International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664, Print ISSN: 2664-7656
Received: 18-12-2024, Accepted: 17-01-2025, Published: 01-02-2025
Volume 7, Issue 1, 2025, Page No. 104-106

Study on fluctuation of soil moisture under different soil matric potential in drip irrigated okra (*Abelmoschus esculentus* (L.) Moench.)

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Abstract

A field trial was conducted during 2021 at Water Technology Centre, Indian Agricultural Research Institute, New Delhi to study the spread pattern and fluctuation of soil moisture in various matric potential under drip irrigated okra. Okra seeds (variety Pusa B5) were sown in raised bed of 60 cm width in sandy loam soil. Drip Irrigation laterals with inline emitter of capacity of 2 lph were laid on the raised beds. Paired row drip irrigation system was followed in order to accommodate two rows of crop in either side of lateral. Soil matric potential was measured using tensiometers with digital pressure transducer during the entire crop growth period. Tensiometer measures soil moisture tension at the depth where it was installed. Tensiometers (Irrometer) were installed in each irrigation treatments at 20 cm depth in the root zone of okra. Soil moisture fluctuation were measured at different matric potential (−20,−30,−35and −40kPa). At the soil matric potential −20 kPa the moisture content ranged at the upper depth of root zone was 92% to 87% of field capacity from the dripper to 30 cm spatial distance. Nearly 83% to 77% of field capacity moisture spread was found horizontally at the soil matric potential of −30 kPa. At the soil matric potential −35 kPa the moisture content at the effective root zone depth was 77%. At the soil matric potential −40 kPa, 72% to 66% of field capacity moisture was observed. There was a decreasing trend of moisture content in the deeper layer and at the location away from the emitting point.

Keywords: Tensiometer, soil moisture distribution, soil matric potential, moisture content

Introduction

Irrigation water application is very important water management aspects in order to save water as well as to increase water use efficiency. Micro irrigation system is widely used to save water and uniform spread of moisture near root zone. The moisture spread also dependent upon the soil type, soil properties, dripper discharge rate, and frequency of irrigation. Many studies were conducted in different crops under drip irrigation about soil moisture spread pattern. Study on soil moisture distribution would help in water management [1]. Moisture distribution at the depth of 30 cm was studied under subsurface drip irrigation in potato cultivation [2] Soil moisture status and spread was studied with different discharge rate in mulberry crop and reported moisture spread would vary based on dripper discharge [3]. Soil moisture distribution pattern under drip irrigated chilli was studied at different root zone depth of 10 cm, 20 cm and 30 cm with different spatial distance away from dripper [4]. At the peas crop root zone tensiometers were installed and moisture spread pattern at different soil moisture tension were monitored [5]. The soil moisture distribution under subsurface drip irrigation with organic mulching and plastic mulching was studied [6]. To understand the correct in which matric potential uniform as well as enough moisture spread pattern occurred in drip irrigated okra this study was carried out.

Materials and Methods

A field experiment was conducted in the experimental plots of Water Technology Centre, Indian Agricultural Research Institute (IARI), New Delhi during 2021. The IARI is situated in West Delhi at a Latitude of 28° 38' 23" N, Longitude of 77° 09' 27" E and an Altitude of 216 m above mean sea level. The climate is subtropical, semiarid with hot dry summer and cold winter and categorized under agro eco region – IV according to National Bureau of Soil Survey and Land use Planning (NBSSLUP) classification. During okra cultivation the mean maximum and minimum temperature during the experimental season was 36.2 °C and 21.3 °C respectively. The rainfall received during crop season was 129.5 mm. The average maximum and minimum relative humidity was 71.8% and 42.2% respectively and the average wind speed was 5.4 kmph during the experimental season. The field capacity of the soil was 24.35% at volumetric basis and the wilting point of the soil was 9.15% at volumetric basis in experimental field. The weather parameter during okra crop growing season is given in Fig.1.

