Biosc.Biotech.Res.Comm. Special Issue Vol 13 No 12 (2020) Pp-44-47

BBRC
Bioscience Biotechnology Research Communications

Pitcher Irrigation Technology for Crop Cultivation in Arid Region

Arunabha Pal[1*], Rahul Adhikary[1], Monishankar Bera[1], Rohit Garanayak[1] and Susanta Kumar De[2]

[1]*Assistant Professor, Department of Agricultural Chemistry and Soil Science, Centurion University of Technology and Management, Odisha, India*

[2]*Professor, Department of Soil and Water Conservation, BCKV, West Bengal India*

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. Pitcher irrigation is an ancient and very effectual irrigation system employed in many arid and semiarid counties. Among traditional irrigation systems, pitcher irrigation is one among the foremost efficient and compatible for little farmers in many areas of the planet. Pitcher irrigation entails burying an unglazed, porous clay pot with in soil before seedling. Water poured into pot seeps slowly into the soil, feeding the seedling's roots with a gentle supply of moisture.

KEY WORDS: PITCHER POT, IRRIGATION, SALINITY, DRIP IRRIGATION.

INTRODUCTION

Pitcher irrigation is cost effective, farmer-friendly, and easy to install. Pitcher irrigation involves no high tech gadgets and does not require any maintenance. It is ideal for small holdings (1-2 acres) and suitable for growing vegetables, coconuts, and areca nuts. It consists of a clay pot with a cotton wick fixed at the bottom of the pot, and buried in the soil (up to its neck) and filled with water (Adhikary et al., 2020 and Pal et al., 2019). The natural pores in the pot allow the water to spread into the soil, creating moisture for crop growth. The water can be filled as and when required, thus maintaining a continuous supply of water to the plants (Umalaxmi et al., 2017 and Adhikary et al., 2020). 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 number of pitchers required per acre depends on the crop variety grown. For coconut seedlings about 170 pots per hectare (that is 70 pots per acre), and for areca nut about 1100 pots (440 pots per acre) will be required. A farmer can save 90 per cent of water as compared to flood irrigation. Fertilizers can also be mixed along with the water and poured into the pot. Weed growth has been found to be very minimal because water delivery is limited to the roots. Many farmers in the coastal districts are following this method. If you have a garden at home try this irrigation method (Adhikary et al., 2020 and Umalaxmi et al., 2017).

ARTICLE INFORMATION

Corresponding author email: arunabha@cutm.ac.in
Received 6th Oct 2020 Accepted after revision 28th Dec 2020
Print ISSN: 0974-6455 Online ISSN: 2321-4007 CODEN: BBRCBA

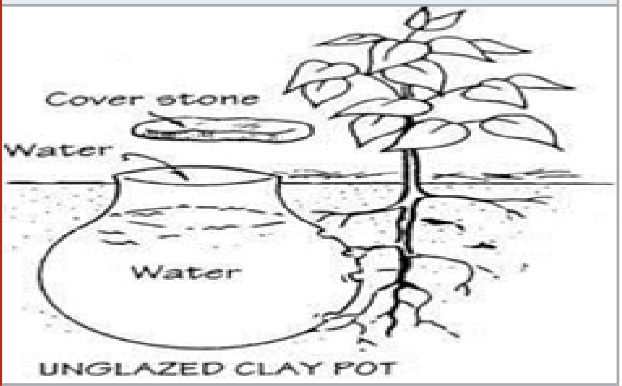
Thomson Reuters ISI Web of Science Clarivate Analytics USA and Crossref Indexed Journal

Clarivate Analytics   crossref

NAAS Journal Score 2020 (4.31) SJIF: 2020 (7.728)
A Society of Science and Nature Publication,

Online Contents Available at: http//www.bbrc.in/

Figure 1: Pitcher irrigation using an unglazed clay pot (Vukasin et al. 1995)



