



## **Clay Pot Irrigation- A Review Study**

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### **Authors' contributions**

*This work was carried out in collaboration between both authors. Author RA designed the study, wrote the first draft of the manuscript and managed the other parts of the study. Author AP managed the literature searches. Both authors read and approved the final manuscript.*

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### **ABSTRACT**

Water is the primary input for crop production and increasingly becomes scarce due to its high demand in agricultural sector. Quality of water is assuming great importance with the increasing demand in industries, agriculture and rise in standard of living. Agriculture is the major user (89%) of India's water resources. However, dwindling of freshwater resources and deterioration of irrigation water quality due to its overuse to meet up the high demands in agriculture sector becomes the serious concern in sustainable crop production. Clay pot irrigation in its simplest form consists of unglazed baked clay pots, which are buried up to the neck in the soil and filled with water. This method is one of the most efficient systems of irrigation known and is ideal for many small farmers. Clay pot irrigation, a traditional system of irrigation alternative to drip method is the latest advancement and effective innovation of localized methods of irrigation and found suitable where water scarcity becomes major stress for crop production. It also helps to improve soil physical properties particularly the structural status in soil and also enhances the water use efficiency of the crop, soil organic carbon and builds up soil fertility.

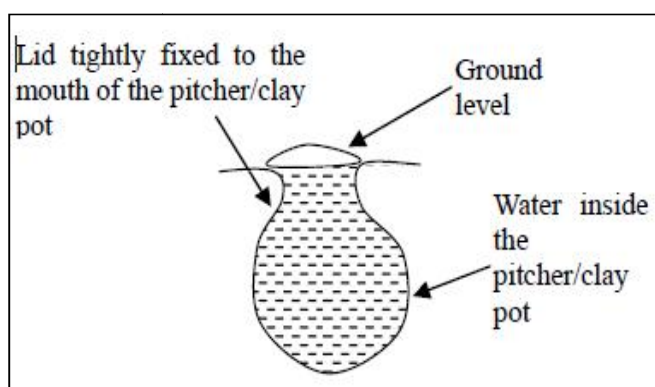
*Keywords: Clay pot; irrigation; soil properties.*

### **1. INTRODUCTION**

Irrigation is the most important input for growing crops that require high water supply in

agriculture. Clay pot irrigation, a traditional system of irrigation alternative to drip method is the latest advancement and effective innovation of localized methods of irrigation and

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**Fig. 1. Schematic diagram of buried clay pot (Setiawan, 1998)**

found suitable where water scarcity becomes major stress for crop production. Pitcher irrigation is a self-regulative, low cost and eco-friendly technique of irrigation having a high potential of energy saving, water saving and very much efficiency in orchard planting [1]. In this method, unglazed backed earthen pitchers buried up to neck into the soil, filled with water which slowly seeps out through their pores wall into the root zone by the action of static and soil suction pressure. The seepage rate is directly proportional to the pitchers' conductance and potential evapo-transpiration of crops and is controlled by the moisture content in the soil matrix or its environments, namely the soil, climate and plants and the pitcher [2]. The efficiency of irrigation depends on many factors including soil type, plant species, soil structure and soil fertility, weed competition, and site microclimate. Only a few scientific studies are available on pitcher irrigation relating to various controlling factors. There is still a lack of sufficient understanding of the system, which is necessary for evolving design criteria. Because of this studies have been conducted by the authors on the rate of water flow through buried pitchers under different climatic conditions. The first step is obtaining or making suitable clay pots. The size of buried clay pot will depend on the type of crop, the density of planting, and the time desired between refills. Five to ten liter (5-10 ltr) sizes are a convenient size for field purposes. Larger pots may be more suitable for trees or for long refill intervals. The hole can be sealed with silicone caulk, a rubber cork, or a wood plug. It is easiest to use caulk, simply put some masking tape over the outside bottom of the pot [3]. Then turn the pot over and use a caulking gun to fill the hole (Fig. 1). Let dry for two days, then use. One pitcher (10 liter capacity) was surrounded by 4

plants. The soil surface was covered with plastic mulches to prevent evaporation. Water and fertilizers were given through the water supplier. The only irrigation operation was to open or close the main water tap at the water supplier [4]. The Root of the plants was accumulating in the region and tended to intensify as closer to the body of the pitcher. In morning, leaves of the plants were seen very fresh but as coming to afternoon they changed as usually indicated when evapo-transpiration was higher than the rate of the water being consumed.

