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Comparative evaluation of efficiency of surface irrigation and micro irrigation in cereals: A review

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Abstract
Irrigation being a necessity for crop growth and productivity is of paramount importance. In order to sustain crop productivity and profitability over the years in this era of increasing water scarcity, it is important to adopt ways with better water use efficiency and higher productivity. Micro-irrigation is one such approach which improves economic returns and can boost production by up to 400% especially in the in arid and semi-arid regions. In general, irrigation efficiency for most well-designed surface irrigation methods reaches 60%, while in sprinkler irrigation it reaches 75%, and it may reach 95% in surface and subsurface drip irrigation. With a greater crop production and higher water use efficiency than traditional irrigation techniques, micro irrigation maintains a constant flow of water in the crop zone. Drip irrigation is the most efficient and it can be practiced successfully to irrigate wide range of crop variety especially in vegetables, orchard crops, and cereal crops. Applicability and success of drip irrigation changes with soil type, climate and management of system of irrigation and hence it has to be tested for region specific. Micro irrigation helps to improves water use efficacy and grain yield.

Keywords: Micro irrigation, Agricultural productivity, Water use efficiency

Introduction

For agricultural production and to lower the risk of drought, water use in agriculture is important. Since it consumes the majority of fresh water worldwide, the irrigation sector is under pressure to improve its efficiency. Due to climate change, rising population, unsuitable irrigation practises, and competition from other commercial and environmental purposes, this is made worse as water resources become scarce. Irrigation is the process of artificially applying water to crops to meet their additional water requirements. Approximate 85% water is used for crop production and by efficient water management we can maximize the water use efficiency (Mahmoud *et al*., 2016).

The main sources of irrigation are canals, wells, tube wells, reservoirs, lakes, and dams. The moisture required for germination, growth, and other metabolic processes is provided through irrigation. Nutrients can be given to the crops by irrigation as well. Depending on the crop, the soil type, and the season, different amounts of water are applied at different times. For instance, summer crops need more water than winter crops do. Unpredictable and insufficient rainfall often hurts agriculture. A shortage of precipitation causes famines and droughts. In this instance, irrigation aids in reducing the crops' moisture stress. Because even excessive irrigation can have a negative impact on crop growth and output, irrigation should always be applied in the ideal quantity. Additionally, compared to non-irrigated or rain fed situations, crop productivity is better in irrigated conditions. For food, fibre, and vegetable crops to yield as much as possible, proper irrigation schedules and water application techniques are essential. As a result, efficient irrigation scheduling would help to optimise irrigation and increase efficiency. Since water is a finite natural resource, conservation efforts should be intensified. As water demand rises for home, industrial, and other uses, less water will be available for agriculture in the future. Nearly half of the entire planted land will reportedly continue to rely solely on rainfall even when the irrigation potential is reached.

The methods that provide some level of soil surface cover are the most critical things for decreasing evaporation losses under surface irrigation. With accurate water application and continuous wetting strategies that retain improved soil water potential, grain yields of 9 to 12 tonnes/ha could be achieved under surface and subsurface drip irrigation. Additionally, by accurately distributing divided fertiliser doses at the appropriate time and location, fertigation can boost maize output potential. Additionally, under drip irrigation, the maize crop's physiology is influenced by the superior soil water-air interactions, which leads to improved growth, water, nutrient, and resource usage efficiency.

The water-holding capacity and permeability of soil can be increased by using modern irrigation techniques, which can also decrease water loss through surface runoff and meet plant needs for water. Sub-surface drip irrigation is a technique that works well for frequent irrigation in arid and semi-arid soils because it offers the finest irrigation water control, prepares irrigation water near the plant's rhizo sp. here, and promotes high crop productivity. The efficiency of irrigation is used to evaluate how well the irrigation system is being applied, to measure how effectively water is being applied to the soil in the plant's root zone, and to determine whether the irrigation technique being used is appropriate. And the ratio of the water applied to the field to the water stored in the rhizo sphere was used to define irrigation efficiency. Greater water inputs than the soil can handle result in runoff and deep penetration losses of water. In general, irrigation efficiency for most well designed surface irrigation methods reaches 60%, while in sprinkler irrigation it reaches 75%, and it may reach 95% in surface and subsurface drip irrigation. Raising the irrigation efficiency is related to reducing water losses and increasing the amount of water stored in the rhizosphere, and this is related to achieving a balance between all the variables affecting the irrigation system (settlement and good management of the field and determining the appropriate slope and drainage and the appropriate field area).

