 2$$

WR = Water required per emitter in mm day^{-1}

Time of operation of single emitter is calculated by

Time of operation (min) = (Area covered by emitter (m^2) × depth of water applied (m))/Discharge of emitter (m^3 min^{-1})

Based on the different treatments, the water requirement and the time of operation were calculated and based on the calculated value irrigation water was supplied. The crop factor value for bhendi crop were adopted based on the recommendation given by Allen *et al.* (1998), the crop factor values are ranging from 0.7 to 1.05, which depends upon different growth stages of the crop [5].

Root parameters

Tap root length, root spread diameter and total number of roots were recorded for randomly selected three plants in each treatment at the time of harvest.

Statistical Analysis

The data collected on root parameters were analysed as per standard programmes for strip plot design. Wherever the treatment differences were found significant ('F' test), critical differences were worked out at 5 per cent probability level. Non-Significant treatment differences were denoted by 'NS' [6].

Results and Discussion

Root Development

Root development under different treatment conditions is shown in [Fig-1].

Fig-1 Effect of irrigation frequency and quantity on Root development

Root depth / Tap root length

Frequency of irrigation greatly influenced the root depth or tap root length. Data's on root depth are shown in Fig. The depth of root was the highest (29.33 cm) in the treatment at every third day irrigation (F_3) and the lowest (21.99 cm) was observed in the treatment of two irrigation per day (F_4).

The soil wetted depth in F_3 treatment was higher than in all other treatments, which caused more root depth in this treatment. In the F_4 treatment wetted volume was lower than all other treatments, which caused less root depth.

Quantity of irrigation water significantly influenced the root depth. Maximum root depth of 26.8 cm was recorded in Q_3 treatment and minimum root depth of 24.7 cm was recorded in Q_1 treatment. Increased quantity of water increased the wetted depth of soil caused maximum root depth in Q_3 treatment.

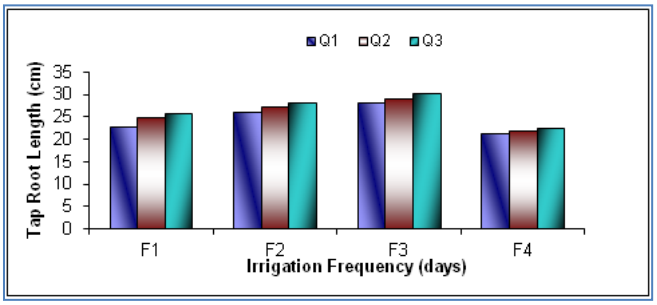

Fig-2 Effect of irrigation frequency and quantity on Tap root length

In frequency and Quantity interaction treatments the maximum length of taproot (30.4 cm) was observed in F_3Q_3 treatment. The shortest length of 21.5 cm was recorded in F_4Q_1 treatment. The depth of wetted volume was more in F_3Q_3, which caused the longest taproot length and the minimum wetted soil volume recorded in F_4Q_1 treatment caused shortest root length in this treatment.

Root Spread Diameter

The diameter of root spread was significantly influenced by frequency of irrigation. Maximum root spread of 41.33 cm was observed in the treatment at every third day irrigation.

In two irrigations per day treatment, horizontal movement of water was more than deep percolation caused the highest root spread in the upper 15 cm depth.

Maximum diameter of 39.2 cm was observed at 40 per cent excess of CWN, and minimum diameter of 37.7 cm observed at no excess water irrigation treatment. Application of 40 per cent excess CWN increased the wetted volume of soil and caused more root spread.

In frequency and quantity interaction maximum root spread diameter of 42.3 cm was recorded in F_4Q_3 treatment and minimum of 35.2 cm was recorded in F_3Q_1 treatment.

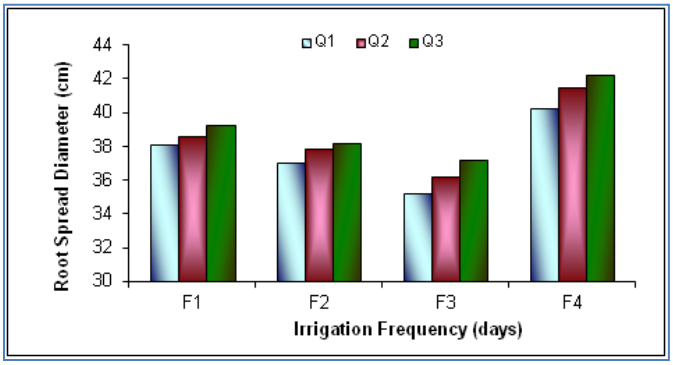

Fig-3 Effect of irrigation frequency and quantity on Root Spread Diameter

In this interaction 40 per cent excess CWN, in F_3 treatment caused deep percolation losses which leads to decrease in root spread diameter, and in F_4 treatment increased wetted volume leads to maximum root spread diameter.

Number of roots

Total number of roots was the highest in F_4, Q_3 and F_4Q_3 interaction treatments. The values were recorded as 39.1, 36.3 and 40, respectively.

Lowest number of roots was recorded as 32, 33.8 and 31.7 in F_3, Q_1 and F_3Q_1 treatments respectively at the end of harvest. Low soil moisture tension in F_4, Q_3 and F_4Q_3 treatment increased the total number of roots in these treatments.

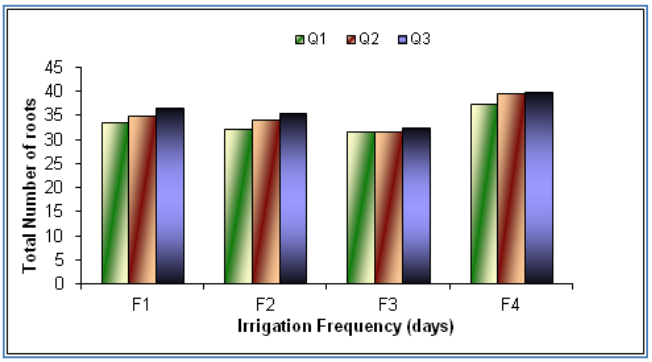

Fig-4 Effect of irrigation frequency and quantity on total number of roots

Summary and Conclusions

The highest taproot length of 30.4 cm was recorded in F_3Q_3 treatment and lower length of taproot 21.5 cm was recorded in F_4Q_1 treatment. Increased wetted depth of once in three days irrigation increased the length of taproot in F_3Q_3 treatment. Root spread diameter of 42.3 cm and total number of roots (40) were found to be higher in twice a day irrigation with 140 per cent CWN treatment (F_4Q_3).

Higher diameter of root spread and more number of roots help to absorb more water and nutrients for plant growth. So, it is concluded that drip irrigation of twice a day with 140 per cent CWN was found to be the best combination of frequency and quantity of irrigation as it is maintaining better root development which directly affects the growth and yield parameters of crop.

Application of Research:

Concluded result will help researcher to do further studies in root distribution and yield of Bhendi under drip irrigation

Acknowledgement/Funding:

Author are thankful to Tamil Nadu Agricultural University for the support provided for conducting field Experiment.

Author Contributions: First author's post graduate research work

Abbreviations:

CWN	:Crop water Need
ET	:Evapotranspiration
hP	:Horse power
K	:Potassium
LLDPE	:Linear Low density Poly ethylene
LPH	:Litre per hour
m.ha	:million hectare
MSL	:Mean Sea Level
N	:Nitrogen
P	:Phosphorous
PVC	:Poly vinyl chloride
SAR	:Sodium Adsorption Ratio
TNAU	:Tamil Nadu Agricultural University

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

Conflict of Interest: None declared

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