Advancement of pulse irrigation (drip) in sandy soil

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Abstract

Pulse irrigation refers to the practice of irrigating intermittent fashion with fixed time off and on until the entire irrigation water is applied. Under pulse irrigation system amount of irrigation water and operation time play a key role in reducing excess flooding, study of soil moisture distribution pattern under pulse irrigation (drip), influencing irrigation levels through pulse irrigation (drip), response of pulse irrigation (drip) for vegetable crops. Based on the literature revived application of irrigation water through pulse irrigation (drip) increased the yield of crips head lettuce, green gram and potato crop on sandy soil by 5.78 %, 19.89 % and 40 %, respectively. The soil moisture distribution pattern close to the field capacity after adoption of 10 pulses per day in case of bell paper study. The reviews pointed that pulse irrigation (drip) system can be useful in terms of water saving, maintaining soil moisture close to the field capacity, increasing soil moisture horizontally in the root zone than vertically, increasing yield. The sandy soil is having high infiltration rate resulting in increased vertical movement of soil moisture. Pulse irrigation (drip) can be used effectively for increasing the horizontal spread in the high infiltrating soil.

Keywords: *Intermittent irrigation, Infiltration, Soil moisture, Water use efficiency and Yield*

Introduction

Pulse irrigation (drip) is the concept where the small part of the per day water requirement is given in fraction with a predetermined time of fraction (Dole, 1994). The surge irrigation and pulse irrigation both are synonymously, but in case of pulse irrigation water can applied through modified drip irrigation as well as sprinkler irrigation. Pulse irrigation refers to the practice of irrigating for a short period, then waiting for another short period, and repeating this on-off cycle until the entire irrigation water is applied (Eric *et al*., 2004). Under pulse irrigation system amount of irrigation water and operation time play a key role in reducing excess flooding. In case of sandy soil under pulse irrigation (drip), horizontal spread of soil moisture is increased than the vertical spread.

High intermittent irrigation used for moisture uptake by roots (Segal *et al.,* 2000). Increased vertical spreading may be undesirable because water moving below the active root zone can result in wastage of water, loss of nutrients and ground water pollution. Application of high amount of irrigation water in single irrigation event may result in deep percolation losses in the root zone of growing plants. Splitting of irrigation depth into six pulses with an interval of fifty minutes increased the yield by 5.78 % with 25 % of water saving in lettuce crop under sandy soils (Willian *et al*., 2015). Under pulse irrigation (drip) productivity of potato increased from 10.44 $t.ha^{-1}$ in continuous drip irrigation to 15.60 $t.ha^{-1}$ in four pulse irrigation (drip) recording an increase of 49 % yield (Abdelraouf *et al.,* 2012). Average maximum green bean yield was obtained under four pulse irrigation (drip) 4.78 $t.ha^{-1}$, while minimum yield was obtained in the treatment of continuous irrigation (drip) 3.92 $t.ha^{-1}$ (Mohamed *et al.,* 2012). The sandy soil is having high infiltration rates resulting in increased vertical movement of water (Mane *et al.* 2011). Pulse irrigation (drip) can be used effectively for increasing the horizontal spread in heavy infiltrating soils (Abdelraouf *et al.* 2012). Pulse irrigation through (drip) enhances the yield and productivity of vegetable crops by increasing horizontal spread in the sandy soil.

Literature review

Reviews were briefly deals with the research work carried out in India and abroad for study of soil moisture distribution pattern under pulse irrigation (drip), influencing irrigation levels through pulse irrigation (drip), response of pulse irrigation (drip) for vegetable crops.

