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Clay pot irrigation of young coffee seedling under Pulney hills of Tamil Nadu, India

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ABSTRACT

Coffee is grown as a rain fed crop at different regions in India. The economic returns of coffee cultivation are primarily dependent upon the amount, intensity and distribution of rainfall received during the growth and developmental periods. The Pulney hills situated at Tamil Nadu is receiving only 20% of the rainfall which will be received during South West monsoon and the remaining 80% of the rainfall will be received during the North East monsoon periods. Hence, North Eastern and South Western monsoon plays a very crucial role in providing precipitation in coffee growing belts of South India. Therefore, the rainfall received by South - West and North - East monsoons were not sufficient for the initiation and establishment of young coffee seedlings. This was due to the prevalence of long dry spells ranging from 3 to 6 months, less water holding capacity and low infiltration rate of the soil also make coffee seedlings prone to moisture stress and it also leads into death of the young plants. At plantation management level, the initiation, pitting, planting and establishment of planted coffee are proved to be serious problems due to the moisture stress. To mitigate this problem, the only practical solution is to overcome moisture stress in soil and young coffee seedling at field conditions by maintaining sustainable moisture conditions. The clay pot irrigation technology is found to be suitable for establishment of young coffee seedlings.

Key Words: Coffee, clay pot, irrigation, Pulney hills, moisture stress.

INTRODUCTION

The most common problem in tropical and sub-tropical tracts ofTamil Nadu in the last three decades was the lack of water due to continues droughts. This has brought about food insecurity at household level as a result of low food production to meet the demands of the ever increasing population in our country. It is therefore prudent for scientists to think of conservation and efficient utilization of water to maximize production per unit volume of the limited available water resources. Water scarcity is never felt if it is needed only for few plants, especially where water is easily available and is in abundance. However, if many plants have to be watered and the water source is far away, regular watering may sometimes become a problem. Even if watering is accomplished, much of the water may be lost due to evaporation, especially under very hot and dry conditions during the summer, and also water loss may also occur due to deep percolation and seepage beyond the rootzone in sandy soils or laterite soil where places located in subtropical hills of Tamil Nadu.These problems generally more acute in arid region of Tamil Nadu but nowadays places like tropical and subtropical condition also getting into

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the same problem. This was mainly because of erratic rainfall, less distribution and varying degrees of rainfall intensity with the change of climate. Best example is Tamil Nadu, Pulney hills region like Thandigudi, Pannaikadu, Perumparai, Perumalmalaiand Mangalamkombu were received erratic North –East monsoon on 2010 onwards (Table 1). The rainfall data was collected from Regional Coffee Researech Station, Thandigudi. The plating and establishment of these subtropical crops like Coffee, Orange and other tree spices require particular attention with regard to water availability for irrigation especially during the first year of establishment and up-to three years. This problem was more prevalent in most of the Pulney hills of Tamil Nadu region. To meet the water scarcity in rain fed areas of Tamil Nadu, buried clay pot irrigation technology is the only alternative solution in order to save the young seedlings in the planted area and to increase the survival of plants and better establishment and it will further increase the yield levels. Inexpensive small-scale irrigation method is still much practicing in the semi-arid regions of Karnal in the state of Haryana, India

The clay pot can be made of locally available clay and it's made of into a congenial standard shape and size with some specification. Clay pot irrigation technology in Coffee is simple and efficient technological device which entails in the creation of rural employment, savings on scarce water resources and reduction in irrigation frequency in order to establish well rooted seedling in early days. Soil is packed around the necks of the pots so that their rims protrude a few centimeters above the ground surface. Since the walls of the pots are porous, the water can seep slowly out and reach the roots of the recently transplanted coffee plant that provides the congenial and optimum soil moisture conditions in the rhizosphere region (Bainbridge *et al*., 2001). It is more depends on the suction capacity of the soil in the rhizosphere (Fig 1). Sub-surface irrigation using unglazed porous clay pots is an ancient method still practiced today in several countries, notably Iran and Brazil. This is an adaptation of an ancient method of irrigation that is thought to have originated in Africa of about 4,000 years ago. It uses the porous nature of clay pots to allow osmotic pressure to suck the water into the soil where it is needed (Bainbridge, 2001).