When field crops like rice, wheat, and other grain crops were tried to be grown in India in the past using a SI system, it was discovered that the sprinklers increased on-farm irrigation efficiency by up to 80% under the local climate. Recent studies have demonstrated that compared to conventional manual watering, micro irrigation produces higher yields of wheat and other grain crops. Along with significantly increasing the number of wage jobs, the expanded irrigation area also enhanced the adopters' income.

According to FAO, more effective irrigation water usage is required to increase irrigation's contribution to food production (FAO, 2003) [12]. The ability of water-saving technology, especially drip irrigation, to boost yields and slow the pace of salinization is a significant advantage. Additionally, brackish water can be utilised with either approach for crops that are not overly sensitive to salinity because neither method puts water into touch with the leaves (Cetin, 2004.) [6]. Both environmental concerns and irrigation efficiency into account More people are getting interested in micro-irrigation, which is the precise application of water on or below the soil surface at low pressure using little devices that spray, mist, shower, or drip water (Hla and Scherer, 2003) [14]. Micro-irrigation has been widely adopted in recent decades as a result of rising sales and technological advancements. Micro-irrigation frequently takes the form of drip irrigation. Numerous countries under drip irrigation land has grown quickly, according to irrigation statistics (Maadramootoo and Morrison, 2013). In underdeveloped nations, a number of governmental and non-governmental groups are actively pushing micro irrigation (Varma *et al*., 2006) [29].

Effect of micro irrigation on growth and productivity of cereals

When compared to other irrigation techniques, the water needed for irrigation with micro-irrigation may be less. Less water is lost to evaporation because the wetted area is less. There is virtually no surface drainage in these systems. With a greater crop production and higher water use efficiency than traditional irrigation techniques, micro irrigation maintains a constant flow of water in the crop zone. By increasing the water productivity and irrigation efficiency, we can improve the yield of crops (Fatih *et al*., 2009).

In many applications, including irrigation of most vegetables, cotton, sugar cane, orchard and vineyard produce, Postel (2000) [25] asserts that drip irrigation has the potential to at least double crop production per unit water. Using drip irrigation and applying 581 mm of irrigation water, Yazar *et al*. (2002) [32] achieved the greatest yield of 11,920 kg/ha on second-crop maize. In comparison to surface watering, drip irrigation might save as much as 55%, according to the research, while potentially increasing grain output by 15–23%. (Cetin, 2004) [6]. In 2013, Abd El-Waheda and Ali compared the effects of drip and sprinkler systems on the yield and WP of maize in Egypt under various IW regimes. In comparison to sprinkler irrigation, the grain production of maize under drip irrigation was 31.4 and 24.8 percent greater for irrigations that compensated 100 and 70 percent of evaporation loss, respectively. WP increased by 60.4 and 45.1 percent in proportion. Similar to Aydinsakir (2004) and Karam *et al*. (2003), Aydinsakir *et al*. (2013) [3] proposed that 1000 grain weight decreased due to soil water deficits and low photosynthesis matter and assimilates to kernels, while other studies claimed that irrigation water amounts did not affect grain weight (Elzubeir & Mohamed, 2011; Yazar *et al*., 2009). Elzubeir and Mohamed (2011) [10] claim that whereas irrigation levels have no effect on yield components, irrigation intervals have a greater impact. According to Katerji *et al*. (2008) [19], the blooming stage (including tasseling, silking, and pollination) and grain filling are the crucial growth stages for water deficiencies. Deep surface drip line had higher 100-kernel weights than the surface drip line, and the changes in the yield components were considerable (Douh B. and A. Boujelben, 2011) [8]. With a reduction in irrigation water volume, fewer grains were planted in each row. Grain production decreased from 23 to 40 percent when 30 and 20 mm of water were applied to the soil because they weren't deep enough to keep the soil moist. Ogretir (1993) [23] claimed that the application of water deficit at the blossoming stage caused a reduction in 1000 grain weight. More root length density is observed in the sub-surface drip irrigation than in the surface drip below 30 cm (Al-Omran *et al*., 2004). Drip irrigation has many benefits; it saves water, labour and machinery (Feleafel and Mirdad, 2013; and Vijayakumar *et al*., 2010) [11, 30]. In an experiment to examine the effects of drip irrigation and drip fertigation on maize yield formation and water use efficiency, Wu *et al*. (2017) [31] found that the latter considerably enhanced grain output by 27% and 9% when compared to the former. Studies carried out in Morocco showed that drip irrigation increased wheat output by 28% and water per acre by 24% when compared to surface irrigation. (Kharrou*et al*., 2011). Phene *et al*., 1991 [24] experimented to analyze the root distribution of sweet corn under the high-frequency surface (S) and subsurface (SS) drip irrigation.