Effect of pulse irrigation (drip) on wetting profile

Bakeer *et al.* (2009) studied on effect of pulse irrigation (drip) on yield and water use efficiency of potato crop under organic agriculture in the sandy soil. The potato crop was grown in two summer growing seasons of 2006 and 2007 at Egypt (Cario). To fulfill the objectives of the study, three irrigation levels 50 %, 75 % and 100 % of ET_C and three pulse treatments P_2 (Two pulses), P_3 (Three pulses) and P_4 (four pulses) were imposed with 30-minute interval between pulses and continuous irrigation (P_1). They observed that average maximum width from emitter around contour line of field capacity was 22.50 cm in soil layer (0-15 cm), 19 cm in the soil layer (15-30 cm) and 16 cm in the soil layer (30-45 cm) under continuous drip irrigation (P_1). In case of four pulse irrigation (drip) treatments, it was 25.50

cm in the soil layer (0-15 cm), 25 cm in the soil layer (15-30 cm) and 8 cm in the soil layer (30- 45 cm). They observed a potato yield of 4.70 $t.ha^{-1}$ for continuous drip irrigation to 6.57 $t.ha^{-1}$ under four pulse techniques resulted from increase in yield of 40 %.

Abdelraouf *et al.* (2012) studied on effect of short irrigation cycles on soil moisture distribution in root zone, fertilizer use efficiency and productivity of potato in newly reclaimed lands. The potato crop was grown in the sandy soil of Egypt. To fulfill the objectives of the study, three short irrigation levels (P_2 = two pulse , P_3 = three pulse and P_4 = four pulse) with fixed time off was 30 minute and continuous irrigation (P_1) were imposed. They observed that average maximum width from the emitter to set contour line of field capacity was 8 cm and maximum depth was 45 cm in continuous irrigation (P_1). This means that area was 360 cm^2 under continuous drip irrigation (P_1). However in case of four pulse irrigation (drip), contemplated that maximum wetted width from the emitter to set contour line of field capacity was 15 cm and maximum depth was 31 cm, while wetted soil volume was 465 cm^2. They ascertained that wetted soil moisture increased from 360 cm^2 in continuous drip irrigation to 465 cm^2 under four pulses per day, recording an increase of 25 %. It was revealed that productivity of potato increased from 10.44 $t.ha^{-1}$ for continuous drip irrigation to 15.60 $t.ha^{-1}$ after applying four pulses irrigation (drip) recording an increase of 49 % yield.

Abdelrouf *et al.* (2013) studied on effect of intermittent irrigation and mulching systems on Soybean crop in sandy soil conditions. They grew Soybean during two growing seasons in 2010 and 2011 at Soybean research Farm in Nubariya Region, Egypt. To fulfil the objectives of the study, they considered factors were adding of daily water requirement on four pulses, eight pulses and twelve pulses compared with adding of water requirements one time. They contemplated that increasing soil moisture distribution in the root zone by increasing number of pulses resulting in increased water movement in the horizontal direction than the vertical direction. In case of twelve pulse irrigation (drip) per day decreased soil moisture close to the field capacity, while increased after applying eight pulse irrigation (drip) per day.

Samir *et al.* (2014) conducted laboratory experiments in 100 × 100 × 15 cm size sandy soil box. To fulfill the objectives of the study, they constraint average discharge of 2 $lit.hr^{-1}$ with a total amount of applied water 6 lit. To determine wetted depth and width after 1, 2, 3 and 4 hr of water application. Pulse flow results showed that the increased wetted width and decreased wetted depth as the irrigation interval (irrigation/rest) decreased for the same amount of applied water. This result contemplated that the advantage of pulse flow, for reducing the deep percolation of water under the crop root zone, while obtaining a wide horizontal spread of wetting.

Okasha A. M. (2017) carried out at Agricultural Engineering Department, Faculty of Agriculture, Kaferelsheikh University during summer 2016. The aim of this work is designing a system which is capable of on/off the water pump for pulse irrigation system in time. Arduino board and other hardware is programmed at 20 min. on/20 min.off (possible to change) with the Arduino software. The proposed prototype can help in reducing hard work of pulse irrigation system due to on/off valves manually, cost and save time.