PRINCIPLE

The clay pot used for irrigation is an unglazed indigenous earthen pot which has many micro pores in its wall. The micro porous wall does not allow water to flow freely from the pot, but guides water seepage from it in the direction where suction develops. When buried neck deep into the ground, filled with water and Coffee planted adjacent to it, the negative suction developed by the respiration of the roots (region of lower water concentration) acts on the porous wall of the clay pot (region of higher water concentration) inside the soil, it in-turn oozes water molecules from the clay pot through the semi-permeable membrane (Clay pot wall). The root system involves in the translocation of these water molecules through xylem cells and finally into the plant system, so that the turgid pressure inside the plant was developed. The better moisture and dissolved nutrients in the form of ionic were taken by the plant this made them to escape from the wilting and death of the plant, due to the moisture stress and prolonged drought. Continued supply of moisture at the root system will override the soil temperature and moisture stress shock.

Choosing and manufacture of right clay pot

1) The number and size of the clay pots needed are depends on the spacing between plants and rows. Two to five liters is convenient for one year old young Coffee seedling, but larger pots of ten to twenty liters could be used for two to three year old coffee plants.
2) Testing of porous nature of the clay pot was carried out by spraying them with water or filling them with water. If the surface becomes damp rapidly, they are porous.
3) If pots need to be made especially for this purpose, then experiment with different wall thickness and types of clay before producing a lot of pots. The firing temperature should be below 1000°C. Copper melts at 1083°C. A copper bead can be put into the kiln to help to manage the temperature.
4) The rims of the pot can be painted with non-toxic white paint to further reduce evaporation and make the pots more visible. This will help you to see the position of the pot and stop water evaporation. If the roots of the plant are quite deep, the upper part of the pot could be painted with varnish or plastic paint so that less water escapes from the top of the pot.
5) The pots need lids. Lids must fit firmly to stop livestock from drinking the water, and prevent mosquitoes and other creatures living inside. A

small hole in the lid will allow rainwater to drain into the pot.

Steps involves in placing of clay pot in the field

1) Dig out the Pit size of about three times as wide and two times as deep as the buried clay pot. Break up the soil at the bottom of the hole with a fork.
2) Mix 1⁄3 compost or well decomposed manure with soil that was removed from the hole, break up the clods. If the soil is very heavy, mix it with some sand. If the soil is very acidic add some hand full of lime.
3) Place enough soil mix in the hole so that the top of the clay pot will be 2 cm above the land surface. Set the pot in place, with the lid on. Fill around the pot with the soil mix, and firm it up. Fill the buried clay pot with water and put the lid back on.
4) Once the pot is fixed in the place, it is time to plant the young coffee seedlings at that place, Or If there was already transplanted with Coffee seedling in the main field, dig the proper sized pit and fix the clay pot or vice versa. But you should be sure about the space of wetting/wetting zone. In most soils, plants should be placed within 1 to 3 cm of the outer edge of the buried clay pot. The spacing of the pots depends on the age of coffee seedling and root spreading (Alemi, 1980).
5) Space between plants must be on one side of the clay pot to make lifting the lid and refilling easier when the plants are fully grown. On planting, a small amount of water should be added to the transplant to help start off the seepage of water from the clay pot.
6) Checking the pots regularly and avoid them from dry out. The time between refills will vary during the growing season. Small pots will need refilling every few days, whereas large pots could last two or three weeks between top ups.
7) The completely diluted organic manures should be supplied through pot irrigation.