## 2. PITCHER IRRIGATION: AN OVERVIEW

Quality of water is assuming great importance with the increasing demand in industries, agriculture and rise in standard of living. Agriculture is the major user (89%) of India's water resources. Indiscriminate use of saline irrigation water in absence of proper management of water – crop- soil poses a grave risk of endangering the development of salt effected soils accompanied by serious crop damage. Saline water is to be irrigated in such amount and quality that it meets the evapo-transpiration demands of the crop minimizes root zone salinity and selecting suitable crop and varieties tolerant to water and salinity stress [5]. Pitcher irrigation, a traditional system of irrigation alternative to drip method is the latest advancement and effective innovation of localized methods of irrigation and is found suitable where water scarcity becomes major stress for crop production. Pitcher irrigation in (Fig. 2) in its simplest form consists of unglazed baked clay pots, which are buried up to the neck in the soil and filled with water [6].

In the alternative, under such circumstances, some dryland countries have adopted certain

water-saving technologies like drip and sprinkler systems to irrigate their crops so that their scarcely available water resources will not be deleted. Here again, although such irrigation methods are known to save about half of the water presently used for surface or furrow irrigation, their technical, economical (high investment and operational costs), and socio-cultural factors have remained a serious hindrance from adoption, especially by small-scale farmers [7]. The use of such techniques has thus been limited to commercial farms and to those areas with relatively plain landscapes or topographies that are relatively located in closer proximity to water points. As such, the large majority of smallholder farmers in those areas are still by and large deprived of irrigated farming and so much exposed to food and nutrition insecurity.



**Fig. 2. Buried clay pot with crops**

Conservation and use of water are very important, especially for farmers in developing countries like India where water is often a major limiting aspect of agricultural production and development. To take benefit of the prospective year-around growing seasons of the tropics and the resulting increased production, well-developed irrigation systems are often essential. A reliable supply of water is critical to intensive for crop production. When the farmer has an irrigation system, even though he may seem to have an unlimited amount of water, it should be used with care. Too much water, besides being a waste of energy and water will leach down through the soil and carry nutrients out of the reach of the roots of plants. Water run-off on that soil which absorbs water slowly will also wash away topsoil and nutrients.

In India, a water resource is reducing slowly and continues increased pressure due to uncertain rainfall, a rising population, old and ineffective irrigation techniques, and dependence on water-

intensive crop varieties. To get maximum crop productivity from each drop of water is observed as vital for the sustainability of the agriculture sector and food security. But achieving this goal will be difficult unless farmers switch to new methods such as pitcher and drip irrigation. State like Rajasthan, Madhya Pradesh receives sparse and erratic rainfall, per year average rainfall is also less, with the temperature hovering above 49 degrees centigrade from May to July. In this harsh climate, which could become even more extreme as the planet warms, villagers have had no access to canal water, ruling out crop cultivation in the past. Pitcher irrigation has made agriculture potential; helping in a new era for local farmers. The clay pot irrigation system is one of the most efficient systems of irrigation known and is ideal for many small scale farmers [8,9]. Pitcher irrigation is an ancient technique that has been practiced in many parts of the arid world including India, Iran, African and South American countries [10]. Developed countries advanced micro-irrigation techniques such as sprinkler and drip irrigation are used progressively; many farmers in developing countries are unwilling to adopt these methods due to their high early cost of installation and costly maintenance. Traditional irrigation methods such as subsurface pitcher and porous clay pipe irrigation [11,12,13] are often preferred by poor farmers in small scale irrigation projects because of their low cost and high irrigation efficiency [14].

The clay pot irrigation technology is a conservation irrigation system, which saves between 50% and 70% of water when compared to conventional watering can irrigation system [15]. The clay pot system is therefore important when water conservation is crucial [16]. The buried clay pot irrigation maintains stable soil moisture, enables crops to grow in both soil or saline soils and is suitable for using saline waters not applicable with conventional irrigation [10]. By using this pitcher irrigation system and unusual water, the salt accumulates in the surface of the soil and the moisture in the soil around the roots, the concentration of salts in the soil around the roots is reduced [17].

Clay pot pores allow the water to spread into the soil and making the availability of moisture for crop growth. Water filled on the pot by weekly checkup and when required, thus maintaining a continuous supply of water to the plants. While burying the pitcher in the soil, farmers should take care to see that the neck region of the pot is

positioned in such a manner that rainwater runoff does not enter into the pitcher. Otherwise, small sand particles will block the pores of the pitcher. The main advantage of the wick which is attached at the bottom of the pot is to increase the water penetration into the soil and to deliver the water directly to the plant roots. The rate of water seepage from a pitcher depends on the type of plant and soil, and climatic conditions. When water level in soil is increased and soil becomes saturated water will soak back into the pot, filling it again. The system is self-regulating and water losses are negligible.