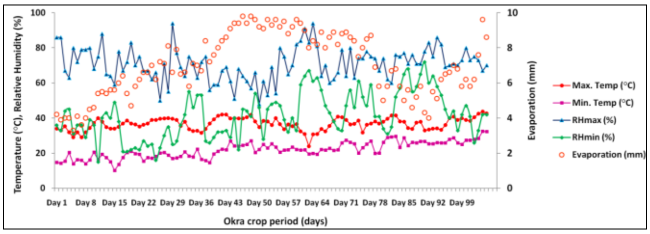

Fig 1: Weather parameters during the experimental season

Soil samples were collected from different depths up to 60 cm using tube auger and analyzed to determine physical properties such as particle size distributions, bulk density, field capacity, permanent wilting point and hydraulic conductivity. Chemical properties like pH, EC, organic carbon, nitrogen, phosphorous were also determined. The soil physical properties of the experimental field is given in Table 1.

Table 1; Soil physical properties of experimental field

Depth (cm)	Mineral content % mass			Textural class	Hydraulic conductivity (cm.h^{-1})	Bulk Density (g.cm^{-3})	F.C (Vol%)	PWP (Vol%)
	Clay	Silt	Sand					
0-15 cm	16	27	57	Sandy Loam	1.42	1.43	24.35	9.15
15-30 cm	18	26	56	Sandy Loam	1.22	1.47	28.20	11.32
30-45 cm	21	24	55	Sandy Clay Loam	1.04	1.38	31.04	12.81

The okra research field area was 28 m x 30 m. During field preparation, Trichoderma viride was applied at the rate of one kg/ha to avoid fungal infection from the soil. Raised beds of 60 cm width were made with furrow spacing of 20 cm with the help of Ridge former and Packer. Drip Irrigation laterals with inline emitter of capacity of 2 lph were laid on the raised beds. Four irrigation treatments and three fertigation treatments were arranged. Each irrigation treatment had 6 raised beds of 48 sq.m area with three replications. The experiment was laid out in Split Plot design with 3 replicates. There were four drip irrigation treatments with controlled soil matric potentials (SMP) of I_1: −20 kPa, I_2: −30 kPa, I_3: −35 kPa and I_4: −40 kPa and three fertigation levels 120%, 100% and 80% of recommended NPK fertilizer dose (RDF).

Results and Discussion

Variation of Soil matric potential between irrigation

Initially, irrigation was carried out equally in all the treatments after sowing through drip system. The depth of water was calculated in each irrigation treatment based on soil moisture depletion to bring back the soil moisture percentage to field capacity level during each irrigation event. The irrigation treatments were started after initial stages of crop growth. Irrigation was actuated based on tensiometer reading.

In okra field the soil moisture tension value fluctuated between the matric potential of −20 kPa to −11 kPa in I_1 treatment. When the soil moisture reached the 20% SMD the particular treatment got irrigated and the soil moisture was brought back to field capacity. Hence in each treatment the soil moisture would fluctuate according to the time interval of irrigation application at different matric potential. Similarly, when the soil moisture reached 30%, 40% and 50% SMD, the respective irrigation treatments I_2, I_3, and I_4 got irrigation and the soil moisture tension values ranged between −30 kPa to −11 kPa; −35 kPa to −11 kPa and −40 kPa to −11 kPa throughout the crop growing season. When the rainfall occurred continuously, the field was maintained with field capacity level during that time no irrigation was scheduled.

The range and counting of soil moisture tension values observed under different treatments throughout the okra crop growing season are depicted in Fig. 2. In the treatment I_1 according to the soil moisture availability the number of times soil matric potential fluctuates between −20 kPa to field capacity was given. Similarly, for the treatments I_2 fluctuates between −30 kPa to field capacity and so on.