Aymen A. *et al.*,(2019) Most researchers have used the pulsing technique to apply variable-rate irrigation to match the crop water needs within a normal application rate that does not produce runoff. This research introduces a variable intermittent algorithm for conservation water decreasing run off losses. (2) Ensuring soil moisture distribution in the direction of machine simulation through MATLAB should be 90.7 per cent distribution efficiency.

Miller A. *et al.* (2019) objective was to verify the distribution of water in the soil profile, with intermittent application of water, considering the hypothesis that antecedent soil water content modifies the wet bulb characteristics after water pulse application, and to evaluate the effect of increasing superficial water accumulation area on the lateral dimensions of the bulb. The water applications were performed using 1, 2 and 4 pulses in the flows of 4 and 8 L h-1, totalizing six treatments, which were carried out in four replications for each treatment. The evaluations of superficial water accumulation area were performed with the continuous application of water at the mentioned flow rates. The results indicate increasing superficial water accumulation area does not affect the wet bulb, differences in the distribution of soil water are visible only in the first moments after last pulse application. It was concluded water tends to distribute in the soil regardless of the amount of irrigation pulses and pulse irrigation tends to result in similar distribution of moisture inside the wet bulb in relation to continuous irrigation.

Response of crop under intermittent irrigation

Assouline *et al.* (2006) studied on soil-plant systems response to pulse drip irrigation and salinity; bell paper case study, at the experimental station in the Northern Negev, Israel. They grew the bell paper (*Capsicum annum* cv. Selika) on seed bed of sandy loam soil, with two crop rows (0.40 m spacing) per bed. To fulfill the objectives of the study they imposed six irrigation treatments viz. daily saline (1.0 ET_c), pulse saline (1.0 ET_c), daily saline (1.25 ET_C), pulse saline (1.25 ET_C), daily fresh (1.0 ET_C) and pulse fresh (1.0 ET_c**)**. Two irrigation frequencies as one application per day and 10 pulses per day at hourly intervals were tested. They observed that in the absence of over-irrigation, the average soil water content in the root zone was improved under higher pulse fresh (1.0 ET_c**)** treatment.

Mohamed *et al.* (2012) studied on response of green bean to pulse surface drip irrigation. They grew the green gram during the year 2008 and 2009 at Agricultural Engineering Department, Egypt. To fulfill the objectives of the study, three pulse treatments viz. four pulses (T_4), three pulses (T_3), two pulses (T_2) with hourly irrigation interval compared with continuous irrigation (T_1) were given. The irrigation water applied was calculated through CropWat software and the on/off time was managed using solenoid valve. They contemplated that average maximum yield of 4.78 $t.ha^{-1}$ was obtained under four pulse (T_4), while the minimum yield of 3.92 $t.ha^{-1}$ was obtained in continuous irrigation treatment (T_1).

Willian *et al*. (2015) studied on drip pulses and soil mulching effect on American crips head lettuce yield. They grew crips head lettuce in a green house on sandy soil at Federal University of Lavas, USA. To fulfil the objectives of the study, provided irrigation water depth (ID), based on crop evapotranspiration (ET_c). The treatments D_1 – 100 % of ET_c applied continuously (control) and D_2 -100 % of ET_c, D_3 - 75 % of ET_c and D_4 - 50 % of ET_c, applied in six irrigation pulses with fixed period of fifty minutes (irrigation/rest). They observed that greater commercial yield of 31.52 $t.ha^{-1}$ was obtained by the treatment D_3 - 75 % of $ET_{c,}$ saves 25 % of water.

Conclusion

Based on the literature revived application of irrigation water through pulse irrigation (drip) increased the yield of crips head lettuce, green gram and potato crop on sandy soil by 5.78 %, 19.89 % and 40 %, respectively. Most of reviewer reported that soil moisture in the root-zone was improved and reaches near field capacity after adoption of 10 pulses per day in case of bell paper study. The reviews pointed that pulse irrigation (drip) system can be useful in terms of water saving, maintaining soil moisture close to the field capacity.

