Shahid Chamran University of Ahvaz

Irrigation Sciences and Engineering (JISE) **Vol. 42, No. 4, Winter 2019, p. 15-27**

EXTENDED ABSTRACT

Effect of Water Head and Irrigation Interval on Cumulative and Lateral Infiltration in Furrow Irrigation

B. Dialameh[1], H. Ebrahimian[2*], M. Parsinejad[3] and A. Mokhtari[4]

1- MSc, Department of Irrigation and Reclamation Engineering, College of Agriculture and Natural Resources, University of Tehran, Karaj, Iran.
2*- Corresponding Author, Associate Professor, Department of Irrigation and Reclamation Engineering, College of Agriculture and Natural Resources, University of Tehran, Karaj, Iran (*ebrahimian@ut.ac.ir*).
3- Associate Professor, Department of Irrigation and Reclamation Engineering, College of Agriculture and Natural Resources, University of Tehran, Karaj, Iran.
4- MSc, Department of Irrigation and Reclamation Engineering, College of Agriculture and Natural Resources, University of Tehran, Karaj, Iran.

Received:4 December 2016 Revised: 17 December 2017 Accepted: 20 December 2017

Keywords: Double-ring, Short block-end furrow, Initial conditions, Boundary conditions, Relative lateral infiltration. ***DOI:*** 10.22055/jise.2017.20123.1440.

Introduction

Infiltration is considered as one of the most important soil parameters in the design and evaluation of furrow irrigation systems. Water is infiltrated through the wetted perimeter when it reaches a given point in the furrow until it recedes. The depth of infiltrated water at a given point, therefore, is a function of opportunity time, wetted perimeter, and soil intake characteristics (Oyonarte et al., 2002). Thus, in-depth knowledge of how the initial (e.g. initial water content) and boundary conditions (such as water head and wetted perimeter) of a furrow can act on the infiltration process is essential. Previous studies show that cumulative infiltration in furrow irrigation is highly affected by the water head and initial water content. In furrow irrigation, water infiltration into the soil is two-dimensional, both vertically and laterally (Bautista et al. 2014). Gravity forces are dominant in vertical infiltration, while suction forces dominate horizontal/lateral infiltration. Suction forces largely depend on soil matric potential, which is a function of the soil texture and structure, and play an important role in soil moisture retention, sorptivity, essential for plant growth, and lateral infiltration. Knowledge of lateral infiltration and edge effect is essential for designing furrow irrigation systems because many researchers have found that more than 60% of total infiltrated water is through the side walls of furrows.

Several studies have been carried out to determine how initial and boundary conditions may affect the cumulative and lateral infiltration in furrow irrigation, but the combined effect of water head and initial water content on infiltration process is not investigated yet. Therefore, the main objective of this study is to investigate the combined effect of various initial (i.e., irrigation interval or initial water content) and boundary (i.e., water level or the wetted perimeter) conditions on the cumulative and lateral infiltration.

Methodology

Field experiments were conducted at the experimental station of the College of Agriculture and Natural Resources of University of Tehran, Karaj. The furrows were trapezoidal and the furrow length, spacing, and bottom width were 1.5, 0.75, 0.15 m, respectively. Three short block-ended furrows were used to conduct infiltration tests. Side furrows were applied as buffer furrows to preserve the edge effects. In order to investigate the effect of initial water content and wetted perimeter on the infiltration process, two different irrigation intervals and two different water heads were considered, as follows: (i) 5- and 10-cm water heads and (ii) 4 and 9 days irrigation intervals, to reproduce two different initial water contents at the soil surface layer. The water head was kept constant during the tests, by initially restoring it every 30 s and subsequently at 10 min intervals. The volume of water added to keep the water head constant was considered to amount to the total cumulative infiltration. The tests were run for 250 min and were repeated in three irrigation events to consider the trend of infiltration through the time and soil stabilization. The wetted perimeters corresponding to the water heads of 5 and 10 cm were determined to be 38 and 62 cm, respectively. Finally, double ring tests were conducted with similar irrigation intervals and water heads to differentiate between lateral and vertical infiltration. Vertical infiltration was then taken off from the total infiltrated water to estimate the lateral infiltration.