History of pitcher irrigation: Pitcher irrigation is an ancient technique that has been practiced in many parts of the arid world including Iran, India, African and South American countries (Mondal, 1974; Stein, 1997). The technique is simple, cheap and could have blarge water-saving potential (Mondal, 1978; Bainbridge, 2001). Pitcher irrigation has been mentioned in a book written some 2000 years ago in China (Sheng, 1974). The method reportedly has been used to irrigate watermelons in India and Pakistan (Mondal, 1974; Soomro, 2002); horticultural crops in Brazil, Germany, and Indonesia (Stein, 1997; Setiawan et al., 1998); and corn, tomato, and okra in Zimbabwe (Batchelor et al., 1996). A few researchers have indicated that pitchers could have self-regulative capability in conditions where seepage is controlled by the soil water pressure head, which is, in turn, a function of the soil water content around the pitcher (Chigura, 1994).

Pitcher Irrigation:

An Overview: Pitcher Irrigation is an inexpensive small-scale irrigation method practiced in the semi-arid state of Karnal, India. The system consists of burying unglazed clay pots in the soil up to their neck. When the pot is filled with water, the natural pores in the pot's walls allow water to spread laterally in the soil, creating the moist conditions necessary for plant growth. Pitchers are filled as needed, maintaining a continuous supply of water directly to the plant root zone. One of the advantages of using pitchers for irrigation is the result of their water saving capacity. To compare pitcher irrigation to flood or sprinkler irrigation one must correct for the fact that the scales are radically different.

Pitcher irrigation is used on small-scale, while flood and sprinkler systems are for more extensive irrigation. Taking this into account, pitcher irrigation is still more efficient. Pitcher irrigation uses water more efficiently than other systems since it delivers water directly to plant root zones, instead of to broader areas of the field. With pitcher irrigation, deep percolation losses are negligible since water is released from smaller areas, and the rate of water loss can be controlled site to site by the amount of water put in each pitcher. Water requirements in a pitcher irrigated field can be even less than those of a drip irrigated system (of the same scale) due to the very low hydraulic conductivity of the pitchers, as well as reduced evaporation losses.

Research with pitcher irrigation at the Central Soil Salinity Research Institute (CSSRI) in Karnal India indicates that the amount of water which seeps out of the pots--and thus the number of plants which can be sustained by each pot--depends on the soil type, the porosity of the pot wall as well as the shape of the pot used. Pitchers are generally placed at distances so that wet areas do not overlap. Soil moisture and salt distribution in the plant root zone are much more favourable with pitcher irrigation than with any surface method of irrigation. Under pitcher irrigation salt accumulates at the soil surface, leaving the salt content of water in the root zone more favourable than the salinity of water used in the pitcher. Thus even saline water can be used for irrigation in the pitcher irrigation system. Scientists at the Central Soil Salinity Research Institute have found that seven to ten litre pots are sufficient to grow most vegetable crops. The number of pitchers needed per hectare varies with the crop. At least four plants of most vegetable crops could be grown around one pot. A creeping crop such as bitter gourd required 2,000-2500 pitchers per hectare. Upright crops or crops producing a canopy around the pot required more pots, up to 4,000-5000 pots per hectare.

The profitability of pitcher irrigation must consider the labour of acquiring, burying, and filling the pots, in addition to the labour involved in managing the crop. Researchers at CSSRI found that the most profitable crops for pitcher irrigation in that area were (in order) tomato> bottle-gourd> bitter-gourd> watermelon> cauliflower. The muskmelon was unprofitable, thus they do not recommend its cultivation with pitcher irrigation. The prospects of pitcher irrigation are reasonably high, especially in areas where water scarcity and salinity limit cultivation. The only difficulty with this method is the high labour demand which it places on the farmer. Pitcher irrigation may be an inappropriate solution where the labour needed to set up and run the system would fall on already overworked labourer's (CSSRI, Karnal).

Advantage of pitcher irrigation:

1. In this method, only the area near the pot gets irrigated and not the whole area.
2. Evaporation of water is minimum in this method.
3. Water seepage below the ground is also in minimum quantity.
4. It is the best method for horticulture crops and vegetables.

5. Once the pitchers are fixed, irrigation can be done for six years, which reduces expenditure.
6. It needs minimum technical knowledge.