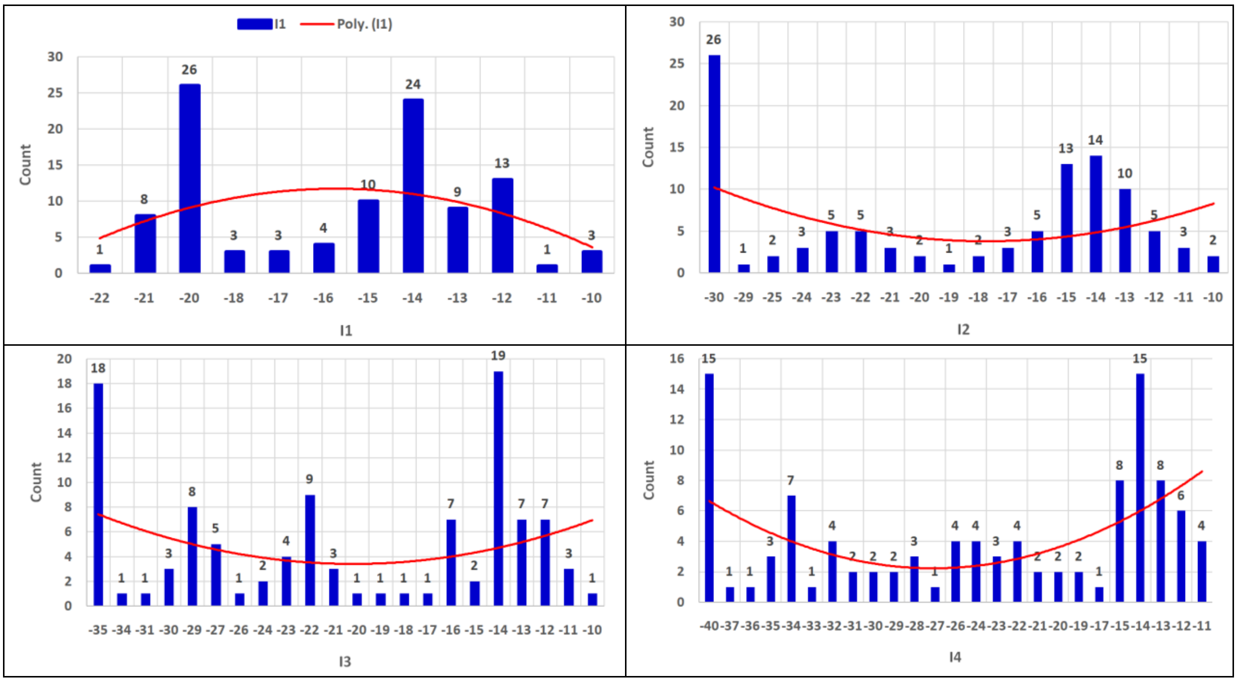

Fig 2: The range and count of soil matric potential in the treatments I_1 (−20 kPa), I_2 (−30 kPa), I_3 (−35 kPa) and I_4 (−40 kPa) during the okra crop growing period

Fluctuation Moisture spread at the effective crop root zone depth of okra

In okra research field the field capacity of the sandy loam soil was 24.35% volumetric basis. At the treatment SMP threshold of -20 kPa, the presence of volumetric moisture content was 21.9% (90% of field capacity). Similarly, for the SMP threshold of −30 kPa, −35 kPa and −40 kPa, the presence of volumetric moisture content was 20% (80% of field capacity), 18.4% (75% of field capacity and 16.7% (70% of field capacity) respectively. The presence of water content at the I_1, I_2, I_3 and I_4 treatment throughout the crop season is given in Fig.3.

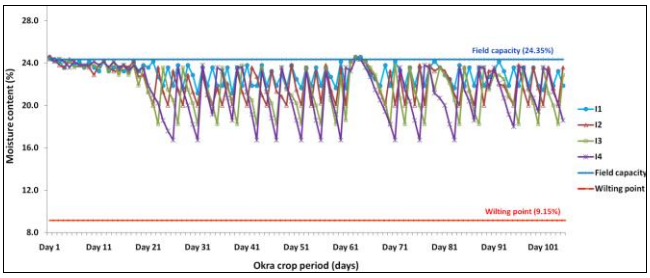

Fig 3: Fluctuation of moisture content under I_1 (−20 kPa), I_2 (−30 kPa), I_3 (−35 kPa) and I_4 (−40 kPa) treatments throughout the Okra crop growing season