Merits of clay pot irrigation in coffee seedlings

1. It's up to 10 times more efficient than watering with can or buckets to young coffee plants because less water is needed and also it is more feasible to do with a rainwater catchment system and a cistern as water source (Daka 2001).
2. It works well with transplants or direct seeding, and helps improve seed germination and establishment even in very hot, dry conditions
3. It's less work to the farmer. There will be less water to fetch and carry, and less weeding to do because the water in the pot is given to the crop, not to weeds. Using buried clay pot irrigation with a treadle pump attached to a hosepipe makes for further labour savings
4. It's good for the soil structure. Because water is not poured on to the soil, the seedbed stays loose and plenty of air can circulate
5. Soil amendments like manure, compost or inorganic fertilizer can be placed where they will help the crop and not the weeds.
6. It's cheaper and more reliable than many high tech drip irrigation systems, which are more likely to be clogged up by insects or damaged by animals and usually require flat fields. The whole system can be made with locally available materials and skills, and doesn't need a pump to work. As long as the farmer keeps checking the pots, the system cannot fail. It is commercially practiced in the semi-arid regions of Karnal, Haryana state, India (Mondal *et al*., 1987)
7. It's good for business. The people who make the pots can sell more pots and lids.
8. It can be used without pressurized water systems, which can be difficult to establish and maintain at remote sites.
9. The water requirement is only once every one to two weeks, unlike a drip system where even a short interruption in power supply or water can cause extensive diebacks and plant failure.
10. This method of irrigation results in zero percent of transpiration loss and the water will reach directly into the rhizosphere
11. Nutrient flux and ionic movement is more in the soil due to the moist soil condition
12. The nutrient fixation especially K+ and other micronutrients is least and the rate of nutrient availability is maximum so the nutrient deficiency may be overcome
13. Soil microbial functions will be enhanced due to the readily dissolving of organic Carbon and humic acids in the soil sub-surface
14. It helps in maintaining the soil temperature at optimum levels
15. Weed number, weed intensity and weed biomass will be minimum and the Crop-Weed completion for water will be reduced to the maximum extent .

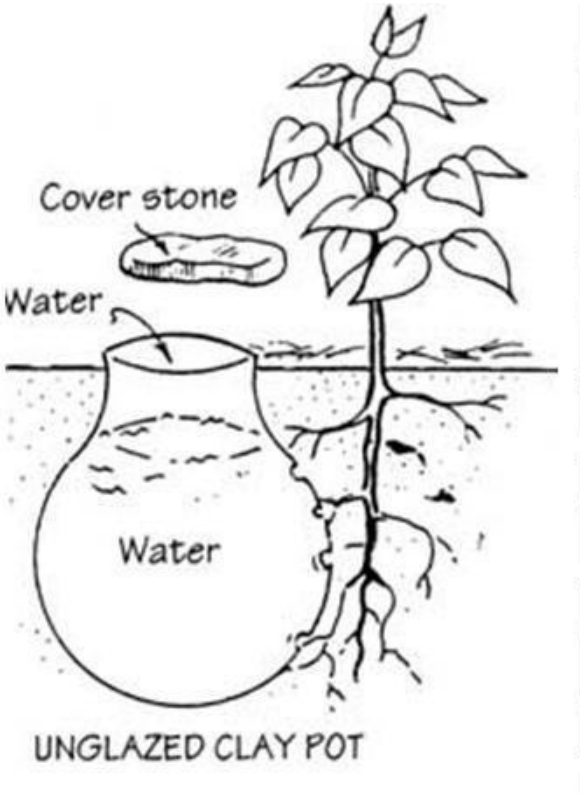

Fig. 1. Clay pot technique used near to the Rhizosphere of the plant.