Effect of Pitcher Irrigation on Crops Cultivation: Batchelor (1997) carried out irrigation trials and experiments in south-east Zimbabwe and northern Sri Lanka during 1985 to 1995 and found that subsurface irrigation using clay pipes was particularly effective in improving yields, crop quality and water use efficiency as well as being cheap, simple and easy to use. Comparing the field experiment conducted by Mondal (1974) and Scheuring (1983), it was found that yield of pitcher pot irrigated melon in India was 25 t ha-1 using only 2 cm water ha-1 (Mondal, 1974), whereas the yields of melon was 33 t ha -1using 26 cm of water with flood irrigation (Scheuring, 1983). Balakumaran et al., (1982) conducted a detailed study of cucumber production which showed that irrigation of 1.9 mm ha-1 with pitcher pots provided yields comparable to 7.3 mm ha-1 by hand irrigation.

Pachpute (2010) also concluded that the increase in total yield due to package of water management practices including pitcher irrigation method is 203 per cent and water use efficiency obtained is 12.06 kg m-3. Saha et al., (2005) conducted an experiment with pumpkin (C. moschata) involving three methods of irrigation (drip irrigation by direct pitcher, drip irrigation by pipe from pitcher and basin system of irrigation). The direct pitcher method recorded significantly higher values for vine length, 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.

Effect of Pitcher Irrigation with Saline Water: The stable soil moisture maintained by pitcher pot irrigation enables crops to be grown in very basic or saline soil or with saline water under conditions in which conventional irrigation would fail (Rai, 1982). High tomato yields of 27 t ha-1, were obtained in India using saline irrigation water, EC 10.2 mmhos cm-1, while typical yields in this area with fresh water, EC 0.4, ranged from 15-25 t (Mondal, 1983). In Kenya 61% of normal crop yield was achieved with irrigation water of EC of 8 dS m-1, when typical irrigation failed at EC of 4 dS m-1 (Okalebo et al., 1995). Alemi (1980) stated that pitcher pot irrigation moved salt out of the plant root zone better than drip irrigation.

Very low-fired pots may break up in very saline soil as a result of chemical reactions with the salts. Mondal et al., (1992) showed a 20% decrease in brinjal yield at 12 dS m-1 compared with the control but was not adversely affected below this level of salinity. Pitcher irrigation is considered more efficient than surface, drip and sprinkler irrigation and produces yields even when saline water is used. Dubey et al., (1990) conducted experiment on ridge-gourd (Luffaacutangula) and found that increasing salinity resulted in increasing delay in germination; highest yield (4.45 kg/pitcher) was obtained with 0.4 dS m-1 irrigation

REFERENCES

Adhikary, R., and Pal, A. (2020). Clay Pot Irrigation-A Review Study. Asian Plant Research Journal. 5(1): 37-42.

Adhikary, R., and Pal, A., Bera, M., and De, S.K. (2020). Pitcher irrigation in salinity management for production of brinjal crop in coastal soil of West Bengal, India. Ecology, Environment and Conservation. 26: 179-183.

Adhikary, R., and Pal, A. (2020). Influences of Kitchen Waste Product to Restore Soil Fertility and Impact on Pulse Crop. Indian Journal of Natural Sciences.10 (60): 19781-19785.

Alemi, M.H. 1980. Distribution of water and salt in soil under trickle and pot irrigation regimes. Agric. Water Manage. 3: 195-203.

Batchelor, C., Lovell, C. and Murata, M. (1996). Simple microirrigation techniques for improving irrigation efficiency on vegetable gardens. Agricultural Water Management 32: 37–48.

Bainbridge, D.A. (2001). Buried clay pot irrigation: a little known but very efficient traditional method of irrigation. Agricultural Water Management 48: 79–88.

Batchelor, C., Lovell, C. and Murata, M. 1997. Simple microirrigation techniques for improving irrigation efficiency on vegetable gardens.Agricultural-Water-Management. 32(1): 37-48.