Results and Discussion

The maximum cumulative infiltration was measured with a higher water head (i.e. 10 cm) and extended irrigation interval (i.e. 9 days). In all cases, cumulative infiltration in the first irrigation was higher than other irrigation events, with the third irrigation having a minimum amount. The cumulative infiltration decreased up to 46 and 34% between the second and first irrigations and between the third and second irrigations, respectively. In the first irrigation, infiltration is increased for an increased water head from 5 to 10 cm. This increase was higher for a lower initial water content (longer irrigation interval). Therefore, by increasing the water head from 5 to 10 cm, average cumulative infiltration is increased up to 92 and 102%, respectively. In the second irrigation, by increasing the water head from 5 to 10 cm, for both irrigation intervals, cumulative infiltration increased up to 58 and 68%, respectively. Also, in the third irrigation, average cumulative infiltration in CFI increased up to 77 and 54%. In all three irrigations and for both water heads, infiltrated water depth was increased for a decreased initial soil water content owing to increased soil matric potential. In the first irrigation, for both 5 and 10 cm water heads, by increasing the irrigation intervals from 4 to 9 days, cumulative infiltration increased up to 37 and 30%. The effect of changes in initial water content on the infiltration process was less in the second irrigation. Cumulative infiltration increased for decreased initial water content up to 14% in the 5 cm water head and up to 21% in the 10 cm water head. Infiltration increase due to increased irrigation interval in the third irrigation was greater than for the first and second irrigations. Decreased initial water content caused 62 and 41% increase for water heads of 5 and 10 cm, respectively.

The highest lateral infiltration was observed for the higher water head (10 cm) and extended irrigation interval (9 days). This findings are in agreement with the results reported by Valiantzas et al. (2009) and Furman et al. (2006) Similar to cumulative infiltration, maximum and minimum lateral infiltrations were observed in the first and third irrigations, respectively. Up to 51% difference between lateral infiltration in the first and second irrigations and up to 32% difference between the second and third irrigations were observed. Lateral infiltration was increased by raising the water head from 5 to 10 cm. This increase was higher for a lower initial water content. By increasing the water head from 5 to 10 cm, cumulative lateral infiltration increased by about 5 times in the first irrigation. In the second irrigation event, cumulative lateral infiltration increased by up to 4 and 5 times, when increasing the water head from 5 to 10 cm in 4 and 9 days irrigation intervals, respectively. Cumulative lateral infiltration in the third irrigation was also increased by up to 3.5 and 4.5 times, when raising the water head from 5 to 10 cm. Cumulative lateral infiltration increased by

DOI: 10.22055/jise.2017.16921.1233

extending the irrigation interval for both water heads because of higher matric suctions. Cumulative lateral infiltration increased up to 62 and 52% by extending the irrigation interval from 4 to 9 days, respectively. For both 5 and 10 cm water heads, by decreasing the initial water content lateral infiltration increased up to 14% in second irrigation event. Decreasing the initial water content caused 45 and 96% increase in lateral infiltration for the third irrigation.

Conclusions

The results of this study showed that for a higher water head and longer irrigation intervals, the total and lateral infiltration increased. The results also indicated that irrigation management leading to apply a higher water head or longer irrigation intervals (or lower initial water content) means less time is needed to infiltrate a given amount of water, which leads to a decreased deep percolation and evaporation losses. Improved lateral infiltration can, in turn, lead to higher water and fertilizer application efficiency. Precise and sufficient knowledge of initial and boundary conditions for prediction of the infiltration process is necessary to manage the inflow rate and irrigation intervals properly. Otherwise, it may lead to improper and insufficient irrigation.

Acknowledgement

This research was conducted in the Experimental Farm of College of Agriculture and Natural Resources of University of Tehran. Hence, we appreciate their time and efforts.

References

1- Bautista, E., Warrick, A.W. and Strelkoff, T.S. 2014. New results for an approximate method for calculating two-dimensional furrow infiltration. Journal of Irrigation and Drainage Engineering, 140(10), pp. 04014032.

2- Furman, A., Warrick, A.W., Zerihun, D. and Sanchez, C.A. 2006. Modified Kostiakov infiltration function: Accounting for initial and boundary conditions. Journal of irrigation and drainage engineering, 132(6), pp. 587-596.

3- Oyonarte, N.A., Mateos, L. and Palomo, M.J. 2002. Infiltration variability in furrow irrigation. *Journal of irrigation and drainage engineering*, 128(1), pp. 26-33.

4- Valiantzas, J.D., Pollalis, E.D., Soulis, K.X. and Londra, P.A. 2009. Modified form of the extended Kostiakov equation including various initial and boundary conditions. Journal of irrigation and drainage engineering, 135(4), pp. 450-458.