References

Abdeleaouf R. E., Aboou-Hussein S. D., Abd-Alla A. M., and Abdallah, 2012. Effect of short irrigation cycles on soil moisture distribution in root zone, fertilizer use efficiency and productivity of potato in new reclaimed lands. *Journal of Applied Science Research* 8 (7); 3823-3833.

Abdelraouf R.E., Abou-Hussein S.D., Neema, M., and Marzouk, 2013. Effect of pulse irrigation (drip) and mulching systems on yield, quality traits and irrigation water use efficiency of Soybean under sandy soil conditions. *Journal of Agricultural sciences* 4(5): 249-261.

Ali MH, Talukder MSU (2008). Increasing water productivity in crop production-A synthesis. Agric. Water Manage. 95(11):1201-1213.

Assouline S., Moiller, M., Cohen, S., and Grava A., 2006. Soil-Plant System Response to Pulsed Drip Irrigation and Salinity: *Bell Pepper Case Study*. *Soil Science Society of American Journal*, 70:1556-1568.

Aymen A. Al Al-Baaj and Andrew Lewis., (2019) Variable Pulsed Irrigation Algorithm (VPIA) to Reduce Runoff Losses Under a Low-Pressure Lateral Move Irrigation Machine. Journal of Horticulture V.5 10: 2:25.

Bakeer G. A., El-Ebabi F.G., El- Sadi M., and Abdelghany A.E., 2009. Effect of pulse irrigation (drip) on yield and water use efficiency of potato crop under organic agriculture in sandy soil. *Journal of Agricultural Engineering Irrigation and Drainage*, (26): 736-765.

Dole J.M., 1994 Comparing poinsettia irrigation methods. The Poinsettia, 10: 4-9.

Eric S., David S. and Robert H., 2004 To pulse or not to pulse drip irrigation that is the question UF/IFAS – Horticultural Sciences Department. Florida, USA NFREC-SV-Vegetarian (04-05).

Mane M. S., U. V. Mahadkar, D. J. Dabake and T. N. Thorat 2011 Study efficiency of different sealant material for lateritic soils of Konkan region. Journal of Indian Society agric, Res. 29(2): 82-83.

Maller A. Roberto Rezende, Paulo S. L. Freitas, Cassio C. Seron, Fernando A. Silva Santos and Jhonatan M. Oliveira., (2016) Growth and production of a Japanese cucumber crop under pulse irrigation. African Journal of Agricultural Research Vol. 11 (42) :4250 -4261.

Mohamed M. E., Mohamed E. A. and Amal L. A. 2012 Response of Green bean to pulse surface drip irrigation. Journal of Horticultural Science and Ornamental plants 4(3): 329-334.

Okasha A. M. (2017) Using Arduino Board For Automatic Pulse irrigation System. Misr Journal of Agricultural Engineering Vol. 34(3) : 1233- 1246.

Samir, I., Tarek Z. E., and E. Abdel- Tawab 2014 Modeling the soil wetting pattern under pulse and continuous drip irrigation. Agricultural and Biosystems Engineering Department Faculty of Agric, Alexandria University., Egypt. *American-Eurasian Journal and Environ. Sciences*, 14 (9) : 913-922.

Segal E., A. Ben-Gal and U. Shani, 2000 Water availability and yield response to high frequency micro irrigation in sunflowers. 6th International Micro-irrigation Congress. ‘Micro-irrigation Technology for Developing Agriculture’. South Africa, 22-27 October. E-mail alonben-gal@rd.ardom.co.in.

Willian F. DE., Almeida, Luiza A. Lima and Geraldo M.P., 2015. Drip pulses and soil mulching effect on American cripshead lettuce yield. Journal of the Brazilian Association of Agricultural Engineering. (35): 6; 1009-1018.