Effect of micro irrigation on water use efficiency of cereals

The quantity of carbon assimilated as biomass or grain produced per unit of water utilised by the crop is known as water use efficiency (WUE). In semi-arid places where irrigation water was a scarce resource, evaluating field crops required an understanding of water use efficiency (WUE) (Johnson and Henderson, 2002) [16]. The effective supply of water and nutrients to plants through drip irrigation not only save the water but also increase the crop yield (Tiwari *et al*., 2003; Deshmukh and Hardaha, 2014) Abdel- Hafez *et al*., 2001 [28, 7, 2], reported that drip irrigation in clay soil increased crop and field water-use efficiency of maize crop by 9.52 and 35 percent, respectively than to furrow irrigation system.

The highest WUE may be the objective in situations with restricted water supplies. By Geneille and Wang, high WUE is possible without suffering a large yield penalty (application depths of 50 and 40 mm), providing prospects for enhancing farm-level water use and sustainable water development (2017). At TNAU in Tamil Nadu, field trials on a maize-based intercropping system revealed that the DI system increased water production while saving up to 43% of water. Drip fertigation with 150 percent of the required fertiliser dose and radish as an intercrop produced higher net returns, or Rs. 56,858 ha-1, and a B-C ratio of 3.24..The drip irrigation had a greater WUE at 0.35 m. (Douh B. and A. Boujelben, 2011) [8]. WUE values as high as 1.62 kg m-3 were recorded in 2013 by Kuscu and Demi. El-Meseery (2003) [9] found that drip irrigation conserved 20–25 percent of the water applied in sandy soils. Drip irrigation in clay soil increased crop and field water-use efficiency of maize crop by 9.52 and 35 percent, respectively, compared to furrow irrigation method, according to Abdel- Hafez *et al*., 2001 [2]. Due to more water applications made using the conventional method, conventional irrigation had a lower WP than drip (Mahmoud and others, 2016). The drip irrigation had a greater WUE at 0.35 m. (Douh B. and A. Boujelben, 2011) [8].

Effect of micro irrigation on profitability of cereals

At TNAU in Tamil Nadu, field tests on a maize-based intercropping system revealed that the DI system increased water production while saving up to 43% of water. Drip fertigation with 150 percent of the required fertiliser dose and radish as an intercrop produced higher net returns, or Rs. 56,858 ha-1, and a B-C ratio of 3.24. Additionally, it is discovered that using drip irrigation during paddy cultivation can lower water requirements by 66 percent when compared to FIM, which also results in a 50 percent reduction in power use.. According to Bandyopadhyay *et al*. (2010) [4], 20 cm irrigation provided up until the wheat plant is in the flowering stage or 14 cm irrigation provided up until the wheat plant is in the tillering stage, through SI systems in 4 and 3 splits, respectively, resulted in higher grain yield and WP of wheat in a vertisol than that in FIM. Drip irrigation produced the highest spikes m-2 (282.43 and 292.05), followed by check basin irrigation (270.28 and 282.43) and sprinkler irrigation (255.95 and 267.15) (Priyanka Suryavanshi 2018).

Conclusion

Drip irrigation system increased water production while saving up to 43% of water in maize intercropping. In central India, drip irrigation can increase wheat output by 15 to 30 percent while lowering water use by 20 to 28 percent, according to efforts to increase wheat productivity. Drip irrigation in clay soil improves crop and field water-use efficiency of maize crop. Compared with the traditional irrigation methods, using micro irrigation techniques with increasing irrigation frequency can significantly improve the crop growth, yield and water use efficiency with much lesser quantity of water and higher economic returns. This can surely pave the path for achieving the goal of 'more crop per drop'.

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