Depth of irrigation water applied in okra

The depth of irrigation determined for the soil matric potential of −20 kPa (I_1), −30 kPa (I_2), −35 kPa (I_3) and −40 kPa (I_4) were 4.9 mm, 8.7 mm, 12.1 mm and 15.3 mm respectively per irrigation cycle for okra. The total amount of water added under I_1, I_2, I_3 and I_4 treatments was 350.7 mm, 350.4 mm, 345.4 mm and 345.0 mm respectively. A similar study was reported by [7] that same quantity of irrigation water was applied for the entire crop season but the time of application was varied to understand the optimum frequency of irrigation in tomato. High frequent application of enough amount of water maintained favourable soil moisture at the effective root zone depth [8].

Conclusion

From this study to maintain favorable moisture content at the effective root zone of okra the optimum soil matric potential to operate drip irrigation system was arrived. At the soil matric potential −20 kPa the moisture content ranged at the upper depth of root zone was 92% to 87% of field capacity from the dripper to 30 cm spatial distance. Nearly 83% to 77% of field capacity moisture spread was found horizontally at the soil matric potential of −30 kPa. At the soil matric potential −35 kPa the moisture content at the effective root zone depth was 77%. At the soil matric potential −40 kPa, 72% to 66% of field capacity moisture was observed. There was a decreasing trend of moisture content in the deeper layer and at the location away from the emitting point.

Acknowledgement

The research work is part of Post-Doctoral study of the first author at Indian Agricultural Research Institute (IARI), Indian Council of Agricultural Research (ICAR), New Delhi. The authors are grateful to ICAR and IARI for providing financial support and facilities to conduct the study. The author is indebted to Tamil Nadu Agricultural University, Coimbatore for providing an opportunity to undergo the ICAR-Post Doctoral Fellowship program.

Reference

1. Thomas SL, Bindhu JS, Pillai SP, Beena R, Biju J, Sarada S. Nutrient Dynamics and Moisture Distribution under Drip Irrigation System. Journal of Experimental Agriculture International,2024:46(10):485-93. https://doi.org/10.9734/jeai/2024/v46i102972.
2. Cabrera JR, Zotarelli L, Dukes MD, Rowland DL, Sargent AS. Soil moisture distribution under drip irrigation and seepage for potato production, Agricultural Water Management,2016:169:183-192. ISSN 0378-3774, https://doi.org/10.1016/j.agwat.2016.03.001
3. Arunadevi K, Selvaraj PK. Moisture distribution and fertilizer mobility under drip fertigation in mulberry. Journal of Soil and Water Conservation,2013:12(2):123-129.
4. Aiswarya L, Siddharam, Sandeepika M. Soil Moisture Distribution Pattern under Drip Irrigation in Sandy Loam Soil Using Gravimetric Method. Asian Journal of Soil Science and Plant Nutrition,2024:10(2):198-204. https://doi.org/10.9734/ajsspn/2024/v10i2276.
5. Marwa MA, Abdelraouf RE, Wahba SA, El-Bagouri KF, El-Gindy AG. Scheduling irrigation using automatic tensiometers for pea crop. Agric Eng Int: CIGR Special issue, 2017, 174-183.
6. Al-Othman AA, Mattar MA, Alsamhan MA. Effect of mulching and subsurface drip irrigation on soil water status under arid environment. Spanish Journal of Agricultural Research,2020:18(1):e1201. https://doi.org/10.5424/sjar/2020181-15343
7. Wang D, Kang Y, Wan S. Effect of soil matric potential on tomato yield and water use under drip irrigation condition. Agricultural water management,2007:87:180–186
8. Satpute ST, Singh M, Khanna M, Singh AK, Ahmad T. Response of drip irrigated onion crop to irrigation intervals and fertigation strategies. Indian Journal of Horticulture,2013:70(2):293-295.