Table 1. Rainfall data of Region Coffee Research Station, Thandigudi (Pulneys hills)

Month	Rainfall 2010	No. of rainy days	Rainfall 2011	No. of rainy days	Rainfall 2012	No. of rainy days	Rainfall 2013	No. of rainy days
January	15.12	1	7	1	16	1	0	0
February	0	0	35	2	13	1	63	5
March	13.13	2	22	2	3	0	50	4
April	153.62	8	179	11	99	5	80	5
May	102.87	11	104	7	226	16	71	5
June	130.94	12	23	3	77	3	113	6
July	153.17	6	110	6	10	2	8	1
August	125.7	7	324	13	327	15	111.5	10
September	219.32	9	112	11	87	8	240.5	14
October	354.84	16	286	21	265	14	137.2	10
November	552.84	21	423	13	75	2	45.75	7
December	133.96	12	76	2	24	2	78	4
Total	**1955.51**	**105**	**1702**	**92**	**1220**	**69**	**996.65**	**71**

16. The maintenance cost is least
17. The root length, root girth, root mass was more in the clay pot irrigated than the surface method of irrigation and the nutrient extraction from the deeper layers was also more in clay pot irrigation
18. It supplies the water for honey –bees so as the honey bee activity will be enhanced and crop pollination will be maximum

Demerit of clay pot irrigation in coffee seedling

1. Inter-cultivation between the rows is not possible
2. Chances of breakage/damage by wild animals and also bullocks
3. The pots may not be durable for longer periods in the field
4. Digging and fixing of clay pots during the installation period requires more labour and time.
5. More initial cost
6. Rarely, buried clay pots are also invaluable in areas affected by salinity or where saline water is the only water available (Okalebo *et al*., 1995).

DISCUSSION

Sheikh and Shah (1983) reported that in Pakistan using of buried clay pot irrigation to establish acacia (*Acacia* spp.) and eucalyptus (*Eucalyptus* spp.) trees seedlings in an area which receive 8 inches (200 mm) of annual precipitation. The trees irrigated with clay pots grew 20 percent taller than trees that were hand-watered at the same rate. The clay pot irrigation increased survival from 65 percent to 96.5 percent. Kurian *et al*. (1983) also used buried clay pot irrigation to grow Prosopis (*Prosopis* spp.) seedlings. In that case, trees irrigated with clay pots were more than three times taller than rain fed trees and 70 percent taller than surface-irrigated trees. By providing stable soil moisture around the pot, the clay pot system may also allow seeds in the soil bank to germinate and grow. We have found that unplanted annuals have germinated and set seed on clay pot sites while the surrounding area remained barren. This leads me to think that seeding in combination with buried clay pots may be a reasonable alternative to planting container-grown plants—and may prove to be much cheaper. Buried clay pots also allow restoration to place both water and soil amendments where they will benefit seedlings rather than weeds. For example, Reddy and Rao (1980) found that the dry weight of weeds in crops irrigated by buried clay pots was only 13 percent compare to weeds where in control plots irrigated by basin irrigation. Buried clay pots are worth considering in areas where water is expensive, water supplies are limited and drainage is rapid. They should also be used to solve problems at landscaping and re-vegetation sites (Mondal, 1983).

CONCLUSION

Earlier studies conducted on various agricultural and plantation crops at various research stations situated in India and around the world, concluded that the utilization of clay pot irrigation was found to be advantageous in terms of growth and establishment of different crops. The present study is also revealed similar conclusions were the utilization of clay pot irrigation was found to be beneficial in terms of growth and establishment of young coffee seedlings at Pulney hills, Tamil Nadu. Prevailing climatic conditions at Tamil Nadu exhibited that, uneven distribution of rainfall pattern and decrease in quantum of rainfall. In the present study, the rate and quantum of water applied was very less and the minimization of water transpiration was too less in clay pot irrigation. The rate and percentage of death of seedlings due to moisture stress was minimized and the percentage of mortality rate of the young seedling was also noticed at minimal. Therefore the adoption and practicing of clay pot irrigation in scare and scanty rainfall areas like Tamil Nadu, Karnataka and Kerala states of Southern India will be of high advantageous and it would result in maximum establishment of young coffee seedlings, maintenance the optimum number of plant population, minimization of crop- weed competition and better economic returns in coffee plantations.

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