The number of clay pot required per hectare differs with the sort of crop. Creeping vegetables like cucumber, okra, eggplant, and bitter gourd need 2,000 to 2,500 pitchers per hectare, whereas upright and canopy crops like beans, tomatoes, leeks, and melons, need up to 4,000 to 5,000 pots per hectare. The amount of water seepage from a pitcher depends on the age of plant and soil, and climate. Once the encompassing soil becomes saturated, water will soak back to the pot, filling it again this method of irrigation is ideal for sandy to loamy soil with good porosity. For small farmers, the system costs around Rs. 4,500 (nearly \$48) per acre – about 80 percent cheaper than drip and sprinkler irrigation. The yield per acre is around 60 percent higher than with furrow and flood irrigation, which many farmers continue to use. A farmer can save 90 percent of water as compared to flood irrigation. Fertilizers can also be mixed along with the water and poured into the pot. Weed growth is very minimal because water delivery is limited to the roots. Many farmers in the coastal districts are following this method.

### 2.1 Advantages of Pitcher Irrigation

- Pitcher irrigation is still used on a limited basis in the dry-lands of India.
- It has been successfully used for a wide range of annual and perennial plants including many vegetables and fruits.
- It is especially useful in difficult conditions of high salinity, extreme aridity, limited water supply and limited resources.
- The water use efficiency of irrigation systems depends on many factors including soil type, crop type, weed competition and microclimate.
- The experimental test has been suggested of pitcher irrigation may use as little as 10% of the water used in conventional surface irrigation.

- Pitcher irrigation facilitated rapid establishment and faster growth of plants.

### 3. EFFECT OF CLAY POT IRRIGATION ON CROPS AND SOIL

Bhingardeve [18] studied the influence of saline, canal water and N-fertilizer level through pitcher irrigation on pH, EC of soil and plant height at different growth stages of brinjal and observed that pH and EC of soil increased in both depths of soil (0-15 and 15-30 cm) at harvesting stage of plant for saline and canal water treatments. Regarding fertility levels, 100% recommended dose of urea (150 kg urea ha<sup>-1</sup>) level recorded the highest values of pH and EC of soil. Similar experiment was conducted with pumpkin (*C. moschata*) involving three methods of irrigation (drip irrigation by a direct pitcher, drip irrigation by pipe from pitcher and basin system of irrigation) [19]. The direct pitcher method recorded significantly higher values for vine length, a number of nodes per vine, stem girth and significantly lower values for inter node length compared to the other two methods of irrigation at all stages of plant growth. Pachpute [20] also concluded that the increase in total yield due to a package of water management practices including pitcher irrigation method is 203 percent and water use efficiency obtained is 12.06 kg m<sup>-3</sup>. than 30 cm and 40 cm, respectively for both tested soils. The surrounding soil moisture was in a range available for plant growth. Different depths of pitcher placement in the soil produced different reaching distances of the wetting front but showed insignificant differences in water availability. Researcher described the salt tolerance of five cultivars of *Capsicum annum* L and the variety NMCA 10652 had the highest survival percentage at 100% in the 4.1 dS m<sup>-1</sup> treatment, followed by 'Early Jalapeno', 'Nu-Mex Sweet', Pimienta De Chiera', 'Santa Fe Grande', 'Golden Treasure', and 'Nu-Mex Joe E' [21]. Scientist found that the highest dry chili yields of 8.12 and 20.78 q ha<sup>-1</sup> were obtained from non-saline canal water followed by two applications of non-saline water alternating with one saline water with 7.30 and 20.38 q ha<sup>-1</sup> respectively [22]. Saline (well) water irrigated plants yielded 3.99 and 11.72 q ha<sup>-1</sup> respectively, which represented yield reductions of 50.8% and 43.6%, respectively as compared with non-saline. The effect of saline water and fertigation on the yield contributing parameters of brinjal and found that the highest dry matter accumulation in plant and fruit (112.66 g and

87.4 g, respectively) was obtained under best available canal water. The dry matter accumulation with saline water under different fertilizer levels i.e. 100, 75 and 50% recommended urea applied through drip irrigation was 103.72, 101.66 and 86.38 g plant<sup>-1</sup> respectively [23]. Similar results showed the infiltration rates decreased linearly rather than exponentially even though the soil was initially dry. The advancement of the wetting front was very slow and somewhat limited to a radius and depth of no more canal water only [24].

#### 4. CONCLUSION

Effective irrigation, water controlling and its suspicious use, by encouraging water-saving irrigation techniques – such as clay pot, drip and sprinkler irrigations – will help sustain food-production structures in our water-stressed country. Clay pot irrigation as a substitute to drip or sprinkler irrigation can be a feasible option for water-scarce area mainly for farmers those are looking to living out of their small holdings of land. Irrigation water saving by clay pot irrigation can be further enhanced by altering the porosity of pots and hence, appropriate clay: sand composition, wall thickness and firing temperature for various vegetables should be further investigated.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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