Balakumaran, K.N., Mathew, J., Pillai, G.R. and Varghese, K. 1982. Studies on the comparative effect of pitcher irrigation and pot watering in cucumber. Agric. Res. J. Kerala.20: 65-67.

Chigura, P.K. (1994). Application of pitcher design in predicting pitcher performance. Unpublished MSc Thesis, UK. Cranfield Institute of Technology, Silsoe College.

Dubey, S.K., Gupta, S.K. and Mondal, R.C. 1990. Response of ridgegourd to saline irrigation water applied through earthen pitchers. Transactions-of-Indian-Society-of-Desert-Technology.15: 53-61

Mondal, R.C. (1974). Farming with pitcher: a technique of water conservation. World Crops 262: 91–97.

Mondal, R.C. (1978). Pitcher farming is economical. World Crops 303: 124–127.

Mondal, R. C., Dubey, S. K. and Gupta, S. K. 1992. Use pitchers when water for irrigation is saline. Indian-Horticulture. 36(4): 13-15

Mondal, R.C. 1983. Salt tolerance of tomato grown around earthen pitchers.Ind. J. Agric. Sci. 53 (5): 380-382.

Okalebo, J.A., Home,P.G. and Lenga, F.K. 1995. Pitcher

irrigation, a new irrigation technique to curb the effects of salinization. Engineering the economy Proceedings 7th annual conference Kenya Society of Agricultural-Engineers, Jomo Kenyatta University of Agriculture and Technology, Kenya,4-15- December-1995.: 15-21.
Pal, A., Adhikary, R., Bera, M., and Garanayak, R. (2020). Pitcher irrigation: a water saving technique in arid region. International Journal of Engineering, Science and Mathematics. 9(2): 50-57.
Pachpute, J.S. 2010. A package of water management practices for sustainable growth and improved production of vegetable crop in labour and water scarce Sub-Saharan Africa. Agricultural Water Management. 97(9): 1251-1258.
Rai, S.N. 1982. Pitcher farming. ADAB News. 9 (3): 24-28.
Thingujam, U., Adhikary, R., Senjam, P., Pal, A. and Kumar, HK (2017). Effects of Pitcher Pot Irrigation on Chilli Production. International Journal of Engineering, Science and Mathematics 6: 1140-1146, (December 2017).
Thingujam, U., Adhikary, R., Senjam, P., Pal, A., Kundu, D., and Khanam, R. (2017). Pitcher Pot Irrigation- A Review Study. International Journal of Trends in Bioscience 10(45):9467-9469, 2017.
Tripathi, S.K., Sharma, B., and Meena S.K. 2017. Pitcher irrigation system: A water saving approach. Indian Farmer 4(8): 696-699.
Stein, T.M. (1997). The influence of evaporation, hydraulic conductivity, wall-thickness, and surface area on the seepage rates of pitchers for pitcher irrigation. Journal of Applied Irrigation Science 321: 65-83.
Sheng, H.S. (1974). Fan Sheng-Chih Shu: An Agriculturist Book of China, Written by Fan Sheng-Chih in the First Century BC. Science Books, Beijing, pp. 36-37.
Soomro, A.A. (2002). Viability of pitcher irrigation. Daily Dawn Karachi. 6th May issue. http://www.dawn.com/2002/05/ 06/ebr12.htm. Accessed on May 11, 2009.
Setiawan, B.I., Saleh, E. and Nurhidayat, Y. (1998). Pitcher irrigation system for horticulture in drylands. [Proc. of Water and Land Resources Development and Management for Sustainable Use. Vol. II-A. The Tenth Afro-Asian Regional Conference. ICID-CIID, INACID, Denpasar-Bali, Indonesia, p. 10.
Scheuring, A.F Ed. 1983. A Guidebook to California Agriculture.UC Press, Berkeley. 17(2): 5-6.
Saha, A., K., Chakraborty, R., Thapa, U. and Ghanti, P. 2005. Growth and yield of pumpkin [Cucurbitamoschata (Duch.) Poir] as influenced by different methods of irrigation. Journal of Interacademicia. 9(1): 28-32.